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The EU Green Deal
2024 edition

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Research Project Report
December 2024

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Report: The EU Green Deal: 2024 edition

December 2024

Published in December 2024 by the European University Institute.
Badia Fiesolana, via dei Roccettini 9
I – 50014 San Domenico di Fiesole (FI)
Italy
https://www.eui.eu/en/home

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

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The European Green Deal: 2024 edition

Abstract

In this report, we focus on the fundamentals of energy and climate policy as reformulated in the EU Green Deal. The 2024 edition of this report includes updates following the adoption of the Fit for 55 Package, the REPowerEU Plan and the recent reforms of electricity and gas markets in Europe. The reader is guided through the landscape of EU policies to achieve climate neutrality by 2050. Starting with the big picture of the foundations of energy and climate policy, we then move to discuss in more detail European climate policy, security of energy supply and energy networks. We continue with energy wholesale and retail markets, and with a closer look at energy innovation. Then we provide a comprehensive overview of sustainable finance, and we finish with an insight into circular economy. Each chapter is divided into several sections, aiming to give the reader a broad overview of the policy areas that are impacted by the EU Green Deal. The references at the end of each section serve as suggestions for further reading on each topic.

Keywords: *EU Green Deal, Fit for 55 Package, EU Clean Energy Package, Electricity Market Design Reform, EU Hydrogen and Decarbonised Gas Markets Package, REPowerEU Plan, EU climate policy, Green Deal Industrial Plan, security of supply, energy markets, energy innovation, energy, electricity, gas, policy pillars, EU institutions, EU treaties, legislation, subsidiarity, solidarity, EU organisations, EU agencies, international climate agreements, EU ETS, carbon-border adjustment mechanisms, WTO, renewable energy policy, energy efficiency policy, network planning, TYNDP, TEN-E, offshore networks, distribution, resource adequacy, capacity mechanisms, TEN-T, strategic autonomy, critical raw materials, just energy transition, energy poverty, energy wholesale markets, retail markets, new deal, energy system integration, smart cities, electro mobility, energy technology, data exchange and interoperability, digital transformation, clean molecules, hydrogen, sustainable finance, greenwashing, climate finance, carbon dioxide removal, circular economy, water and sanitation services, municipal waste management, methane emissions, biogenic methane emissions.*

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List of abbreviations

ACER	Agency for the Cooperation of Energy Regulators
AFID	Alternative Fuel Infrastructure Directive
AFIR	Alternative Fuel Infrastructure Regulation
APLMA	Asia Pacific Loan Market Association
ARCI	ACER Retail Competition Index
ATR	Auto-Thermal Reforming
ATSOI	Association of Transmission System Operators in Ireland
BAU	Business as Usual
BCM	Billion Cubic Metres
BECCS	Bio-Energy Carbon Capture and Storage
BIP	Biomethane Industrial Partnership
BRPs	Balance Responsible Parties
BSPs	Balancing Service Providers
CACM GL	Capacity Allocation and Congestion Management Guideline
CAP	Common Agricultural Policy
CAPEX	Capital Expenditure
CBA	Cost-Benefit Analysis
CBAM	Carbon Border Adjustment Mechanism
CBI	Climate Bonds Initiative
CCAC	Climate and Clean Air Coalition
CCfD	Carbon contracts for difference
CCHP	Combined Cooling, Heat and Power
CCUS	Carbon Capture, Use and Storage
CDM	Clean Development Mechanism
CDP	Carbon Disclosure Project
CDR	Carbon Dioxide Removal
CDSB	Climate Disclosure Standards Board
CEC	Citizen Energy Community
CEAP	Circular Economy Action Plan
CEER	Council of European Energy Regulators
CEP	Clean Energy for all Europeans Package
CHP	Combined Heat and Power
CJEU	Court of Justice of the European Union
CM	Capacity Mechanism
CMA	Conference of the Parties Serving as the Meeting of the Parties to the Paris Agreement
CMP	Conference of the Parties Serving as the Meeting of the Parties to the Kyoto Protocol
COP	Coefficient Of Performance
COP	Conference Of the Parties
CPR	Construction Products Regulation
CRM	Critical Raw Material
CRMA	Critical Raw Materials Act
CSRD	Corporate Sustainability Reporting Directive
DACCS	Direct Air Carbon Capture and Storage
DC NC	Demand Connection Network Code
DR	Demand Response
DRI	Direct Reduced Iron
DoEAP	Digitalisation of Energy Action Plan
DSOs	Distribution System Operators
WFD	Drinking Water Directive
DWS	Deutsche Asset & Wealth Management
EAEC	European Atomic Energy Community
EB GL	Electricity Balancing Guideline
EC	European Commission
ECA	European Court of Auditors
ECB	European Central Bank

ECHA	European Chemicals Agency
ECRB	Energy Community Regulatory Board
EE	Energy Efficiency
EEA	European Environment Agency
EEC	European Economic Community
EED	Energy Efficiency Directive
EER	Energy Efficiency Ratio
EERA	European Energy Research Alliance
EFRAG	European Financial Reporting Advisory Group
EGD	European Green Deal
EGDIP	European Green Deal Investment Plan
EIB	European Investment Bank
EIONET	European environment information and Observation network
EIP SCC	European Innovation Partnership on Smart Cities and Communities
EIPs	European Innovation Partnerships
ENNOH	European Network for Network Operators of Hydrogen
ENTSO-E	European Network for Transmission System Operators for Electricity
ENTSOG	European Network of Transmission System Operators for Gas
ENVI	Environment, Public Health and Food Safety
EP	European Parliament
EPBD	Energy Performance of Buildings Directive
EPCs	Energy Performance Certificates
EPR	Extended Producer Responsibility
EPREL	European Product Database for Energy Labelling
EPS	Emission Performance Standard
ER NC	Network Code on Electricity Emergency and Restoration
ERGEG	European Regulators' Group for Electricity and Gas
ESG	Environmental, Social and Governance
ESI	Energy System Integration
ESMA	European Securities and Markets Authority
ESO	Energy Saving Obligation
ETD	Energy Taxation Directive
ETF	Enhanced Transparency Framework
ETPs	European Technology Platforms
ETS	Emissions Trading System
ETSO	Association of European Transmission System Operators
EU	European Union
EUGBS	EU Green Bond Standard
EVs	Electric Vehicles
FCA GL	Forward Capacity Allocation Guideline
FIT	Feed-In Tariff
FSR	Florence School of Regulation
GATT	General Agreement on Tariffs and Trade
GBP	Green Bond Principles
GCs	Green Certificates
GHG	Greenhouse Gas
GIE	Gas Infrastructure Europe
GLE	Gas LNG Europe
GLP	Green Loan Principles
GRI	Global Reporting Initiative
GSE	Gas Storage Europe
GTE	Gas Transmission Europe
GWP	Global Warming Potential
H2020	Horizon 2020
HGMDP	Hydrogen and Decarbonised Gas Market Package
HVDC NC	Requirements for Grid Connection of High Voltage Direct Current Systems and Direct Current-connected Power Park Modules Network Code
ICMA	International Capital Market Association
ICT	Information and Communication Technology

IEA	International Energy Agency
IFRS	International Financial Reporting Standards
IIRC	International Integrated Reporting Council
IMEO	International Methane Emissions Observatory
IPCC	Intergovernmental Panel on Climate Change
IPCEI	Important Projects of Common European Interest
IRENA	International Renewable Energy Agency
ISSB	Sustainability Standard Board
ITS	Intelligent Transport Systems
JAO	Joint Allocation Office
JI	Joint Implementation
KP	Kyoto Protocol
LCOE	Levelised Cost of Electricity
LD	Landfill Directive
LDAR	Leak Detection and Repair
LMA	Loan Market Association
LNG	Liquified Natural Gas
LOHC	Liquid Organic Hydrogen Carrier
LSTA	Loan Syndications and Trading Association
LT-LEDS	Long-Term Low Greenhouse gas emission Development Strategies
LULUCF	Land Use, Land Use-Change and Forestry
MCF	Multilateral Climate Funds
MEPs	Members of the European Parliament
MFN	Most-Favoured-Nation
MMRs	Market Monitoring Reports
MRV	Measurement, Reporting and Verification
MSs	Member States
MSW	Municipal Solid Waste
NC	Network Code
NCEPs	National Climate and Energy Plans
NDCs	Nationally Determined Contributions
NEMOs	Nominated Electricity Market Operators
NFRD	Non-financial Reporting Directive
NGEU	NextGenerationEU
NGFS	Network of Central Banks and Supervisors for Greening the Financial System
NGOs	Non-Governmental Organisations
NORDEL	Organization of the Nordic Transmission System Operators
NPF	National Policy Framework
NRAs	National Regulatory Agencies
nZEBs	Nearly Zero Energy Buildings
NZIA	Net-Zero Industry Act
OECD	Organisation for Economic Cooperation and Development
OGCI	Oil and Gas Climate Initiative
OGMP	Oil and Gas Methane Partnership
OPAL	Ostsee-Pipeline-Anbindungsleitung
OPEX	Operational Expenditure
OTC	Over-The-Counter
PPA	Power Purchase Agreement
PPWD	Packaging and Packaging Waste Directive
PX	Power Exchange
R&I	Research and Innovation
RD&I	Research, Development & Innovation
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
REC	Renewable Energy Community
RED	Renewable Energy Directive
RES	Renewable Energy Sources
RfG NC	Network Code on Requirements for Grid Connection of Generators
RFNBOs	Renewable Fuels of Non-biological origin
RIs	Regional Initiatives

SAF	Sustainable Aviation Fuel
SBI	Subsidiary Body for Implementation
SBSTA	Subsidiary Body for Scientific and Technological Advice
SDAC	Single Day-Ahead Coupling
SDGs	Sustainable Development Goals
SDS	Sustainable Development Scenario
SECAP	Sustainable Energy and Climate Action Plan
SET	Strategic Energy Technology
SFDR	Sustainable Finance Disclosure Regulation
SMEs	Small and Medium Enterprises
SMR	Steam Methane Reforming
SO GL	Electricity Transmission System Operation Guideline
SRM	Strategic Raw Material
STEPS	Stated Policies Scenario
SUP	Single-Use Plastics Directive
TCMs	Terms and Conditions or Methodologies
TEN-E	Trans-European Energy Networks
TENs	Trans-European Networks
TEN-T	Trans-European Transport Network
TEU	Treaty on European Union
TFCFD	Task Force on Climate-related Financial Disclosures
TFEU	Treaty on the Functioning of the European Union
TPA	Third Party Access
TRIMs	Trade-Related Investment Measures
TSOs	Transmission System Operators
TYNDP	Ten-Year Network Development Plan
UCPTE	Union for the Coordination of Production and Transmission of Electricity
UCTE	Union for the Coordination of Transmission of Electricity
UKTSOA	United Kingdom Transmission System Operators Association
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UWWTD	Urban Waste Water Treatment Directive
VRE	Variable Renewable Energy
WEEE	Waste Electrical and Electronic Equipment
WFD	Water Framework Directive
WSS	Water and sanitation services
WTO	World Trade Organization
WW	Wastewater

Acknowledgements

This report was developed for the online training course on the 'EU Green Deal' organised by the Florence School of Regulation. The report aims to provide introductory reading material on the EU Green Deal and its policy areas relevant for energy, climate, sustainable finance, and the EU circular economy. The four editions of the training that took place in 2021, 2022, 2023 and 2024 brought together almost 350 participants from many different countries, more than half of whom were senior professionals from the private and public sector. Below we provide the infographics of the four course editions.

Like the Green Deal itself, this text is a collective work done by the course team and many of our colleagues at the Florence School of Regulation (FSR), the Florence School of Transnational Governance (STG) and the Florence School of Banking and Finance (FBF). We would like to thank them. Moreover, we would like to acknowledge our debt to the editors of the former editions of this text, namely Valerie Reif, Athir Nouicer, Leonardo Meeus and Leigh Hancher.

This text also benefited from the contribution of many participants of the training course who provided insights and remarks. We would like to thank them, especially those who provided significant contributions. You can find their names listed year on the basis of the edition oof the course they attended:

- ***First edition**: Hasanali Atalay, Julian Betge, Luka de Bruyckere, Nele Dhondt, Lisa Ferreira, Maria Teresa Galante, Maurin Hörler, Erik Kolstoe, Misha Odisharia, Paulo Prunzel, Herlita Bobadilla Robles, Giovanni Taglialatela, Nino Tsikhiseli, Lavinia Tanase and Faisal Wahid;*

- ***Second edition**: Justina Alsyte-Gogeliene, Maria Tereza De Alencar, Sofia De Paolis, Lisa Ferreira, Davine Janssen, Sofia Karagianni, Kateryna Kontsur, Tutana Kvaratskhelia, Patrícia Lages, Elisa Molinari, Andrew Morton, Yanming Ren, Gjorgji Shemov, Cristina Tararache, Tuomas Vanhanen and Joana Vieira;*
- ***Third edition**: Linda Austere, Olesea Ghedrovici, Malgorzata Pezak;*
- ***Fourth edition**: Pierre-Olivier Bigo, Ricardo Fernandez-Blanco Carramolino, Joelle de Sepibus, Norma Garcia, Sarah-Luise Grimm, Friedmar Hoppe and Roel van der Veen.*

The journey of the EU Green Deal has only just started, and its implementation will be a process taking place over the next 30 years. Therefore, this text has been continually updated. This 2024 edition considers updates to legislative proposals until July 2024.

Disclaimer: The editors did their best to ensure the accuracy and the update of the text. However, also due to the fast-changing policy landscape, it is possible that some information in the text is no more updated. The authors are responsible for any errors or omissions.

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Florence School of Regulation
November 2024

Introduction

In the aftermath of the elections to the European Parliament in June 2024, European leaders discussed what should be the EU's priorities for the next five years. A 'clean industrial deal' will likely play a central role, building on and expanding the European Green Deal (EGD), one of the key political priorities of the EU during the previous policy cycle.

When the former European Commission (EC) took office in December 2019 under the presidency of Ursula von der Leyen, it launched the EGD with the aim of making Europe the first climate-neutral continent by becoming a modern resource-efficient economy (von der Leyen, 2019). The deal defined a new growth strategy for Europe and included a dedicated roadmap to make the EU economy sustainable and achieve climate neutrality by 2050. It was followed up through multiple EU laws and strategies across a number of sectors. Some of the measures and policy areas addressed by the EGD relate to energy and climate while other go beyond EU energy policy but are nonetheless important to fight climate change.

Looking closely at the EGD and the policies that were adopted is important for a number of reasons. First, insights on the impact that the EGD had on EU legislation in different policy areas offer lessons on how an overarching political initiative like the upcoming clean industrial deal could shape policymaking over the next years. Second, even if the EU will shift its focus on the support of a competitive and clean industrial base in Europe, it is likely to remain committed to the implementation of EGD-related policies, which represents an ongoing process that will continue towards 2030 and beyond. Third, experiences from the making and implementation of EGD-related EU legislation will likely feed into further review and revision of such legislation, which is anticipated to follow once the EU adopts its climate and energy targets for 2040.

This report offers an overview of how the EGD emerged and the specificities of the many new or revised EU laws that have come about between late 2019 and mid 2024. The report focuses on the measures related to energy and climate policy, sustainable finance and the EU circular economy. The report contains seven chapters.

- In Chapter 1 we introduce the 'the big picture.' We start with an overview of the EU Green Deal and the Fit for 55 Package. We then move on to explaining the EU institutions and treaties, the subsidiarity and solidarity principles, EU agencies and organisations, and energy taxation.
- Chapter 2 focuses on EU climate policy. We cover international climate agreements, the EU ETS, carbon-border adjustment mechanisms and the World Trade Organization (WTO), and decarbonisation instruments such as renewable energy and energy efficiency policies.
- Chapter 3 covers EU security of supply policy. We define the concept of security of supply and discuss its application in the oil and natural gas and electricity sectors. We also explore resource adequacy and capacity mechanisms. We cover energy infrastructure planning and transport and (electro) mobility infrastructure. Finally, we discuss EU strategic autonomy as it relates to critical minerals and clean tech supply chains.

- Chapter 4 focuses on EU energy markets. We discuss electricity and gas wholesale and retail markets. We give an overview of the recent energy crisis and refer to mitigation measures that have been taken. We also look at the concepts of a just energy transition and energy poverty.
- Chapter 5 on EU energy innovation spotlights policies to promote the development of innovative energy technologies, smart city initiatives, digital transformation, green molecules and hydrogen.
- Chapter 6 introduces sustainable finance instruments, standards and principles, with a particular focus on green bonds. We reflect critically on the issue of greenwashing and share experiences with the financing of carbon removal projects.
- Chapter 7 investigates the EU circular economy. We give an overview of related legislative and non-legislative measures, with a specific focus on water and urban solid waste. We also discuss methane emissions and related mitigation measures.

This is the fourth edition of this report. The first one was produced in early 2021 as a reading material for the EU Green Deal training course that took place in late spring 2021 at the FSR. Following the publication of the Fit for 55 Package (Part I in July 2021, Part II in December 2021), the report was updated to reflect the changes that those packages brought to EU energy and climate policy. This second edition of the report, edited by Leigh Hancher, Leonardo Meeus, Athir Nouicer and Valerie Reif, was then published in late 2022 (Hancher et al., 2022). Later, in the context of the third edition of the training in late spring 2023, the report was expanded to include two new chapters dedicated to sustainable finance and circular economy respectively. The revision also took notice of the adoption, in Spring 2022, of the REPowerEU Plan and the several emergency measures adopted as a reaction to the war in Ukraine. A subsequent revision of the text in 2024 considered the full implications of the REPowerEU Plan on the Fit for 55 Package adopted in 2023 as well as the reforms of the electricity and gas markets adopted before the elections of a new European Parliament in June 2024. This last revision collects updates until July 2024. For the sake of simplicity, only the most substantial amendments adopted by the Parliament and the Council to EU climate and energy policy that have come to our attention are considered.

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Vonn der Leyen, U. (2019), 'A Union that strives for more. My agenda for Europe'.

1 The big picture

In Chapter 1 we introduce the 'the big picture' We start with an overview of the EU Green Deal. We then move on to explaining the subsidiarity and solidarity principles, the EU's institutions and treaties, energy taxation in the EU, and the key EU agencies and organisations in energy policy.

1.1. Past, present and future of the Green Deal

Athir Nouicer, Valerie Reif, Max Münchmeyer

In this section, we provide an overview of the European Green Deal. We first briefly contextualise it within the long history of EU energy and climate policy before then outlining its principal law and policy components. We further investigate how crises such as the COVID-19 pandemic and the Russian invasion of Ukraine have influenced the course of the Green Deal and look ahead at the principal challenges that the Green Deal will face in the coming years.

1.1.1 The foundations of the Green Deal: a brief history of EU energy and climate policy

In this subsection we present an overview of the evolution of EU energy and climate policy up to the inception of the European Green Deal in December 2019. We show that the Green Deal has its roots in a long history of EU energy and climate law and policy, the principal measures of which are shown in Figure 1.1.

Figure 1.1: Principal EU energy and climate measures (source: Dupont et al., 2024)

1.1.1.1 An Energy Policy for Europe and the 2020 Climate and Energy Package

Over the past seven decades, Europe's energy policy originally developed through various legislative measures addressing specific aspects of the EU's energy sector (based initially on different provisions in European Treaties, see also Section 1.2). It was only in 2007, however, that the European Union created a dedicated EU energy policy, which was referred to as 'An

Energy Policy for Europe'. This was proposed by the European Commission (EC, 2007) and endorsed by the European Council (2007) later that year.

The policy was based on three pillars defined in an earlier Green Paper on a European Strategy for Sustainable, Competitive and Secure Energy (Commission of the European Communities, 2006). The Green Paper was developed following a summit of EU Heads of State and Government in 2005, which underlined the role of an integrated approach to climate change, energy and competitiveness objectives. These three equally important pillars,[1] which remain an important foundation for EU energy policy, are:

- Sustainable development,
- Security of supply, and
- Competitiveness.

Sustainable development principles are among the key drivers of EU climate policy as the EU is committed to tackling climate change by reducing greenhouse gas (GHG) emissions.

Security of supply is a concept that is often discussed at the national and European levels, especially in times of crisis (see Section 3.1). Three ways were highlighted in the 'An Energy Policy for Europe' communication to promote energy security: (1) diversification of gas supply, especially in Member States depending on one gas supplier; (2) improving the functioning of the EU's strategic oil stock mechanism; (3) electricity interconnections together with binding and enforceable reliability standards.

The **competitiveness** pillar is based on integrated energy markets as its most crucial element. Competitiveness is considered key to bring down costs for citizens and industry and to stimulate energy efficiency and investments, in particular in renewable energy.

When they were introduced in EU energy policy in 2007, these pillars represented the three challenges in Europe's energy sector that the Internal Energy Market was expected to meet. The 'An Energy Policy for Europe' communication defined the following starting points to tackle these challenges: fighting climate change, limiting the EU's dependence on imported fuels and providing economic growth and jobs.

The 'An Energy Policy for Europe' communication led to the adoption of the 2020 Climate & Energy Package, a set of laws designed with the aim of ensuring that the EU would meet its climate and energy targets for the year 2020. The package set the so-called '20-20-20 targets':

- A 20% reduction in GHG emissions (compared to 1990 levels);
- At least a 20% share of renewables in the EU's energy consumption and at least a 10% share of renewables in the transport sector;
- A 20% energy consumption reduction target to improve energy efficiency (compared to a 2007 business-as-usual scenario).

The targets were agreed by EU leaders in 2007 and enacted in legislation in 2009. More concretely, a set of four main laws was developed to implement them:

- Renewable Energy Directive 2009/28/EC (RED I);
- Revised Directive on emissions trading 2009/29/EC (ETS Directive);

1 Note that the prominence of the individual pillars in the public policy debate changes over time as a function of the specific political circumstances, such as an interruption in the supply of fossil fuels or a spike in energy prices, as well as the strengthening of the environmentalist movements in the public opinion.

- Carbon Capture and Storage Directive 2009/31/EC;
- Effort Sharing Decision 406/2009/EC.

These legal acts were later complemented by the Energy Performance of Buildings Directive EU/2010/31 and the Energy Efficiency Directive 2012/27/EU.

Piebalgs et al. (2020) state that the EU was relatively successful in achieving the 2020 objectives, even though they came with relatively high costs, e.g. infrastructure investments and RES subsidy payments. This is confirmed by the EC (2022) which reported in its seventh State of the Energy Union report that, in 2020, the EU surpassed its targets on emissions reduction (32%), energy efficiency (5 to 6% lower than the 20% target) and renewables (22.1%), and even if figures rebounded in 2021, they remained below pre-pandemic levels.

1.1.1.2 *The 2030 Climate and Energy Framework*

In 2014, the European Commission announced a reform and transformation of Europe's energy policy. This came together with the European Council's endorsement of the 2030 Climate and Energy Framework (European Council, 2014), which set four key Union-level targets in the areas of GHG emissions, energy efficiency, renewable energy and electricity interconnection.

The 2030 Energy and Climate Framework built on the 2020 Climate and Energy Package. This framework was a non-legislative, political agreement adopted by the European Council (heads of state and government in EU Member States) that set the following targets for 2030:

- A reduction of at least 40% in economy-wide GHG emissions (from 1990 levels);
- An indicative target at the EU level of at least a 27% improvement in energy efficiency;
- A binding target at the EU level of at least 27% renewable energy consumption;
- Achieving the existing electricity interconnection target of 10% by 2020, with the objective of arriving at 15% by 2030.

The framework recognised the importance for all sectors to contribute to the achievement of the 40% GHG reduction target by both reducing emissions and increasing removals.

1.1.1.3 *The Energy Union*

The Energy Union Strategy, 'A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy', was launched by the Commission on 25 February 2015. This had been preceded by discussions, especially among Eastern Member States and members of the European Parliament, on security of supply. These actors were concerned about the relationship with Russia following the annexation of Crimea, as well as the gas disputes between Ukraine and Russia in 2006 and 2009. The Commission built on this, but expanded the initiative. The Energy Union was the way in which the Commission sought to pursue the EU's energy and climate objectives in a coherent fashion. The strategy was based on five mutually reinforcing dimensions:

- Energy security, solidarity and trust;
- A fully integrated European energy market;
- Energy efficiency contributing to moderation of demand;
- Decarbonising the economy; and
- Research, innovation and competitiveness.

These five dimensions could be seen as an evolution of the three pillars of the 2007 communication. The first dimension (energy security, solidarity and trust) built on the security of supply pillar. This reflected the Commission's vision that the Member States should rely on each other to securely and reliably deliver energy to citizens, based on solidarity and trust.

The second dimension (a fully integrated European energy market) built on the competitiveness pillar of the 2007 communication. The emphasis on this dimension reflected the need for a new political boost to complete the internal energy market, as was highlighted in the Energy Union Strategy. The strategy stated that *'the current market design does not lead to sufficient investments, market concentration and weak competition remain an issue and the European energy landscape is still too fragmented".*

The third dimension (energy efficiency contributing to moderation of demand) reflected the importance of energy efficiency, which was now included as a standalone dimension in the Energy Union Strategy. Energy efficiency should be considered a decarbonisation instrument and indeed an energy source on its own represented by energy savings.

The fourth dimension (decarbonising the economy) built on the sustainable development pillar of the 2007 Energy Policy for Europe. This dimension had two subcategories: an ambitious climate policy and renewable leadership. This aimed to contribute to the achievement of the EU-wide binding targets for GHG emissions and renewables, in line with commitments in the Paris Agreement that was signed a few months later (see Section 2.1).

The fifth dimension was Research and Innovation (R&I), which were given more weight and put in a standalone dimension. This highlighted the fact that R&I were to be at the heart of the 2015 Energy Union Strategy. According to the strategy, the European energy R&I approach should build on Horizon 2020[2] and focus on four core priorities: worldwide leadership on the next generation of renewable energy technologies; facilitating consumer participation in the energy transition; efficient energy systems; and more sustainable transport systems. It also considered the achievements of the European Strategic Energy Technology Plan (SET Plan; see Section 5.1) addressing the challenges involved in the commercialisation of innovative low-carbon technologies.

1.1.1.4 *From the Energy Union Strategy to the Clean Energy Package*

Following the 2030 Climate and Energy Framework (2014) and the Energy Union Strategy (2015), the Clean Energy Package (CEP) was presented by the Commission in November 2016 as the legislative way forward to implement the various targets and dimensions. The CEP included four directives and four regulations (see Section 1.3.4 for more details on the distinction between these elements):

- Energy Performance in Buildings Directive (EU) 2018/844;
- Renewable Energy Directive (EU) 2018/2001, commonly known as RED II;
- Energy Efficiency Directive (EU) 2018/2002;
- Governance of the Energy Union Regulation (EU) 2018/1999;
- Electricity Regulation (EU) 2019/943;
- Electricity Directive (EU) 2019/944;

2 Horizon 2020, commonly referred to as H2020, was a financial instrument bringing together EU research and innovation funding under the same common strategic framework. It was established in 2013 in Regulation (EU) No 1291/2013. In January 2021, Horizon Europe replaced Horizon 2020. Horizon Europe covers the financial period 2021-2027.

- Risk Preparedness Regulation (EU) 2019/941;
- ACER Regulation (EU) 2019/942.

The CEP also anchored the Union's 2030 targets for energy and climate in EU law (see Article 2(11) of the Governance Regulation), and in the process also adjusted two of them upwards:

- A Union-wide binding target of at least a 40% domestic reduction in economy-wide GHG emissions compared to 1990 levels;
- A binding target at the EU level of at least a 32% share of renewable energy consumed in the EU (increasing the 27% target originally agreed for 2030 by the European Council);
- An energy efficiency target at the EU level of an improvement at least 32.5% relative to a 2007 baseline scenario (increasing the 27% target agreed for 2030 by the European Council);
- A 15% electricity interconnection target.

The Governance Regulation for the Energy Union was introduced by the CEP, and requires the Member States to develop and submit National Energy and Climate Plans (NECPs). These are ten-year plans that include national objectives for each of the five Energy Union dimensions together with corresponding national policies and measures to achieve them. Member States have some flexibility in formulating their plans, but these must follow a template provided by the Commission and it is mandatory to submit the plans to the Commission. The European Commission can then guide Member States' action by issuing country-specific recommendations addressing the level of ambition of objectives and targets as well as policies and measures relating to those targets. The Commission also publishes reports summarising the state of the Energy Union. In October 2023, the European Commission published its eighth report on the state of the Energy Union (EC, 2023) following the requirements of Article 35 of the Governance Regulation. This was accompanied by a wide range of reports and annexes outlining the progress made in different fields of energy and climate policy. This monitoring is central to the functioning of the regulation. It aims to avoid gaps in reaching the EU targets for renewable energy and energy efficiency with warning signals and recommendations to Member States lagging behind.

1.1.2 The Green Deal (2019)

In December 2019, the European Commission presented the EU Green Deal. Compared to previous EU climate and energy packages and strategies, the Green Deal is broader in scope. It is a new growth strategy for Europe and a dedicated roadmap to make the EU economy sustainable and achieve climate neutrality by 2050 in an economically and socially just manner (relating to the concept of just transition, see Section 4.6, and especially 4.6.3).

This subsection describes the principal elements of the Green Deal: the policy areas covered; the Green Deal Roadmap; the European Climate law; the Fit for 55 Package; the Hydrogen and Decarbonised Gas Markets Package; the Green Deal Industrial Plan; and the financing pillar of the Green Deal. In addition, it assesses how the Green Deal has evolved and changed as the European Union confronted the energy crisis caused by Russia's 2022 invasion of Ukraine, addressed through the REPowerEU Plan.

1.1.2.1 The policy areas in the Green Deal

First outlined as a strategic priority in Commission President Ursula von der Leyen's political guidelines in July 2019 (von der Leyen, 2019), the European Green Deal was detailed in a Commission Communication in late 2019 (EC, 2019). Eight policy areas are covered and they are accompanied by additional actions that aim to mainstream sustainability in all EU policies, as is shown in Figure 1.2.

Figure 1.2: The EU Green Deal (source: EC, 2019)

- **Climate action**: Making the EU climate-neutral by 2050 is at the heart of the Green Deal. Therefore, the Green Deal includes a strong decarbonisation component, paving the way towards climate-neutrality. The European Climate Law enshrined the climate-neutrality objective in law. The European Climate Pact was introduced as an EU-wide initiative to engage citizens, communities and organisations in climate action. Finally,the 2030 Climate Target Plan 'Stepping up Europe's 2030 climate ambition' set in motion a process to update the EU's 2030 climate objectives, introducing a 55% reduction objective by 2030 relative to 1990 levels, and proposing sectoral targets aligned with this level of reductions. The revisions to EU law required by the Climate Target Plan were presented in the 'Fit for 55' Package.
- **Clean energy**: Decarbonising the EU energy system is critical to reach climate neutrality. This policy area is based on three fundamental principles: prioritising energy efficiency and renewable energies; a secure and affordable EU energy supply; and a fully integrated, interconnected and digitalised EU energy market.
- **Biodiversity measures**: The EU's ecosystem is fragile and needs to be protected. The EU biodiversity strategy for 2030 aims to put Europe's biodiversity on a path to recovery by 2030, targeting biodiversity loss drivers and bringing benefits to people, the climate and the planet.

- **From Farm to Fork/Sustainable agriculture**: Global food systems account for nearly a third of global GHG emissions and consume large amounts of natural resources, which means there is a need to redesign them (EC, 2020a). The 'From Farm to Fork' strategy aims to ensure a healthier and more sustainable EU food system. Related to this was a reform of the Common Agricultural Policy (CAP) for the period 2023-27, agreed in December, aligning the Policy with the Green Deal's sustainability objectives and the 'Farm to Fork' Strategy.
- **Sustainable industry and circular economy**: EU industry should be helped to evolve and make the most of domestic and global opportunities. The European Industrial Strategy, which is based on circular economy principles, aims to support the green transformation. In March 2020, the European Commission adopted the Circular Economy Action Plan. It included initiatives along the entire life cycle of products, with the aim of ensuring that waste is prevented and resources used are kept in the EU economy for as long as possible (see Chapter 7 for more on the EU's circular economy policy). Additionally, in March 2023 the Commission put forward a Green Deal Industrial Plan, aimed at securing the EU's strategic autonomy and competitiveness in the cleantech sector (see Section 3.5).
- **Building and renovating**: The European Commission recognises the need to develop a cleaner construction sector and to start a wave of building renovation to help people cut their energy bills and decrease their energy use. The Renovation Wave Strategy aims to improve the energy performance of buildings, leading to higher energy and resource efficiency. The Commission targets at least double renovation rates by 2030. Thirty-five million buildings could be renovated by then and up to 160,000 additional green jobs created (EC, 2020b).
- **Sustainable mobility**: The Green Deal includes measures to reduce transport emissions by promoting more sustainable means of transport. The Sustainable and Smart Mobility Strategy lays the foundations for the future EU transport system. The strategy aims to achieve a green and digital transformation and make the transport system more resilient. The objective is to create a transport system that is smart, competitive, safe, accessible and affordable.
- **Eliminating pollution**: The Green Deal includes a plan to protect Europe's citizens and ecosystems and prevent air, water and soil pollution. The Zero Pollution Action Plan includes measures to cut pollution rapidly and efficiently. It aims to reach no pollution from *'all sources'* and clean the air, water and soil by 2050.

These policy areas are founded on the overarching factors of making sure that adequate financing is available for the transition to net zero (see Section 1.1.2.5) and the principle of pursuing this transition in a socially and economically inclusive way (see the material on just transition in this course text, Section 4.6).

1.1.2.2 *The Green Deal roadmap*

The publication of the European Green Deal Communication (2019) was only the beginning of the long journey towards 2050. In general, all EU actions and policies are now expected to contribute to the Green Deal objectives. The annex of the Communication included an indicative timetable for 47 key policies and measures to be implemented in the framework of the Green Deal. This initial roadmap is updated according to evolving needs and required policy responses.[3] So far, a large number of EU laws have been proposed, with most also adopted or whose formal adoption is pending.

1.1.2.3 *The European Climate Law*

In March 2020, the European Commission published a proposal for a European Climate Law (EC, 2020c). The aim was to complement the existing 2030 Climate and Energy Framework by setting the long-term direction of travel towards 2050 and turning the political Green Deal commitment to achieve climate neutrality by 2050 into a legally binding obligation.

Later that year, and based on the 2030 Climate Target Plan, the European Commission published an amended proposal for the European Climate Law (EC, 2020d). In addition to setting the long-term direction towards 2050, it introduced an intermediate target for 2030. The GHG reduction target for 2030 would be raised from at least 40% (as had been previously agreed under the 2030 Climate and Energy Framework) to at least 55% compared to 1990 (EC, 2020d). In April 2021, the Council and the Parliament reached agreement on the proposal. The regulation entered into force in July 2021 (EP and Council, 2021a). The law establishes a framework for achieving climate neutrality within the EU by 2050, i.e. a balance between EU-wide GHG emissions and their removal regulated in EU law;

- in addition to the binding objective of climate neutrality in the EU by 2050, includes the aim of achieving negative emissions in the EU thereafter;
- recognises the need to enhance the EU carbon sink;[4]
- provides a binding EU target of a net domestic reduction in GHG emissions by at least 55% (compared to 1990 levels) by 2030;
- obliges the Commission to propose a climate target for 2040 within six months of the first global stocktake under the Paris Agreement;[5]
- introduces rules (e.g., monitoring and reporting) to ensure continual progress towards the global adaptation goal in the Paris Agreement;
- includes stronger provisions on adaptation to climate change and a commitment to engage with sectors to prepare sector-specific roadmaps for climate-neutrality.

The regulation establishes an independent European Scientific Advisory Board on Climate Change composed of 15 senior scientific experts with broad expertise, which provides independent scientific advice and issues reports on existing and proposed EU measures.[6]

Member States are required to take further actions, such as setting up climate advisory bodies and establishing a multilevel climate and energy dialogue with different stakeholders. They must submit their 30-year strategies to the Commission by 1 January 2029, and every 10 years after that.

Building on the process introduced by the Governance Regulation (see above, Section 1.1.3) the European Commission is required to regularly assess EU and national progress, including whether the measures at these levels are consistent and whether draft EU measures and legislation, including budgetary proposals, are consistent with the 2030, 2040 and 2050 targets.

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3 On its website, the European Commission provides a timeline of Green Deal actions from its inception in December 2019 to the present, available at https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en (last accessed 07 January 2022).

4 A carbon sink is a reservoir that removes carbon dioxide from the atmosphere.

5 On 6 February 2024, the European Commission (EC, 2024) proposed a 2040 greenhouse gas emissions reductions target of 90% relative to 1990 levels, following advice from the abovementioned European Scientific Advisory Board (2023).

6 More information on the advisory board is available at https://climate-advisory-board.europa.eu/ (last accessed 7 February 2022)

The updated GHG emissions reduction target for 2030 resulted in a need to revise all relevant policy instruments. In 2021, the European Commission adopted a series of proposals as part of the so-called ‘Fit for 55’ Package. These are described in the following subsection (see also Section 1.2).

1.1.2.4 The Fit for 55 Package

In July 2021, the European Commission published the first part of the Fit for 55 Package, which was followed by a second part, including the Hydrogen and Decarbonised Gas Markets Package (see Section 4.2.5), in December 2021.[7] In alignment with the updated GHG emissions target for 2030, the Fit for 55 Package proposed an update of other 2030 climate targets:

- a 40% share of renewable energy sources (RES) in the EU’s energy mix (an EU-level target to be realised through indicative national targets);[8]
- a 36% energy efficiency target for final energy consumption.[9]

The package consisted of several proposals. The following legal acts were proposed by the Commission on 14 July 2021:

- Revision of the EU Emissions Trading System – see Section 2.2;
- A Carbon Border Adjustment Mechanism – see Section 2.3;
- Review of the Effort Sharing Regulation;
- Revision of the Energy Taxation Directive – see Section 1.4;
- Amendment of the Renewable Energy Directive to implement the ambition of the new 2030 climate target – see Section 2.4;
- Amendment of the Energy Efficiency Directive to implement the ambition of the new 2030 climate target – see Section 2.5;
- Revision of the Regulation on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry (LULUCF);
- Revision of the Directive on deployment of alternative fuel infrastructure – see Section 3.4;
- Revision of the Regulation setting CO_2 emission performance standards for new passenger cars and for new light commercial vehicles (COM(2021) 556 final) – see Section 3.4.

In addition to these initiatives, the Social Climate Fund (see Section 4.5) and an EU Forest Strategy are also considered part of the Fit for 55 files.

The following legal acts were proposed by the Commission on 15 December 2021:

- A proposal for a regulation on methane emission reduction in the energy sector – see Section 7.4;
- Revision of the Energy Performance of Buildings Directive – see Section 2.5;
- Revision of the gas legislation in the Third Energy Package to regulate competitive decarbonised gas markets – see Sections 4.2, 5.4 and 5.5.

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7 If you want to know more about how the Fit for 55 gave a new shape to the EU energy policy, you can watch the recording of FSR Debate “Fit for 55 in approval phase: the new shape of the EU energy policy”, available at https://fsr.eui.eu/event/fit-for-55-in-the-final-approval-phase-the-new-shape-of-the-eus-energy-policy/

8 See section 2.4 for the current state of play.

9 See section 2.5 for the current state of play.

1.1.2.5 *Financing the EU Green Deal*

To achieve the Green Deal's ambition, significant investments will need to be made and sustained over time. In January 2020, the European Commission published a communication that detailed the investment pillar of the European Green Deal, the European Green Deal Investment Plan (EGDIP), also referred to as the Sustainable Europe Investment Plan (EC, 2020c). The EGDIP builds on contributions from the EU budget and national budgets to EU projects, and public and private investments mobilised by InvestEU and ETS funds, as is shown in Figure 1.3.

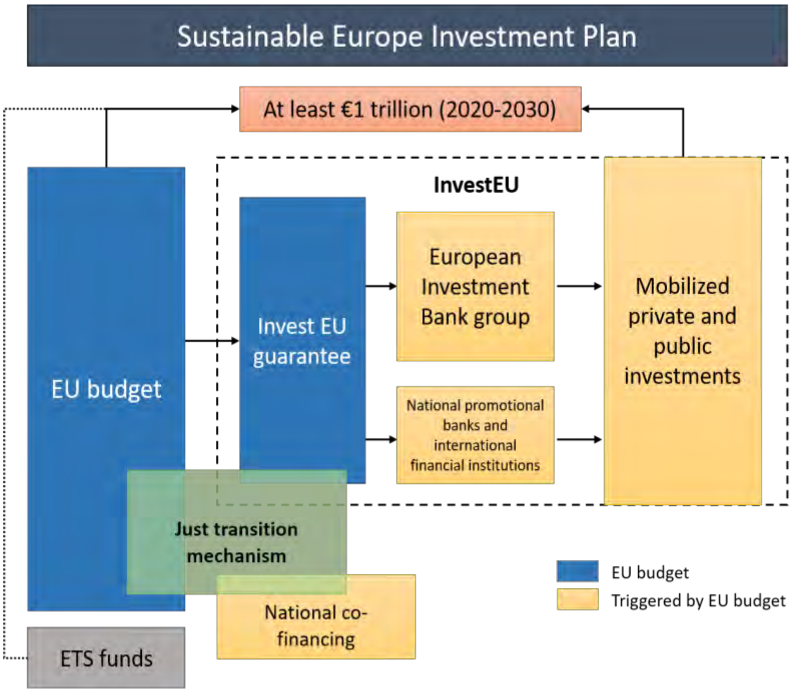

Figure 1.3: Conceptual overview of the mechanisms to finance the European Green Deal (modified from EC, 2020e)

The Commission has pledged to mobilise at least one trillion euros in sustainable investments over the period 2020-2030 to reach the updated 2030 climate and energy targets.

A significant contribution to the EGDIP comes from the EU budget. Thirty per cent of the EU's multiannual budget (2021-2027) and of the EU's unique NextGenerationEU (NGEU) instrument to recover from the COVID-19 pandemic has been allocated for green investments. Member States must use at least 37% of the financing they receive under the Recovery and Resilience Facility (which is part of the NGEU) for investments and reforms that support climate objectives. The Commission intends to raise 30% of the funds under NGEU through issuance of green bonds. It is expected that this high contribution from the EU long-term budget to the EDGIP will stimulate additional national co-financing of climate and environment projects.

A smaller contribution to the EGDIP comes from the Innovation and Modernisation Funds which are financed by a part of the revenue stemming from auctioning carbon allowances under the EU ETS.

The Just Transition Mechanism is designed to provide those most affected by the green economy transition with financial support and technical assistance.[10] It has three main sources of financing (EC, 2020b):

- A Just Transition Fund, used primarily to provide grants;
- A dedicated just transition scheme under InvestEU, which will crowd in private investments;
- A public sector loan facility with the European Investment Bank backed by the EU budget to leverage public financing and mobilise additional investments in the regions concerned.

The InvestEU programme is intended to provide the EU with crucial long-term funding by leveraging substantial private and public funds. Noteworthy is the inclusion of an EU budget guarantee that allows the European Investment Bank Group and other implementing partners such as national promotional banks and international financial institutions to invest in more and higher-risk projects. As is stated in the InvestEU Regulation (EU) 2021/523 (EP and Council, 2021), actions under the InvestEU programme are expected to contribute at least 30% of the overall financial envelope of the InvestEU Programme to climate objectives.

In addition, sustainable finance measures are foreseen to contribute to the European Green Deal by boosting and channelling private sector investment in green and sustainable projects. These measures include the Taxonomy Regulation (EU) 2020/852, which creates a common classification system for sustainable economic activities.[11] In essence, the Taxonomy Regulation requires that '*"green funding" will have to finance predominantly, if not exclusively, the commercial activities that are "taxonomy compliant"*' (Piebalgs and Jones, 2021), which will have an influence on the attractiveness of energy investments in the future. Jones et al. (2021) state that '*it is fair to expect that non-taxonomy aligned activities will become progressively more difficult, and more expensive to finance*'.[12] See also Chapter 6 on Sustainable Finance.

1.1.2.6 *REPowerEU*[13]

In response to the hardships and global energy market disruption caused by Russia's invasion of Ukraine, the European Commission presented the REPowerEU Plan in May 2022. This plan consisted of a set of proposals putting forward a strategy for saving energy, producing clean energy, and diversifying energy supply and imports. REPowerEU is backed by financial and legal measures to build the new energy infrastructure and system that Europe needs to dramatically accelerate its energy transition (in line with the Fit for 55 and Green Deal targets of, respectively, achieving at least -55% net GHG emissions by 2030 and climate neutrality by 2050) and increase its energy independence. The plan proposed a set of short-term measures as well as medium-term measures to be completed before 2027.

10 The Just Transition Mechanism is more than funding. It includes a governance framework and a Just Transition Platform, which is described in more detail in section 4.4.

11 More information about the EU taxonomy of sustainable activities and the most recent developments are provided by the European Commission at https://finance.ec.europa.eu/sustainable-finance/tools-and-standards/eu-taxonomy-sustainable-activities_en (last accessed 7 January 2023).

12 For more information on the EU Taxonomy, watch the recording of the FSR debate on Sustainable Finance and the EU taxonomy in June 2021, available at https://fsr.eui.eu/the-implications-of-sustainable-finance-and-taxonomy-for-the-energy-industry/ (last accessed 3 March 2022).

13 Link to more information on REPowerEU: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en .

The execution of the REPowerEU Plan saw the adoption of short-term market interventions (some of which are discussed in Section 1.2.4.3.) as well as revisions of some key components of the Fit for 55 legislative package, which were already being considered by the co-legislators at the time of publication of REPowerEU. Notable examples of this latter kind of intervention include the upward revision of the 2030 targets for renewable energy and energy efficiency. While the Commission had proposed a 40% target share of renewables in its July 2021 package, the REPowerEU Plan contributed to a target of 42.5% being included in the final legal act. Similarly, the 9% energy efficiency target proposed by the Commission in July 2021 was revised upwards to a 11.7% improvement target. Both of these Acts are discussed in greater detail in Sections 2.4. and 2.5. respectively.

A new European Solar PV Industry Alliance was launched as part of REPowerEU to enhance diversification of supplies through more diverse imports and to scale up solar PV manufacturing in the EU. The Commission approved 'IPCEI Hy2Tech', the first ever Important Project of Common European Interest (IPCEI) in the hydrogen sector that aims to develop innovative technology for the hydrogen value chain to decarbonise industrial processes and mobility. The EU, the US and eleven other countries have launched the Global Methane Pledge Energy Pathway to catalyse methane emissions reductions in the oil and gas sector to advance both climate progress and energy security.

With regard to diversifying energy supply, the EU Energy Platform[14] was set up to coordinate measures to secure alternative energy supplies for the EU, including through the voluntary common purchase of pipeline gas, liquified natural gas (LNG) and hydrogen. The EU has also strengthened its partnerships with a number of gas exporting countries, such as Norway, Egypt, Israel and Azerbaijan. To finance REPowerEU, the Commission proposed in May 2022 to use the Recovery and Resilience Facility (RRF). The RRF is a temporary recovery instrument to help Member States implement reforms and investments that are in line with the EU's priorities (in particular with a view to climate neutrality and the digital transition) and address country-specific challenges. Originally designed as an instrument to hep finance the EU's recovery from the COVID-19 pandemic as a key component of the Union's NextGenerationEU instrument, the RRF has always had a strong emphasis on supporting this recovery in a green, low-carbon manner. However, it has since become even more central to the EU's energy and climate policy, and Member States have added dedicated REPowerEU chapters to their recovery and resilience plans.

14 For more information, please see https://energy.ec.europa.eu/topics/energy-security/eu-energy-platform_en If you want to know more about the energy platform, you can watch the recording of FSR Debate "The EU Energy Platform: an insurance against energy market challenges?", available at https://fsr.eui.eu/event/the-eu-energy-platform-an-insurance-against-energy-market-challenges/

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1.2 Solidarity and subsidiarity

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In this section, we first give an overview of how competences are distributed between the EU and the Member States. We then explain the principles of subsidiarity and solidarity. Finally, we look at how these principles materialise in European energy policy.

1.2.1 The distribution of competences between the EU and the Member States

The Treaty on European Union (TEU) governs how competences are distributed between the EU and the Member States.[15] Article 5(1) of the TEU states that '*the limits of Union competences are governed by the principle of conferral. The use of Union competences is governed by the principles of subsidiarity and proportionality*' (OJEU, 2016). More concretely, the principle of conferral means that the EU can only act within the limits of the competences that have been conferred on it by the Member States in the EU Treaties. In turn, competences that are not conferred on the Union in the Treaties remain with the Member States.

The Treaty of Lisbon (signed in 2007 and in force since 2009) clarified the division of competences between the EU and the Member States. The competences that are conferred on the Union are defined in Articles 2-6 of the Treaty on the Functioning of the European Union (TFEU) and can be categorised in four types[16]:

- *Exclusive competence* (Article 3 TFEU): only the EU can act in these areas and adopt legally binding acts, e.g. customs union and monetary policy for the countries that use the euro.
- *Shared competence* between the EU and Member States (Article 4 TFEU): Member States can only act if the EU has chosen not to, e.g. internal market, trans-European networks, consumer protection, energy and environment. According to Declaration No. 18 annexed to the Treaty of Lisbon, Member States may ask the European Commission to repeal an adopted legislative act in one of the shared areas to ensure better compliance with the principles of subsidiarity and proportionality.
- *Supporting competence*: The EU can support, coordinate or supplement Member State actions without suspending their competence in these areas (Article 6 TFEU), e.g. protection and improvement of human health, industry, culture and tourism.
- *Special competence*: The EU sets up arrangements like broad guidelines within which EU countries must coordinate policy (Article 5 TFEU), e.g. economic policy.

1.2.2 The subsidiarity principle

The principle of subsidiarity as laid down in Article 5(3) of the TEU is fundamental in the functioning of the EU and European decision-making as it determines when the EU is competent to legislate. It applies to all EU institutions in areas in which competence is shared between the Union and the Member States.

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15 More information on the EU Treaties and EU institutions mentioned in this section is provided in section 1.3

16 See also the website of the European Commission, available at https://commission.europa.eu/about-european-commission/what-european-commission-does/law/areas-eu-action_en#:~:text=The%20European%20Union%20can%20only,EU%2C%20national%20governments%20or%20both. (accessed 15 March 2022).

Subsidiarity means that decisions (in areas in which the EU does not have exclusive competence) are to be taken at the level that is the closest possible to the citizen, i.e., local, regional or national. The principle also seeks to safeguard the ability of Member States to take decisions and actions and authorise interventions by the EU in case action at the Member State level is not sufficient to achieve the objectives of a proposed action. In other words, the EU should only become active when it is more effective (for reasons of scale or effects of the proposed action) than action at the national, regional or local level, and constant checks should be carried out to verify that EU action is justified in the light of the possibilities available at these levels.

Subsidiarity was first introduced in the TEU in 1992 alongside the principles of conferral and proportionality. The proportionality principle requires that any action by the EU should not go beyond what is necessary to achieve the objectives of the Treaties (Article 5(4) TEU). The Treaty of Amsterdam (signed in 1997) extended the subsidiarity principle by requiring that all legislative proposals be assessed for their impact on subsidiarity. The Treaty of Lisbon (signed in 2007) further strengthened the subsidiarity principle by introducing several mechanisms to monitor its application.

Two protocols annexed to the Treaty of Lisbon are important in terms of national parliamentary scrutiny:

- *Protocol No. 1 on the role of national Parliaments* requires closer communication with national parliaments during the legislative process and encourages their involvement in EU activities. It requires EU documents and proposals to be forwarded promptly to the national parliaments so they can examine them before the Council makes a decision.
- *Protocol No. 2 on the application of the principles of subsidiarity and proportionality* provides for greater consultation with the local and regional levels when drafting legislative proposals. It requires the European Commission to take into account the regional and local dimensions of all draft legislative acts and to make detailed statements on how the principle of subsidiarity is respected. Under an *ex ante* 'early warning' mechanism, national parliaments can object to a proposal on the grounds that it breaches the principle. Subject to a voting procedure laid down in Protocol No. 2, the proposal is reviewed ('yellow card') and may be maintained, amended or withdrawn by the European Commission. In the case that the European Commission decides to maintain its proposal, the matter is referred to the Parliament and the Council, which may approve or reject it ('orange card').[17]

After the adoption of a legislative act, there is also the option to initiate *an ex post* review of compliance with the principle of subsidiarity by means of a legal action before the Court of Justice of the EU. Member States may request the annulment of a legislative act on the ground of a breach of the principle of subsidiarity. The Committee of the Regions may also bring such actions before the Court in areas where the TFEU provides for it to be consulted.

17 Until October 2021, the 'yellow card' procedure had been triggered three times, while the 'orange card' procedure had never been used. For more information see for example https://www.europarl.europa.eu/factsheets/en/sheet/7/the-principle-of-subsidiarity#:~:text=In%20areas%20in%20which%20the%20EU%20does%20not%20have%20exclusive,States%2C%20but%20can%20be%20better (accessed 15 March 2022).

1.2.3 The origin of the solidarity principle

The foundation of the European Union as we know it today was based on two core principles: peace and solidarity. The founding principle of solidarity was included in the Schuman Declaration of 9 May 1950, in which the French foreign minister Robert Schuman proposed the creation of a European Coal and Steel Community: '*Europe will not be made all at once, or according to a single plan. It will be built through concrete achievements which first create a de facto solidarity'*.[18]

De facto solidarity in energy was at the heart of the European project from the very beginning. Jacques Delors, former president of the European Commission (1985-1994), described it as follows:

> "*Back in 1951, six European countries decided to pool their interests in two key areas of the economy in order to create a Community designed to replace conflict with cooperation and animosity with prosperity. Energy was one of those areas and solidarity was one of its founding principles*" (Andoura, 2013).

The European Union was later founded on the basis of core values that are common to the Member States, one of which is solidarity, as is laid out in Article 2 of the TEU signed in 1992:

> "*The Union is founded on the values of respect for human dignity, freedom, democracy, equality, the rule of law and respect for human rights, including the rights of persons belonging to minorities. These values are common to the Member States in a society in which pluralism, non-discrimination, tolerance, justice, solidarity and equality between women and men prevail*" (OJEU, 2016).

1.2.4 Solidarity and subsidiarity in European energy policy

Energy had long been an area driven by national independence and sovereignty, with Member States unable to develop a common energy policy. In fact, the European Union did not gain formal, shared competence in energy until the Treaty of Lisbon, discussed in detail below (see also Section 1.2 above). Until today, Member States retain the right to determine their choice of energy sources and the overall structure of their energy supply. The resulting diversity is mirrored in the different energy mixes in Member States.

In spite of Member States closely guarding their sovereignty in energy matters, the European Commission has for a long time considered solidarity to be an important cornerstone of European energy policy and argued that such solidarity goes hand-in-hand with greater market integration. In its 1995 White Paper on 'An Energy Policy for the European Union', the Commission already acknowledged *'the fact that the integration of the Community involves greater solidarity in the energy choices made by each of the Member States'* (EC, 1995, para. 6). However, it was not until 2005, at an informal summit at Hampton Court, that the Heads of State and Government laid the foundations for a common and ambitious European energy policy. This was a response to growing concerns about climate change, increased energy prices, a growing dependence on foreign supplies of fossil fuels and problems with supplier and transit countries. In 2007, the European Council agreed on an energy and climate package, which brought about the famous 20-20-20 targets. Given that, at this point, energy was not yet a shared competence, these targets were anchored in legislation based on the EU's competence in environmental matters, where such shared competence already existed

18 The full text of the Schuman Declaration is available at https://european-union.europa.eu/principles-countries-history/history-eu/1945-59/schuman-declaration-may-1950_en (accessed 15 March 2022).

before the coming into force of the Treaty of Lisbon. For the first time, solidarity among Member States was a clear priority, both as a prerequisite for increased security of supply of oil, gas and electricity and in terms of achieving the 2020 climate targets, particularly where those targets were translated into targets that are legally binding at the national level, namely in renewable energy and greenhouse gas emissions not covered by the ETS. Indeed, when establishing the national objectives to reach the 2020 targets, the EU took account of the different starting points and overall conditions in the Member States. For example, the Effort Sharing Decision (EP and Council, 2009), establishing 2020 Member State targets for greenhouse gas emissions in sectors not covered by the ETS, allowed some Member States to increase their emissions by up to 20% when compared to 2005 levels, while other Member States were obliged to reduce these emissions by at least 20%.

At the same time, the 2005/2006 conflict between Russia and Ukraine over the price of gas heavily affected several EU countries and highlighted the vulnerability of certain Member States, mainly in Central and Eastern Europe, and the overall lack of solidarity in the European energy system. Eventually, this crisis marked a turning point in European energy policy and led to the inclusion of an energy solidarity clause in the Treaty of Lisbon, which was signed in 2007.The Russian invasion of Ukraine in February 2022 led to a further intensification of solidarity discourse in EU energy policy and to several legislative measures aiming to give stronger expression to such solidarity, as we examine in Section 1.2.4.4. below.

1.2.4.1 *Energy solidarity in the Treaty of Lisbon*

As mentioned above, Article 4 of the TFEU states that energy is a shared competence between the EU and its Member States. Moreover, according to Article 194 of the TFEU the EU shall strive to achieve the main aims of energy policy '*in a spirit of solidarity between Member States.*" However, each Member State maintains its right to *'determine the conditions for exploiting its energy resources, its choice between different energy sources and the general structure of its energy supply'.* Article 122 is also of importance as it states that:

> "*Without prejudice to any other procedures provided for in the Treaties, the Council, on a proposal from the Commission, may decide, in a spirit of solidarity between Member States, upon the measures appropriate to the economic situation, in particular if severe difficulties arise in the supply of certain products, notably in the area of energy*".

The Treaty does not provide a clear definition of what is meant by the *'spirit of solidarity'*, and neither does it include a framework or guidelines for how solidarity should be respected and reflected in the development of European energy policy. In fact, until recently (see Box 1.1), there has been considerable uncertainty as to whether the *'spirit of solidarity'* has legal implications for Member States, or whether it is intended only as a political guiding principle for EU energy policy. For these reasons, there has been ongoing debate on the application of the solidarity principle and the related legal obligations of Member States and the European institutions.

Nevertheless, the principle of solidarity has proven to be of high political importance in light of crises and shortages of supply of both electricity and gas. European institutions have increasingly been mentioning energy solidarity in their strategies and communications. It is also referred to in secondary legislation such as the Effort Sharing Regulation (EU) 2018/842 for non-ETS sectors and the European Climate Law. The OPAL case described in Box 1.1 answered the question about the legal character of the solidarity principle, but also left many questions open when it comes to its application.

1.2.4.2 *Subsidiarity and solidarity in the context of the Energy Union*

In 2015, the Paris Agreement was signed and the European Commission proposed a new energy strategy for the EU, namely the 'Energy Union.' As was described in Section 1.1, one of the five dimensions of the Energy Union is 'security, solidarity and trust,' namely diversifying Europe's sources of energy and ensuring energy security through solidarity and cooperation among EU countries. Taking into account both the objectives of the Energy Union and the Paris Agreement, the European 2030 climate targets were proposed by the European Commission and subsequently adopted in 2018. An important distinction between the 2020 and 2030 targets is that, while the EU's 2020 target for renewable energy was translated into individual, binding targets for each Member State, the 2030 renewable energy target is binding only at the EU level. Targets for non-ETS greenhouse gas emissions continue to be binding at Member States level in the Energy Union. Meanwhile, the energy efficiency target remained EU-wide and non-binding, although the recast of the Energy Efficiency Directive (2023/1791) made this target, too, binding at Union level.

Setting (binding) targets at the EU level only, without splitting them up into binding targets for each individual Member State, has both advantages and disadvantages. On the one hand, this approach gives Member States more freedom to set their individual climate and energy targets and choose their energy mixes according to what they consider most cost-effective for them. On the other hand, it makes it difficult to ensure that Member States adopt adequate individual policies to collectively achieve the 2030 climate and energy goals at the EU level (Piebalgs et al., 2020). This is because failure to reach a target binding at Member State level would enable the Commission to bring the Member State in question before the Court of Justice of the European Union, using what is called the infringement procedure. With targets binding at the EU level only, however, this path of enforcing targets through the Court seems to be unavailable to the Commission.

Box 1.1 The OPAL case

The OPAL case is a long dispute between Poland and the European Commission over the exemption of the OPAL gas pipeline from provisions in the Gas Market Directive 2009/73/EC.[19] The OPAL (Ostsee-Pipeline-Anbindungsleitung) pipeline is one of the onshore extensions of the Nord Stream 1 pipeline, which carries Russian gas from the Baltic Sea to the German grid (Figure 1.4).

In 2009, the German NRA initially granted the OPAL pipeline derogations from provisions on regulated third-party access and tariff regulation laid down in Directive 2003/55/EC. The same year, the European Commission reviewed this decision and provided for a cap on cross-border capacity reservation, which effectively meant that Gazprom was able to operate the OPAL pipeline only up to 50% of its capacity after it was put into service in 2011. In 2016, and given the intention of the German NRA to modify certain provisions in the exemption, the Commission updated its decision and essentially granted a lift of the capacity cap.

Figure 1.4: Nord Stream 1 and OPAL gas pipelines (source: Wikipedia)

Poland appealed to the General Court of the EU for annulment of the 2016 Commission decision. The country claimed that the decision violated the principles of energy security and energy solidarity in that it undermined the interests of certain EU countries. Poland also claimed the decision brought a risk of significant reductions in the utilisation of other supply routes competing with the OPAL pipeline. In 2019, the General Court ruled that the Commission had breached the TFEU, and more concretely the principle of energy solidarity, when issuing the OPAL decision and pointed out that the principle of energy solidarity is a legal principle of European Union law and a cornerstone of the European integration process. In 2020, Germany filed a plea against the General Court's 2019 ruling, while Poland, Lithuania and Latvia called to uphold it.

The dispute over the OPAL exemption decision focuses on the application of the solidarity principle. For the first time, a principle typically used in general terms in EU legislation was interpreted as having concrete legal significance. The decision gave rise to an extensive legal debate, including on the question of how to take Member States' interests into account in important regulatory decisions by EU institutions (see Iakovenko, 2021).

In its final ruling on the OPAL case on 15 July 2021, the Court of Justice dismissed the appeal brought by Germany and ruled on the nature and scope of the principle of energy solidarity. It stated that the principle can indeed produce binding legal effects and that the legality of energy policy-related actions by the EU institutions must be assessed in the light of the principle. The court also stated that the principle not only applies to situations involving terrorist attacks or disasters but to any action falling within the EU's energy policy. It further clarified that solidarity is to be observed by Member States not just in matters relating to energy security, but with regard to all four priorities of European energy policy enumerated in Article 194 TFEU.

Despite open questions on its exact applicability, upholding the principle of solidarity as a legal tool could have far-reaching consequences for the governance of energy and climate action, including under the Green Deal.[20] It may no longer be possible for EU countries to develop energy infrastructure while ignoring the vital interests of other countries. The OPAL case could also provide a basis for the European institutions, Member States and other parties to bring legal challenges against Member States which violate the principle of solidarity.

To help the EU reach its 2030 climate targets, Regulation (EU) 2018/1999 on Governance of the Energy Union and Climate Action ('Governance Regulation') was adopted as part of the Clean Energy Package. It sets common rules for planning, reporting and monitoring of current and future energy policies and greenhouse gas emissions for all Member States and also ensures that EU planning and reporting on emissions are synchronised with the ambition cycles in the Paris Agreement. Recital 12 to the Governance Regulation, recalls the European Council's conclusion that this planning-and-reporting mechanism should '*help ensure that the Union meets its energy policy goals, while fully respecting Member States' freedom to determine their energy mix'*. Recital 73 confirms that, in the European co-legislators' view, this balancing exercise has been achieved, stating that the objectives of the Governance Regulation cannot be sufficiently achieved by the Member States alone, which is why the EU may adopt measures in accordance with the subsidiarity principle.

The Member States are mandated to develop integrated national energy and climate plans (NECPs) based on a common template.[21] They are also to provide annual and biennial progress reports. The EC assesses the draft NECPs and may issue country-specific recommendations to a Member State, for example where policy developments in the Member State show inconsistencies with the overarching objectives of the Energy Union (Art. 30) or insufficient progress is made towards meeting its objectives, targets and contributions or its binding trajectory towards its self-set 2030 renewable energy target, or in implementing the policies and measures set out in its NECP (Art. 32). Although the recommendations are not legally binding, Member States should explain insufficient outcomes and cover the gaps, thereby taking '*due account of the recommendation in a spirit of solidarity between Member States and the Union and between Member States*' (Art. 34).

It is important to mention that the Governance Regulation does not provide any detail on the (punitive) measures that may be available to European authorities if recommendations are not implemented and/or progress at the national level remains insufficient. The regulation merely provides that, should national plans or Member States' progress on implementing them be insufficient, the Commission should '*propose measures and exercise its powers at Union level in order to ensure the collective achievement of those objectives and targets*' (Arts. 31, 32). Rather than a *carte blanche* for Commission intervention, these *'measures and powers'*, too, would need to adhere to the principles of conferral, subsidiarity, and proportionality. Vandendriessche et al. (2017) raises the question of whether this 'soft governance' approach, which depends much on Member States' goodwill, will be effective enough to reach the climate targets and whether there will be a need for stronger governance.

As part of the Energy Union Package, Regulation (EU) 2017/1938 governing the security of natural gas supply was adopted (EP and Council, 2017). It aims to safeguard an uninterrupted supply of gas and lays down the framework for EU emergency preparedness and resilience to gas disruption. In addition to provisions aimed at enhancing regional cooperation and improving transparency, the regulation also includes a *solidarity mechanism*, which can be activated as a last resort in extreme gas crisis situations. The regulation aimed to ensure that EU countries help each other to always guarantee gas supply to the most vulnerable consumers, even in severe gas supply situations, with fair compensation from the country receiving solidarity (see also Sections 1.3 and 3.1). The implementation of the regulation proved challenging, however, since it relied on the conclusion of solidarity arrangements between Member States. While the regulation set out a deadline of October 2018 for the

21 For a brief overview of the National Energy and Climate Plans, see for example an FSR blog post available at https://fsr.eui.eu/national-energy-and-climate-plans-necps/ (accessed on 30 March 2021).

conclusion of agreements specifying the technical, legal and financial arrangements for solidarity, at the time of writing only nine such agreements had been concluded.[22]

As part of the Green Deal, the recast of the Gas Regulation (2024/1789) sets out new solidarity obligations. These amend the Security of Gas Regulation (EU) 2017/1938, extending the scope of solidarity to also cover new renewable and low-carbon gases. Member States are encouraged to set up bilateral solidarity arrangements. The regulation contains the default conditions and procedures for implementing a solidarity measure if no such bilateral agreements exist between Member States. These default solidarity rules were first introduced as part of REPowerEU in Council Regulation 2022/2576 (for more details on the provisions introduced by this Regulation, see Section 1.2.4.3 below).

1.2.4.3 *Energy Solidarity in the Energy Crisis* [23]

In May 2022, the Commission published its detailed REPowerEU plan together with a number of other communications (EC, 2022a).[24] Next to energy savings, clean energy production and diversification of energy supply, the plan stresses the importance of building new energy infrastructure. This includes the implementation of '*many long pending projects, with a particular focus on cross-border connections to build an integrated energy market that secures supply in a spirit of solidarity'.* Ahead of what was expected to be a difficult winter 2022-2023, the Commission also called on Member States to conclude the outstanding bilateral solidarity arrangements between neighbouring countries, which should have served as last resort in the event of an extreme gas shortage to ensure supply to households, district heating systems and basic social facilities in the affected country.

In June 2022, new gas storage rules were adopted under Regulation (EU) 2022/1032 (EP and Council, 2022b).[25] The objective is to ensure that storage capacities in the EU do not remain unused and that the gas stored can be shared easily across the Union in a security-of-supply emergency, in a spirit of solidarity.[26] The regulation requires all EU Member States with gas storage facilities to fill these to 80% of capacity by November 2022 – and to 90% in the years thereafter. Not all Member States have underground gas storage facilities on their territory, however. And while increased security of supply would benefit all Member States, the storage obligations would impose financial burdens on the relevant actors in those Member States that have relevant underground gas storage facilities.

Thus, to share the burden, recital 21 states that:

> "[in order to] *share the burden of ensuring that underground gas storage facilities in the Union are sufficiently filled to safeguard the security of gas supply, in a spirit of solidarity, Member States without underground gas storage facilities should use underground gas storage facilities in other Member States*".

More concretely, Member States without underground gas storage facilities should ensure that market participants within such Member States have in place arrangements in Member States that have such facilities that provide for the use, by 1 November, of storage volumes

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22 A list of solidarity agreements currently in place can be accessed here: https://energy.ec.europa.eu/topics/energy-security/security-gas-supply_en#solidarity-arrangements

23 See also section 3.1

24 See footnote 6.

25 A recording of an online debate by the Florence School of Regulation on the "regulatory framework for gas storage" is available at https://fsr.eui.eu/event/a-regulatory-framework-for-gas-storage/ (last accessed 11 April 2022).

26 If you want to know more about gas supply and the concept of solidarity, read the FSR interview "Gas supply: how has the concept of solidarity evolved in the EU? ", available at https://fsr.eui.eu/gas-supply-how-has-the-concept-of-solidarity-evolved-in-the-eu/

corresponding to at least 15% of their average annual gas consumption over the preceding five years.

However,

> *"in the event that a Member State has no interconnection with other Member States or if a Member State's limited cross-border transmission capacity or other technical reasons make it impossible to use underground gas storage facilities in other Member States, that obligation should be reduced accordingly"*.

There would also be an option to develop alternative burden sharing mechanisms with Member States with storage facilities. However, these solidarity measures by Member States without storage facilities may also have a financial impact on the relevant market actors in these countries. Recital 22 states that:

> "*Member States without underground gas storage facilities should therefore be allowed to provide financial incentives or compensation to market participants for the shortfall in revenues or for the costs of obligations imposed on them which cannot be covered by revenue. If such measures are financed through a levy, that levy should not be applied to cross-border interconnection points".*

The implementation in law of the REPowerEU Plan has also proved fertile ground for the utilisation of Article 122(1) of the TFEU (see above) as a legal basis. This provision allows the Union to adopt economic measures when *'severe difficulties'* arise in energy supply, using an extraordinary legislative procedure which excludes the European Parliament and thus only involves the European Commission and the Council. In this emergency legislation, the Commission is increasingly relying on solidarity as a legal principle of European Union law as defined by the Court of Justice in its OPAL ruling (Box 1.1). In July 2022, the European Commission published the gas demand reduction plan 'Save gas for a safe winter' with the aim to reduce gas use in Europe by 15% between 1 August 2022 and 31 March 2023 (EC, 2022b). In this context, the European Commission also proposed a Council regulation, based on Article 122 of the TFEU, that includes the possibility for the Commission to declare, after consulting Member States, a 'Union Alert' on security of supply imposing a mandatory gas demand reduction on all Member States. In this proposal, the Commission stated that the legislation

> *"reflects the principle of energy solidarity, which has recently been confirmed by the Court of Justice as a fundamental principle of EU law. Member States which make all efforts to cope with the gas shortage within their territory should be entitled to fully benefit from the energy solidarity of their neighbours"*

(EC, 2022c, p. 2). The Council reached a political agreement only one week later, and the Council regulation was published in the Official Journal on 8 August 2022 (Council, 2022a). In this final legislative act, too, the measures are presented as reflecting the legal principle of energy solidarity (ibid, recital 14).

Over the course of 2022, several other important legal acts to adapt to the energy crisis were passed by the Council under Article 122(1) (for a concise overview, see Marin, 2022). A Council regulation adopted in October 2022 introduced a so-called *'solidarity contribution'* (Council, 2022b), a temporary levy on excess profits generated by fossil fuel companies. While the Regulation provides in Article 17(1)(e) that *'in a spirit of solidarity between Member States, Member States may assign a share of the proceeds of the temporary solidarity contribution to* *the common financing of measures to reduce the harmful effects of the energy crisis'*, a Commission review of the use of the solidarity contribution found that the proceeds of this contribution were only used *within* Member States to further the objectives of the REPowerEU Plan (EC, 2023a) The regulation further introduced a revenue cap on producers of energy from inframarginal technologies and sought to encourage Member States to conclude *'solidarity agreements'* to share the proceeds from enforcing this cap (Art. 11). The Commission review of the emergency measures, however, makes no reference to these agreements having been concluded (EC, 2023b).

A further significant development regarding solidarity in the pursuit of the REPowerEU objectives is Council Regulation 2022/2576, which was adopted on 19 December 2022. Entitled *'enhancing solidarity through better coordination of gas purchases, reliable price benchmarks and exchanges of gas across borders'* (Council, 2022c), the regulation extends the scope of the emergency solidarity mechanism under the Security of Gas Regulation (see above) to include LNG, and to instances where low gas stocks threaten a Member States' ability to guarantee electricity supply to its citizens. It further established a gas demand aggregation mechanism, obliging Member States to pool gas demand equal to 15% of their storage obligation under Regulation 2022/1032 (see above). A service provider contracted by the European Commission then seeks offers to match that demand though the so called AggregateEU platform. Joint *purchasing*, as opposed to demand aggregation, however, remained voluntary, as this was seen as encroaching upon Member States' right to determine their energy mix and the structure of their energy supply and, thus likely raising subsidiary concerns. When the measure was extended for an additional 12 months just before its planned expiry in December 2023, the Council decided to delete the reference to obligatory demand aggregation, making the scheme fully voluntary.

The experience with the implementation and extension of REPowerEU emergency measures, and their mainstreaming into the main body of EU energy and climate law shows how careful Member States are, even when politically committed to solidarity in crisis time, not to cede too much power over their decision making in energy to the European level,

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1.3 EU treaties, institutions and legislation

Athir Nouicer

In this section, we first focus on the different treaties governing the operation of the EU. Second, we present the main EU institutions that are involved in the development of EU legislation.

1.3.1 EU treaties

The EU is based on the rule of law. This means that actions taken by the EU are founded on the treaties (European Union, 2020a). The EU treaties are a group of international treaties between the EU Member States. They are binding agreements between these states and have been approved voluntarily and democratically by them. The EU treaties are primary legislation that set the EU's objectives and the rules for the EU institutions.

There are eight main EU treaties. Four of them are founding treaties and two are considered core functional treaties, as is shown in Table 1.1. The founding treaties were amended when new countries joined the EU in 1973 (Denmark, Ireland, United Kingdom), 1981 (Greece), 1986 (Spain, Portugal), 1995 (Austria, Finland, Sweden), 2004 (Czech Republic, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia), 2007 (Bulgaria, Romania) and 2013 (Croatia).

Treaties - in chronological order	Entry into force	Founding treaty	Core functional treaty
Treaty establishing the European Coal and Steel Community	23 July 1952	✓	
Treaty establishing the European Atomic Energy Community	1 January 1958	✓	
Treaty establishing the European Economic Community – Rome Treaty (EEC), then becoming the Treaty on the Functioning of the European Union (TFEU)	1 January 1958	✓	✓
Merger Treaty – Brussels Treaty	1 July 1967		
Single European Act	1 July 1987		
Treaty on European Union (TEU) – Maastricht Treaty	1 November 1993	✓	✓
Treaty of Amsterdam	1 May 1999		
Treaty of Nice	1 February 2003		
Treaty of Lisbon	1 December 2009		

Table 1.1: Overview of the main EU treaties (source: European Union, 2020a)

1.3.1.1 *Treaty establishing the European Coal and Steel Community (ECSC)*

The Treaty establishing the European Coal and Steel Community (ECSC) was signed on 18 April 1951 and entered into force on 23 July 1952. It brought together six countries (Belgium, Germany, France, Italy, Luxembourg and the Netherlands) to create a common market and organise free movement for coal and steel. It reduced distrust and tensions following the second world war (WWII) and transformed coal and steel into materials for peace. The Treaty, which had been valid for 50 years, expired in 2002. It represented the first step towards European integration and was the origin of the EU institutions.

1.3.1.2 Treaties of Rome: EEC and EURATOM treaties

The European Economic Community (EEC) and the European Atomic Energy Community (Euratom) treaties were signed on 25 March 1957 and entered into force on 1 January 1958. The treaties extended European integration to include general economic cooperation. The EEC treaty, which brought together the same six countries, created a common market based on free movement of goods, persons, services and capital. The EEC Treaty has been amended multiple times and is today called the Treaty on the Functioning of the European Union (TFEU). A solidarity clause was added in 2004, which provides the EU and its Member States with the option to act jointly and provide assistance to other Member States in emergency situations and disasters.

The Euratom Treaty was initially created to coordinate the Member States' research programmes for the peaceful use of nuclear energy. The Treaty established the European Atomic Energy Community (EAEC or Euratom), which is an international organisation that coordinates these research programmes, helps to pool knowledge, infrastructure and funding, and implements a centralised monitoring system to ensure the security of nuclear energy supply.

1.3.1.3 Merger Treaty – Brussels Treaty

The Merger Treaty, also known as the Brussels Treaty, was signed in the eponymous city on 8 April 1965 and entered into force on 1 July 1967. The Treaty streamlined the European institutions. It established a single Commission of the European Communities and a single Council to serve the three European Communities (EEC, Euratom, ECSC). The Treaty was a significant steppingstone toward the modern EU. It was repealed by the Treaty of Amsterdam, which was signed in 1997.

1.3.1.4 Single European Act

The Single European Act was signed on 17 February 1986 in Luxembourg and on 28 February 1986 in The Hague. It entered into force on 1 July 1987. The Treaty aimed to reform the institutions for the membership of Portugal and Spain and to accelerate decision-making in preparation for the single market. The Single European Act set qualified majority voting in the Council in several areas, making it harder for a single EU country to veto proposed legislation. It also strengthened the role of the European Parliament, giving it legislative power.

The Single European Act was the first treaty to include a dedicated chapter on environmental policy. It amended the EEC Treaty by adding environmental policy (Title VII). The Single European Act stipulated that environmental protection was to be integrated in the Community's other policies. It also set out a number of environmental policy objectives and the means to achieve them. Following this, the inclusion of environmental policy in subsequent EU treaties increased, becoming a main pillar in EU policies.

1.3.1.5 The Maastricht Treaty – Treaty on European Union

The Maastricht Treaty, also known as the Treaty on European Union (TEU), was signed in Maastricht on 7 February 1992. It entered into force on 1 November 1993 and represented a new step in European integration, creating an *'ever-closer union among the peoples of*

Europe'. It is considered the founding treaty of the European Union. It prepared the ground for the European Monetary Union and established the European Central Bank (ECB) and the European System of Central Banks. Cooperation between the Member States was increased in several new areas. The Maastricht Treaty introduced the concept of European citizenship and citizens were allowed to reside in and move freely across the EU. The Treaty established a common foreign and security policy and developed new forms of close cooperation on justice and home affairs. In addition, criteria that countries have to meet in order to join the euro, such as inflation and public debt levels, were defined.

The Treaty of Maastricht established the principle of subsidiarity in EU law and the two other principles of conferral and proportionality. These are considered to be essential in European decision-making. Related to energy, Article 3 of the treaty *includes 'measures in the spheres of energy, civil protection and tourism'* among the activities of the Community. The Treaty also extended the activities of the EU to the development of trans-European networks (TENs) in the areas of transport, telecommunications and energy infrastructure.

1.3.1.6 *Treaty of Amsterdam*

The Treaty of Amsterdam was signed on 2 October 1997 and entered into force on 1 May 1999. The Treaty was established to reform the EU institutions preceding the addition of future members. It amended, renumbered and consolidated the TEU and EEC treaties. It brought more transparent decision-making. It also extended and made more effective the ordinary legislative procedure, the so-called co-decision procedure.

Sustainable development has been recognised as an overarching aim of the EU since its inclusion in the Treaty of Amsterdam in 1997.

1.3.1.7 *Treaty of Nice*

The Treaty of Nice was signed on 26 February 2001 and entered into force on 1 February 2003. It aimed to reform the institutions to cope with new challenges involved by the enlargement to 25 Member States. The Treaty imposed new measures for changing the composition of the European Commission. It also redefined the voting system in the Council. The legislative and supervisory powers of the Parliament were increased. In addition, qualified-majority voting in the Council was extended to more areas – but with the notable exception of fiscal matters.

1.3.1.8 *Treaty of Lisbon*

The Treaty of Lisbon was signed on 13 December 2007 and entered into force on 1 December 2009. It had the purpose of making the EU more democratic and efficient. It also reinforced the EU's commitment to combat climate change and promoted sustainable development and renewable energy sources.

The Treaty of Lisbon enhanced the European Parliament's law-making powers, amending the previous Treaties to put it on an equal footing with the Council. The European Parliament therefore became a fully recognised co-legislator with enhanced budgetary powers. The Treaty also clarified the division of powers between the EU and the Member States.

The Lisbon Treaty amended the TEU and the EEC, which was later renamed the Treaty on the Functioning of the European Union (TFEU). It included a new part on energy, which was added to the TFEU as Article 194 (Article 176A in the Lisbon Treaty). The treaty introduced a new legal basis for the EU in the matter of energy policies based on the principle of solidarity and promoting the objective of an integrated and efficient energy market. Article 194 of the TFEU states:

> *"1. In the context of the establishment and functioning of the internal market and with regard for the need to preserve and improve the environment, Union policy on energy shall aim, in a spirit of solidarity between Member States, to:*
>
> *(a) ensure the functioning of the energy market;*
>
> *(b) ensure security of energy supply in the Union;*
>
> *(c) promote energy efficiency and energy saving and the development of new and renewable forms of energy; and*
>
> *(d) promote the interconnection of energy networks.*
>
> *2. Without prejudice to the application of other provisions of the Treaties, the European Parliament and the Council, acting in accordance with the ordinary legislative procedure, shall establish the measures necessary to achieve the objectives in paragraph 1. Such measures shall be adopted after consultation of the Economic and Social Committee and the Committee of the Regions.*[27]
>
> *Such measures shall not affect a Member State's right to determine the conditions for exploiting its energy resources, its choice between different energy sources and the general structure of its energy supply, without prejudice to Article 192(2)(c).*
>
> *By way of derogation from paragraph 2, the Council, acting in accordance with a special legislative procedure, shall unanimously and after consulting the European Parliament, establish the measures referred to therein when they are primarily of a fiscal nature."*

1.3.2 The EU's Multilateral Energy Treaties

The EU and its Member States have also long been part of two multilateral, international treaties concerning energy: the Energy Charter Treaty and the Energy Community Treaty.

1.3.2.1 *Energy Community Treaty*

The Energy Community Treaty was signed on 25 October 2005 in Athens and it entered into force on 1 July 2006 for a ten-year term. It aimed to bring together the EU and its neighbours. According to the treaty, the Energy Community is composed of the EU on the one hand and:

> *"the Republic of Albania, the Republics of Bulgaria, Bosnia and Herzegovina, the Republic of Croatia, the former Yugoslav Republic of Macedonia, the Republic of Montenegro, Romania, the Republic of Serbia and the United Nations Interim Administration Mission in Kosovo (pursuant to United Nations Security Council Resolution 1244)"*

on the other hand. It established the contracting parties as an Energy Community, which is an international organisation serving the purposes of the treaty.

The treaty aimed, among other things, to create a legal and market framework that is stable and attractive for investors in order to guarantee security of energy supply. It also aimed to extend the EU regulatory rules and principles to its neighbours for energy trade purposes. In

27 The European Committee of the Regions (CoR) was established in 1994 following the Treaty of Maastricht. It is composed of representatives of regional and local bodies, and acts in advisory capacity and assists the European Parliament, the Council and the European Commission on certain topics that affect local or regional interests. It must be consulted in areas like energy and climate change, environment, or trans-European networks, can be consulted on any other matter that the institutions consider appropriate and may also draw up opinions on its own initiative.

addition, the Treaty sought to improve energy efficiency and develop renewable energy sources.

The Energy Community has its own established institutions following the treaty. The Ministerial Council provides general policy guidelines following the treaty's objectives. A Permanent High-Level Group prepares the work of the Ministerial Council. The Energy Community Regulatory Board (ECRB) advises the other institutions on regulatory and technical rules. The ECRB working groups are composed of representatives of all interested parties and provide advice to the Energy Community. Finally, the Secretariat based in Vienna provides the other institutions with administrative support.

The treaty was extended for a new ten-year period until 2026 by unanimous decision of the Ministerial Council on 24 October 2013. On 17 December 2020, the Energy Community Ministerial Council met to discuss a future amendment to enhance market integration and energy transition within the Energy Community. The Council also discussed the application of the Green Deal in the region, and the Commission presented a Communication on the Economic and Investment Plan for the Western Balkans (European Commission, 2020b).

1.3.2.2 *The Energy Charter Treaty*

This treaty was signed in 1994 and entered into force in April 1998 to enable a multilateral framework for energy cooperation among the signatories (currently 56) and it was designed to foster energy security through the operation of more open and competitive energy markets while respecting the principles of sovereignty over energy resources and sustainable development. The lack of substantial updates since the 1990s, made the Treaty outdated, no longer matching the EU and international climate ambition. In January 2021, EU leaders sent a political message in the Council conclusions on climate and energy diplomacy, affirming that *'EU energy diplomacy will discourage all further investments into fossil fuel-based energy infrastructure projects unless they are fully consistent with an ambitious, clearly defined pathway towards climate neutrality in line with the long-term objectives of the Paris Agreement and best available science*'. (Council, 2021) After a failed attempt to negotiate the modernisation of the Treaty, on 7 July 2023, the Commission adopted proposals to withdraw the EU and Euratom from the Energy Charter Treaty.

1.3.3 The EU institutions

According to Article 13 of the Treaty on European Union (TEU) the EU institutional framework has seven main institutions. These are the European Parliament, the European Council, the Council of the European Union (simply called 'the Council'), the European Commission, the Court of Justice of the European Union, the Court of Auditors and the European Central Bank. In this subsection, we introduce this unique institutional setting and the roles of the institutions in the EU.

1.3.3.1 *The European Commission*

The European Commission (EC), which is based in Brussels, was established in 1958. However, it was only named the 'European Commission' in 2009 following the Lisbon Treaty.[28] It is the Union's executive body and represents the interests of the Union as a whole. The EC

28 The European Commission was preceded by the High Authority of the European Coal and Steel Community, established in 1951. In 1958, the EEC and EURATOM treaties established two additional commissions: one for the EEC and one for the Euratom. The three Commissions co-existed until the Merger Treaty established the Commission of the European Communities on 1 July 1967. In 2009 the Treaty of Lisbon officially renamed The Commission of the European Communities the European Commission.

is headed by a team, called the 'College' of Commissioners, one from each of the 27 EU countries. The President of the EC assigns responsibility to the College for specific policy areas.

The EC has a monopoly on legislative initiatives. It also implements the decisions of the European Parliament and the Council. It manages EU policies and allocates EU funding. In addition, the EC enforces EU law together with the Court of Justice. Furthermore, the EC represents the EU internationally, for instance in trade policy, and negotiates international agreements for the EU (European Union, 2020b).

1.3.3.2 *The European Parliament*

The European Parliament (EP) is based in Brussels, Luxemburg and Strasbourg and represents the EU's citizens. It is the only institution directly elected by citizens in all the Member States. It was created in 1952 as the Common Assembly of the European Coal and Steel Community. Then, following the establishment of the EEC and Euratom, the ECSC Common Assembly was expanded to cover the three communities and met for the first time on 19 March 1958. On 30 March 1962 the Assembly adopted a resolution changing its name to the European Parliament. The first direct elections were held in 1979. The Parliament is part of the EU legislative process, and most laws have to go through the EU Parliament and the Council of the EU before they are adopted. There are circa 700 Members of the European Parliament (MEPs). Direct elections of the MEPs take place every five years in the Member States.

The European Parliament has three main roles: legislative, supervisory and budgetary (European Union, 2019). The legislative role entails passing laws together with the Council of the EU based on European Commission proposals. The EP also reviews the work of the European Commission and can ask for legislative proposals. In addition, the Parliament decides on international agreements and EU enlargements. The supervisory role of the Parliament involves democratic scrutiny of all the EU institutions. It also elects the EC President and approves the other members of the Commission, who are nominated by the Council of the European Union. The Parliament has the right to vote on a motion of censure obliging the EC to resign. It can also question the EC and the Council. The budgetary role of the Parliament encompasses establishing the EU budget together with the Council. It also approves the long-term EU budget.

1.3.3.3 *The Council of the European Union*

The Council of the EU, or the Council, is based in Brussels and was founded in 1958 (as the Council of the European Economic Community). It is composed of government ministers from each Member State in relevant policy areas. The Member States share the Presidency of the Council on a 6-month rotating basis. It is not to be confused with the European Council (see Section 1.3.3.4.), or with the Council of Europe, which is not an EU body.

The Council's role is to negotiate and adopt EU laws together with the European Parliament based on European Commission proposals. The Council also coordinates the policies of Member States. It has a role in developing the EU's foreign and security policy based on European Council guidelines. In addition, the Council concludes agreements between the EU and other countries and international organisations. Moreover, jointly with the European Parliament it adopts the annual EU budget (European Union, 2020c).

1.3.3.4 *The European Council*

The European Council is based in Brussels and is composed of the heads of state or government of the EU countries, the European Council President and the European

Commission President. It was created in 1974 as an informal forum for discussion among heads of state. Under the 1992 Treaty of Maastricht, the European Council obtained formal status and a role. In 2009 following the Lisbon Treaty, the European Council became one of the seven EU institutions (European Union, 2020d).

The role of the European Council is to define the general political direction of the EU and its priorities, as is set out in Article 15 of the Treaty on European Union (TEU). It has no legislative power, unlike the Council of the European Union.

For instance, in 2014 the European Council agreed on the 2030 climate and energy policy framework for the European Union after it was proposed in an EC communication of 22 January of the same year. The 2030 framework was a political agreement setting EU targets for renewables, energy efficiency and greenhouse gas emissions. It did not entail legislative resolutions.

1.3.3.5 *The other EU institutions*

According to Article 13 of the TEU, next to the four institutions presented above three other EU institutions complete the EU institutional framework. The Court of Justice of the European Union (CJEU) and the European Court of Auditors (ECA) are two institutions that play vital roles. The CJEU ensures correct interpretation of EU law and that it is applied in the same way across the Member States. It also ensures that the Member States and the EU institutions comply with EU law. The ECA's role is to check the correct collection and use of EU funds and to help improve EU financial management. The seventh institution is the European Central Bank (ECB). Its role is to manage the euro, maintain stable prices and conduct EU economic and monetary policy.

1.3.4 EU legislation

In this subsection we introduce the various types of legislative action that can be used at EU level. EU climate and energy legislation, and the legislative 'packages' introduced in Section 1.1 mainly include directives and regulations, which are types of secondary legislation, or law derived from the principles in the EU Treaties. Table 1.2 below provides an overview of all types of secondary law that the EU institutions can adopt. It also provides an overview of atypical acts. A legislative term that is also frequently used in the EU's energy and climate lawmaking is the idea of 'recasting' a legal act. A recast of an existing legal act is proposed when so many changes, or amendments, are needed that a single, consolidated, new act, which incorporates both old and new provisions, is passed by the European institutions.

Type of secondary law	**Description**
Listed in Article 288 TFEU	
Regulations	A regulation is a binding legislative act. It is to be applied wholly in every EU Member State. One example is Regulation (EU) 2019/943 which introduces a new European entity for distribution system operators (EU DSO Entity).
Directives	A directive is a legislative act that sets out common principles for national regulatory frameworks or for the achievement of common goals. Examples include the Energy Efficiency Directive 2023/1791, which sets out the overarching EU target of achieving a 11.7% improvement in energy efficiency by 2030 based on a 2020 reference scenario. Member States need to transpose directives into national laws and as such are given a certain amount of freedom regarding detailed implementation.
Decisions	Decisions are binding on those to which they are addressed. An example is Decision (EU) 2017/684, which established an information exchange mechanism between Member States and the Commission on intergovernmental agreements in the field of energy.
Opinions	Opinions are not binding and allow institutions to make a statement without an underlying obligation. Examples are the European Commission opinions on national implementation plans for market reforms to be made by all Member States with identified adequacy concerns (European Commission, 2020c).
Recommendations	Recommendations suggest lines of actions that are not binding and do not have any legal consequences. An example is the Commission Recommendation of 3.4.2019 on cybersecurity in the energy sector.
Not listed in Article 288 TFEU	
Atypical acts: Communications, resolutions, white papers and green papers	Atypical acts are adopted by EU institutions. They are called this way because they do not fall within the TFEU categorisation. They may relate to EU internal organisations, or they can have a more general scope or be focused on specific topics. An example of these is the Green Paper – A European Strategy for Sustainable, Competitive and Secure Energy (Commission of the European Communities, 2006).

Table 1.2: Overview of the different types of secondary law (source: own elaboration)

References

European Union (2020a), EU treaties, accessed 6 March 2023 at https://europa.eu/european-union/law/treaties_en

European Union (2020b), European Commission, accessed 6 March 2023 at https://europa.eu/european-union/about-eu/institutions-bodies/european-commission_en

European Union (2020c), Council of the European Union, accessed 6 March 2023 at https://europa.eu/european-union/about-eu/institutions-bodies/council-eu_en

European Union (2020d), European Council, accessed 6 March 2023 at https://european-union.europa.eu/institutions-law-budget/institutions-and-bodies/search-all-eu-institutions-and-bodies/european-council_en

European Union (2019), European Parliament, accessed 6 March 2023 at https://europa.eu/european-union/about-eu/institutions-bodies/european-parliament_en

Council (2021), 'Council conclusions on climate and energy diplomacy', accessed 2 August 2023, available at https://energy.ec.europa.eu/topics/international-cooperation/international-organisations-and-initiatives/energy-charter_en.

1.4 Energy taxation

Daniele Stampatori and Valerie Reif

This section introduces energy taxation and related discussions in the context of the Fit for 55 Package. We first explain what energy taxation is and how it impacts energy prices for EU households and industry. We then explain how energy taxation can contribute to achieving the Green Deal objectives. Finally, we give an overview of the current and proposed EU legislative framework for energy taxation.

1.4.1 What is energy taxation?

Energy taxation is a tool that governments can use not only to raise revenue but also to support climate objectives. It can ensure that the price signals of different energy products reflect their impact on the environment and can incentivise business and consumers to make greener energy choices.

Energy taxes are part of the wider category of environmental taxes, which serve the purpose of internalising negative external environmental costs. According to the OECD Glossary of Statistical Terms,[29] an environmental tax is a '*tax whose tax base is a physical unit (or a proxy of it) that has a proven negative impact on the environment*'. Four subsets of environmental taxes can be distinguished: transport taxes, pollution taxes, resource taxes and energy taxes. In the EU27, energy taxes account for more than three quarters of total environmental taxes (Figure 1.5).

29 Available at https://www.oecd-ilibrary.org/economics/oecd-glossary-of-statistical-terms_9789264055087-en (accessed 15 March 2022).

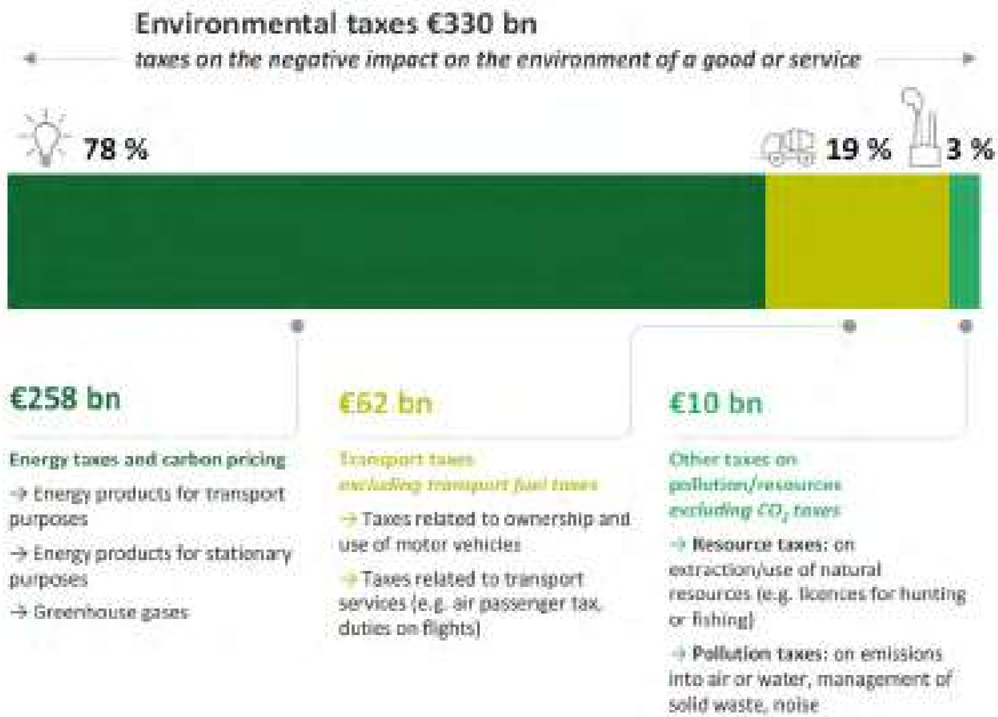

Figure 1.5: EU27 energy taxes as part of total environmental taxes, based on data from 2019 (source: ECA, 2022)

According to Eurostat (2013), energy taxes include taxes on energy production and on energy products used for both transport and stationary purposes. The most important energy products for transport purposes are petrol and diesel. Others are natural gas, kerosene and fuel oil. Energy products for stationary use include fuel oils, natural gas, coal, electricity, coke and biofuels. Taxes on biofuels and on any other form of energy from renewable sources and taxes on stocks of energy products are also included. Note that CO_2 taxes are also included among energy taxes rather than pollution taxes. Moreover, revenue from auctioning emissions permits (such as under the EU ETS) are treated as tax receipts in national accounts and should therefore be included in this category.

Energy taxes and carbon pricing can take different forms (ECA, 2022):

- specific taxes on fuel use (primarily excise duties[30]), typically a tax rate per physical unit (litre or kilogram) or unit of energy (kilowatt hour or gigajoule);
- explicit carbon taxes typically set a tax rate for energy use based on carbon content;
- emission allowances traded in emission trading systems.

In the field of indirect taxation, the EU has competence to coordinate, harmonise and approximate VAT and excise duties, as these can affect the single market (ECA, 2022). Note that all tax decisions taken at the European level are subject to the unanimity rule. This means that all Member States must agree on any measure adopted in the taxation field. This results in a very high threshold for the adoption of taxation measures as compared to other EU legislative action in the energy field. In 2019, the European Commission (EC) published a communication (EC 2019a) on more efficient and democratic decision-making on EU energy

30 According to the European Commission, excise duties are indirect taxes on the sale or use of specific products, such as energy (and also alcohol and tobacco), the revenue from which go entirely to the country where they are paid. In energy, EU excise duty rules cover all energy products used for heating and transport, as well as electricity.

and climate policy, in which it asked the European Parliament and Council to reflect on the benefits of moving from the current unanimity system to qualified majority voting. This is part of a broader review involving all EU tax policies, not just energy. At the time of writing, and in spite of the European Parliament (2023) urging the Council to enable qualified majority voting on measures related to energy taxation, there seems to be little appetite so far on the part of the Member States to abandon unanimity.

In line with EU competencies, the EU Energy Taxation Directive (ETD) (see below) focuses on excise duties. It sets out rules and minimum excise duty rates for taxation of energy products, electricity used as motor fuel and heating fuel to harmonise national legislation and avoid distortions in the internal market.

1.4.2 What is the impact of taxation of energy prices on EU households and industry?

Taxes account for a significant share of the final prices consumers pay for energy in the EU and can have a strong impact on consumption and investment patterns, the type of energy consumed and its use.[31]

Taxes vary across types of consumers (industry, households), energy products (electricity, gas) and Member States. To illustrate the differences, this is an excerpt from a factsheet on energy taxation produced by the EC (2019b) based on a report on energy prices and costs that is published every two years:[32]

> *"For households, [taxes] represent on average 40% of the electricity price, 25% of the gas price and 31% of the heating oil price in 2017. Industry, for competitiveness reasons, is usually taxed less than households: the average industrial consumer pays 13% of the gas price in taxes (and large consumers only 6%), and between 34-38% in taxes on electricity. The importance of taxes on prices also varies significantly across Member States, e.g. taxes on households range from 7% to 70% of the price for electricity and from 10% to nearly 60% for gas.*
>
> *Taxes on motor fuels account for 60% for gasoline and 55% for diesel, with a variation range across Member States of 50-66% for gasoline and 45-60% for diesel.*
>
> *Tax rates vary considerably between households and industry, as important tax reductions or exemptions are applied by Member States for various users or uses of these products."*

Voulis et al. (2019) explain that there is a stream of literature on energy taxes specifically and environmental taxes in general that addresses the question of how to set such tax rates correctly, including what should be taxed and by how much. The authors also refer to Pigouvian Theory (Pigou, 1920), which classically addresses the choice of tax base and level, and states that energy taxes (as a type of excise duty) should equal the marginal cost of the damage energy products cause and should be levied directly on the source of emission.

Accordingly, there is an ongoing debate among both academics and practitioners on how to implement an environmental tax in a cost-effective way in terms of the kind of taxation (e.g., on energy or carbon emissions) and the taxable base (e.g., a kWh consumed or the input to

31 In this regard, since September 2021, almost all Member States introduced tax/VAT reduction on energy products in order to reduce prices for final consumers. For further details on measures implemented by Member States to tackle with the energy crisis, please refer to https://www.bruegel.org/dataset/national-policies-shield-consumers-rising-energy-prices#:~:text=On%2022%20September%202022%2C%20the,MWh%20per%20household%20%E2%80%93%20above%20this .

32 See https://energy.ec.europa.eu/data-and-analysis/energy-prices-and-costs-europe_en (accessed 9 February 2023).

produce it) (see, e.g., Feindt et al., 2021; Teixidó et al., 2017). This is relevant in the context of revision of the ETD, which suggests a change (and expansion) of the taxable base for excise duties, as is described further below.

1.4.3 How can energy taxation help to achieve the Green Deal objectives?

As part of the Green Deal, the European Commission aims to align European energy taxation with climate objectives. Taxation can help to achieve these goals by encouraging a switch to cleaner energy and more sustainable industry. By increasing the final prices of energy products, energy taxes can induce citizens and businesses to:

- consume less energy, incentivising energy savings and energy efficiency;
- switch to cleaner technologies, if, for example, energy taxation is differentiated according to the carbon intensity of fuels.

The European Court of Auditors (ECA, 2022) lists examples of the effect of taxation on energy efficiency and therefore its key role in reaching the EU's climate objectives. In its report the ECA makes three points in this context. First, energy taxation measures that go beyond the EU minimum rate were the second-biggest driver of energy savings (16% of the total energy savings reported) in progress towards national energy efficiency targets for 2020. Second, in their initial National Energy and Climate Plans (NECPs) for the period 2021-2030, four Member States quantified the impact of planned energy taxation measures, estimating a range between 4% and 32% of total expected energy savings. And third, the OECD evidenced a negative correlation between taxation and the energy intensity of GDP; it concluded that countries with higher energy taxes tend to have less energy-intensive economies. In the same document, the ECA reports having carried out a similar assessment for EU Member States and having found a similar correlation.

1.4.4 What is the current legal framework for energy taxation in the EU?

This subsection provides an overview of the evolution of European legislation concerning energy taxation until today. It also highlights the main shortcomings of the current legislation that make an update under the Fit for 55 Package necessary.

1.4.4.1 Pre-2003

Before 2003 the so-called Mineral Oils Directives (Council, 1992a/b) were the only European laws regulating minimum taxation levels for energy products, although they had very limited application. In fact, they only covered oil used for transport and heating and gas for heating. During the 1990s there were proposals to introduce common CO_2/energy taxes in the EU and to restructure the Community framework for the taxation of energy products, but both were blocked because of lack of agreement. It was not until March 2003 that a proposal for energy taxation resulted in an effective directive setting out minimum levels of taxation for energy products in Member States.

1.4.4.2 The first Energy Taxation Directive (2003)

The Energy Taxation Directive (ETD; Council, 2003) answered the need for a clear framework for energy taxation among Member States, removed market distortions due to tax competition and supported other EU policies (e.g., environment, labour, transport). The ETD had four main objectives:

- to reduce distortions caused by divergent national frameworks;

- to remove competitive distortions between mineral oils and other fuels used in the transport, heating and electricity sectors;
- to support the competitiveness of EU businesses;
- to promote the use of renewables (e.g., biofuels).

The ETD lays down a common EU framework for taxing motor fuels, heating fuels and electricity. This includes minimum excise duty rates that Member States must apply to energy products used as motor or heating fuel and some options for exemptions for the use of energy products and electricity.

Moreover, the directive sets minimum rates for commercial and industrial purposes (such as agriculture, stationary motors and machinery used in construction and public works), includes special provisions on commercial diesel and also defines which uses of energy products and electricity it does not apply to.

Note that EU legislation only sets harmonised minimum rates, while Member States are free to apply excise duty rates above these minima according to their national needs. Indeed, most Member States tax most energy products and in some cases electricity considerably above the ETD minimum rates, as is shown in the following subsection.

1.4.4.3 *Developments in the energy sector since the first ETD*

In the period 2003-2021, energy markets and technologies in the EU underwent significant developments:

- The share of renewable energy in the EU's gross available energy reached 17.2% (see Figure 1.6);
- The share of renewable electricity increased from 13% to over 37%;
- Consumption of biofuels increased ten-fold. The share of biofuels in transport grew from virtually zero to over 6%.
- Several new products including hydrogen and synthetic gases entered the market.

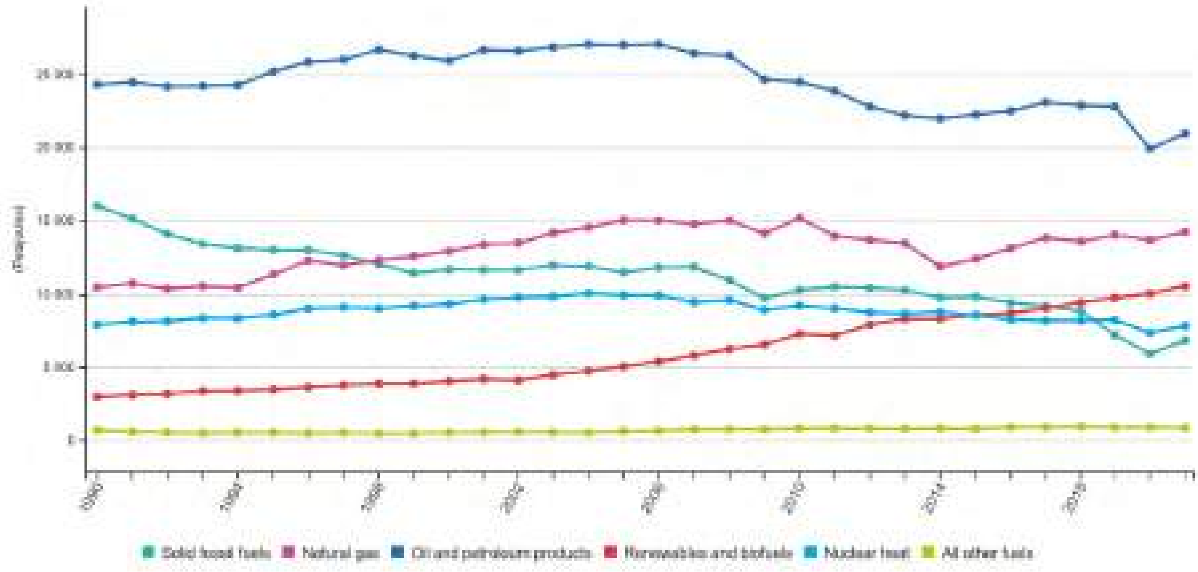

Figure 1.6: Gross available energy in the EU in the period 1990-2021 (source: Eurostat, 2023)

However, the energy tax framework has not kept up with these changes as it has not changed since the ETD entered into force in 2003. It is considered outdated for several reasons, which are listed in a proposal for a recast of the ETD (EC, 2021a).

First, the existing ETD is not in line with EU climate and energy objectives as it does not adequately promote greenhouse gas emissions reductions, energy efficiency or take-up of electricity and alternative fuels. The existing framework does not guarantee consistent treatment of energy sources based on the polluter-pay principle, i.e. on externalities such as pollutants and GHG emissions arising from their use. On the contrary, fuel taxation according to the first ETD is based on volume and not according to energy content, and penalises renewable fuels over fossil ones (in particular gas oil, i.e. diesel) due to their lower energy density.

Second, the existing ETD *de facto* favours fossil fuel use. Highly divergent national rates are applied in combination with a wide range of tax exemptions and reductions. The wide range of exemptions and reductions are forms of fossil fuel incentives which are not in line with the objectives of the Green Deal. An example is the taxation of gas oil in the agriculture sector. On the one hand, Figure 1.7 shows the highly divergent situation across Member States in terms of effective rates compared to the ETD minimum. On the other hand, it shows that in some countries the rate is effectively zero due to tax exceptions, refunds and rebates.

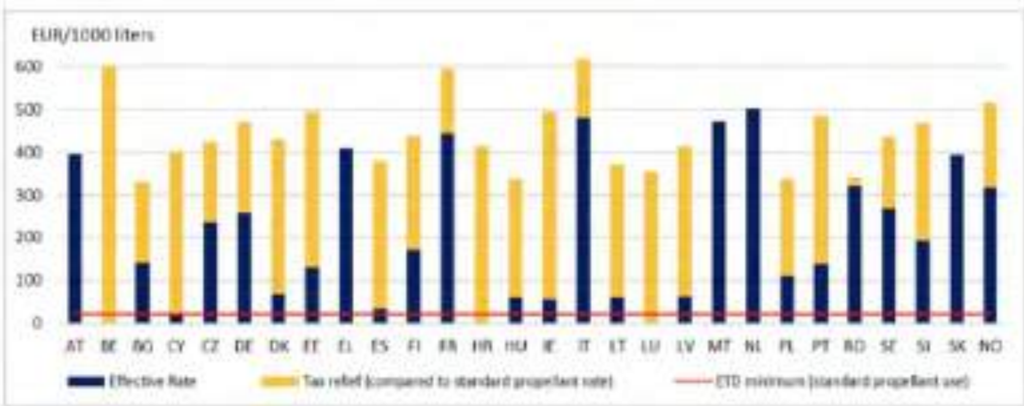

Figure 1.7: Effective rates for gas oil use in agriculture in 2019/20 (source: EC, 2021c)

Third, the ETD is no longer contributing to the proper functioning of the internal market as the minimum tax rates have lost their converging effect on national tax rates. The minimum tax levels are low as they have not been updated since 2003. In addition, they have become more and more misaligned with current market energy prices and have therefore not been sufficient to promote diversification of energy sources and investment in energy efficiency (EC, 2019b). Although national rates are often significantly higher than the minimum rates (see also Figure 1.7), the differences are large and the rates do not produce the convergence effect among countries that had originally been intended.

Last, legal uncertainties have been created by some aspects of the ETD that lack clarity, relevance and coherence. These include, among others, the definition of taxable products, uses that are beyond the scope of the directive, and interpretation of the exemption related to motor fuels used in air and waterborne navigation.

1.4.5 What does the proposed revision of the ETD entail?

The proposal to recast the ETD (EC, 2021a) embedded in the Fit for 55 Package[33] aims to address the shortcomings of the 2003 ETD by:

- fostering the transition toward clean fuels, incentivising electricity and (advanced) renewable fuels over fossil fuels;
- resolving the harmful effects of energy tax competition;
- overcoming outdated exemptions and incentives for the use of fossil fuels;
- ensuring revenue for Member States from environmental taxes rather than taxes on labour.

In order to achieve these objectives, the ETD proposal foresees updating the energy taxation framework. First, the proposal brings forward a new structure of minimum tax rates based on the energy content and environmental performance of fuels and electricity, rather than on volume (as is currently mostly the case). Hence, minimum rates will be expressed in €/GJ. At the same time the new system ensures that, within the same category (i.e., motor fuels, motor non-fuel use, heating in the new proposal), the most polluting fuels are taxed the highest.

Second, energy products and uses that had previously escaped the EU's energy taxation framework will be included, enlarging the taxable base. At the same time, a number of national

33 For a recent discussion on revision of the Energy Taxation Directive, see the recording of the FSR online debate in March 2022, available at https://fsr.eui.eu/event/the-revision-of-the-energy-taxation-directive/ (accessed 17 March 2022).

exemptions and rate reductions will be removed; kerosene used for aviation and heavy oil used in the maritime industry will no longer be fully exempted from energy taxation for intra-EU voyages. In general, there will be an upward adjustment of minimum tax rates. The increase in minimum values for certain fuels will be implemented with an intermediate step in 2023 (see Figure 1.8).

Third, in order to foster its use, electricity is always among the least taxed energy sources. In fact, tax rates have been set according to the energy content and environmental performance of different fuels and electricity. In this way, the new system will ensure that the most polluting fuels are taxed the highest. Figure 1.8 shows that, excluding fuels that are not listed in the ETD, the highest percentage increases will be applied to coal (83%), heavy fuel oil (55%), natural gas and LPG for transport applications (around 63%). Only petrol used as motor fuel will benefit from a slight decrease in the minimum rate (of about 2%). In absolute terms, electricity and renewable fuels of non-biological origin (RFNBO, such as hydrogen) are the most favoured in terms of minimum tax rates.

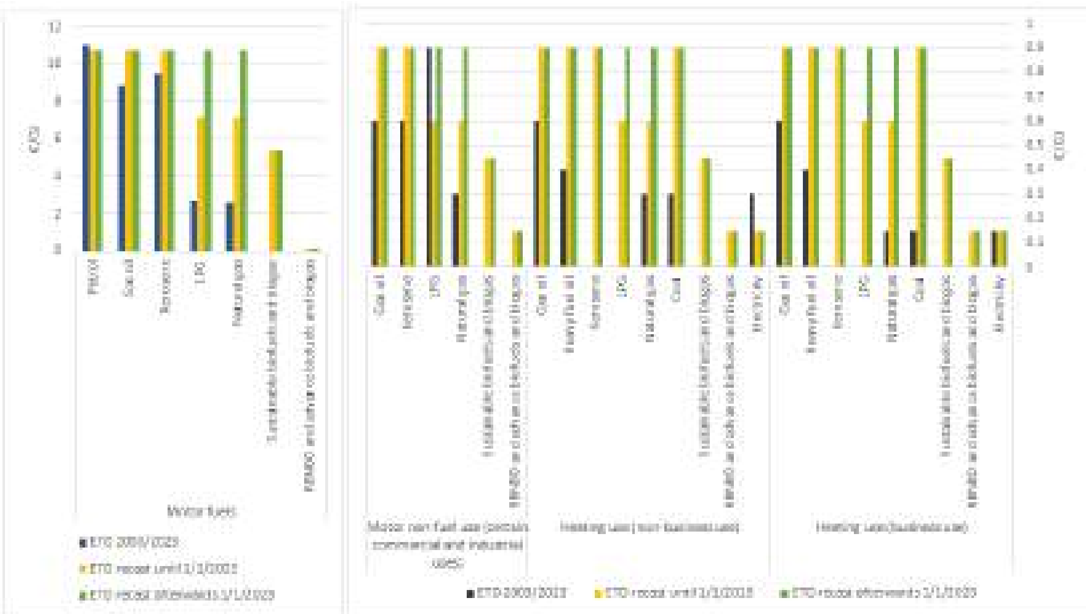

Figure 1.8: Evolution of minimum levels of taxation for some energy products (source: own illustration based on data from EC, 2021b)

The proposal maintains the possibility for Member States to apply tax rates higher than the minimum values set in the text. Indeed, more ambitious taxation is recommended. Moreover, in order to remove intersectoral distortions, the proposal eliminates distinctions between commercial and non-commercial diesel and between business and non-business use for heating fuels and electricity. In Figure 1.8 above these distinctions are only maintained according to the ETD for graphical coherence (but the values indicated in the ETD recast are the same). In order to ensure smooth implementation of the directive, the tax exemptions for fuel used by cargo-only flights are maintained while the minimum levels of taxation for some fuels, namely motor fuels used for intra-EU non-business and non-pleasure flights, sustainable alternative fuels and electricity, and intra-EU waterborne navigation, will be introduced after a transition period of ten years.

At the time of writing, no agreement has been reached on the proposal to recast the ETD, despite successive presidencies of the Council of the EU seeking to find a compromise that is acceptable to all Member States. (Messad, 2024).

1.4.6 What complementarities are there with other forms of environmental taxation?

According to the EC (2021d), energy taxation and the Emission Trading System (ETS) are instruments that could continue to co-exist (the ETS was established in 2005) on the basis of their complementarity. In fact, while the ETD puts a tax on output fuels/energy content, the ETS limits GHG emissions by putting a price on these emissions (in a limited number of sectors). While the same energy product or economic sector can be subject to both mechanisms at the same time, the European Commission guarantees that as long as a particular sector or energy use is taxed under the ETD for fuel consumption and charged under the ETS for CO_2 emissions, no overlap or double taxation will occur.

In this context, the introduction of a specific ETS for the road transport and building sectors should be complementary to the proposed revision of the ETD. Emissions trading will tackle CO_2 emissions while the ETD will ensure that fuel taxation incentivises an efficient use of energy and the consumption of more sustainable energy products, while not including a specific CO_2 tax component.

Nowadays, only a limited number of Member States have implemented an explicit carbon tax, which does not usually involve sectors already covered by the existing EU ETS (Figure 1.9). An OECD (2021) publication estimates a carbon price equal to €120 per tonne in order to meet the carbon neutrality target by 2050, a value higher than those implemented in European Member States so far (Figure 1.9).[34]

34 The study refers to 44 OECD and G20 countries.

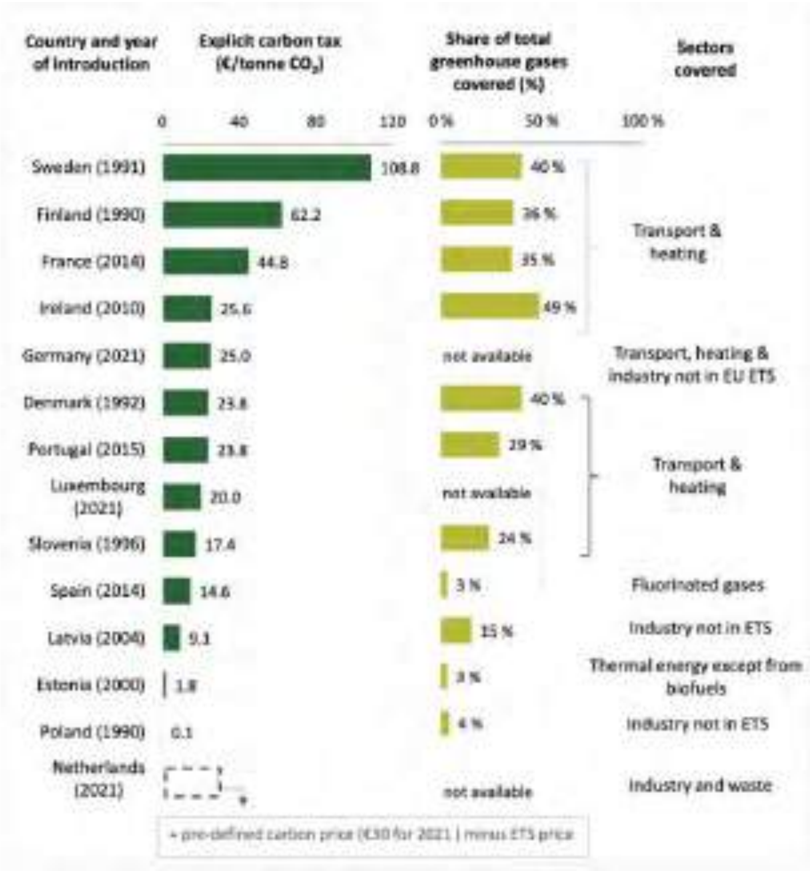

Figure 1.9: Explicit carbon taxes in the EU (source: ECA, 2022)

Finally, note that a flat carbon tax on electricity which does not distinguish between the carbon content of different generation mixes could jeopardise the switch towards low-carbon technologies. However, such differentiation may only be temporary since in the long-term revenue from excise duty and carbon tax on fossil fuels may eventually disappear, leaving electricity as the main source of energy tax revenue.

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1.5 EU agencies and organisations

Athir Nouicer

The aim of European authorities to realise the transition from fragmented national energy systems to well-functioning European energy markets has increased the need for cooperation across borders among the Member States, national regulatory authorities (NRAs), national companies such as transmission system operators (TSOs) and, more recently, distribution system operators (DSOs) and hydrogen network operators. Energy policy is no longer an exclusive competence of national governments.

EU energy market legislation that has been adopted so far (see Section 4.1.) has mandated the creation of several EU bodies and organisations, i.e., ACER, the European Union Agency for the Cooperation of Energy Regulators; ENTSO-E, the European Network of Transmission System Operators for Electricity; ENTSO-G, the European Network of Transmission System Operators for Gas; and the EU DSO Entity – the European association for electricity DSOs. The Hydrogen and Decarbonised Gas Market Package extends the scope of the EU DSO entity to natural gas DSOs and creates a new European Network of Network Operators for Hydrogen (ENNOH).

To facilitate interaction among stakeholders involved in completing the EU internal energy market, the European Commission has introduced the concept of stakeholder interactions through informal forums. Four forums exist today, which are named after the cities in which they take place: the Florence Forum, the Madrid Forum, the Copenhagen Infrastructure Forum and the Dublin Forum (also 'Citizens' Energy Forum'). Other forums like the Amsterdam Forum on renewable energy and energy efficiency and the Berlin Forum, initially on fossil fuels, are no longer taking place. These forums finish with formal minutes providing relevant inputs for legislation. They typically take place once or twice a year and are structured around timely issues related to energy regulation.

In what follows, we present the main EU agencies relating to the electricity and gas sectors, followed by the relevant EU forums. Finally, we introduce two other EU organisations relating to the environment and chemicals that are relevant in the Green Deal context.

1.5.1 The European Union Agency for the Cooperation of Energy Regulators (ACER)

The liberalisation of energy markets created a need to establish 'watchdogs' independent from industry and national governments to ensure non-discriminatory and effective access to transmission and distribution networks for electricity and gas. Such watchdogs were first created at the national level (national regulatory agencies, NRAs) and a European agency (ACER) followed years later. Figure 1.5 shows the evolution of NRAs and ACER through the relevant EU Energy Packages.

At the national level, the Second Energy Package required Member States to designate one or more competent bodies, independent from the energy industry, to function as national regulatory authorities. The Third Energy Package adopted in 2009 increased the independence of these authorities from national governments and put an obligation on Member States to have a single NRA entrusted with pursuing the regulatory objectives provided in the Package.

At the European level, the Third Package included Regulation (EC) No 713/2009 (also known as the 'ACER Regulation'), which established an Agency for the Cooperation of Energy Regulators (ACER). ACER was the successor to the European Regulators' Group for Electricity and Gas (ERGEG), an advisory body established to assist the European Commission in consolidating a single EU market for electricity and gas. ACER was created to assist and complement the work of NRAs regarding issues with cross-border relevance.

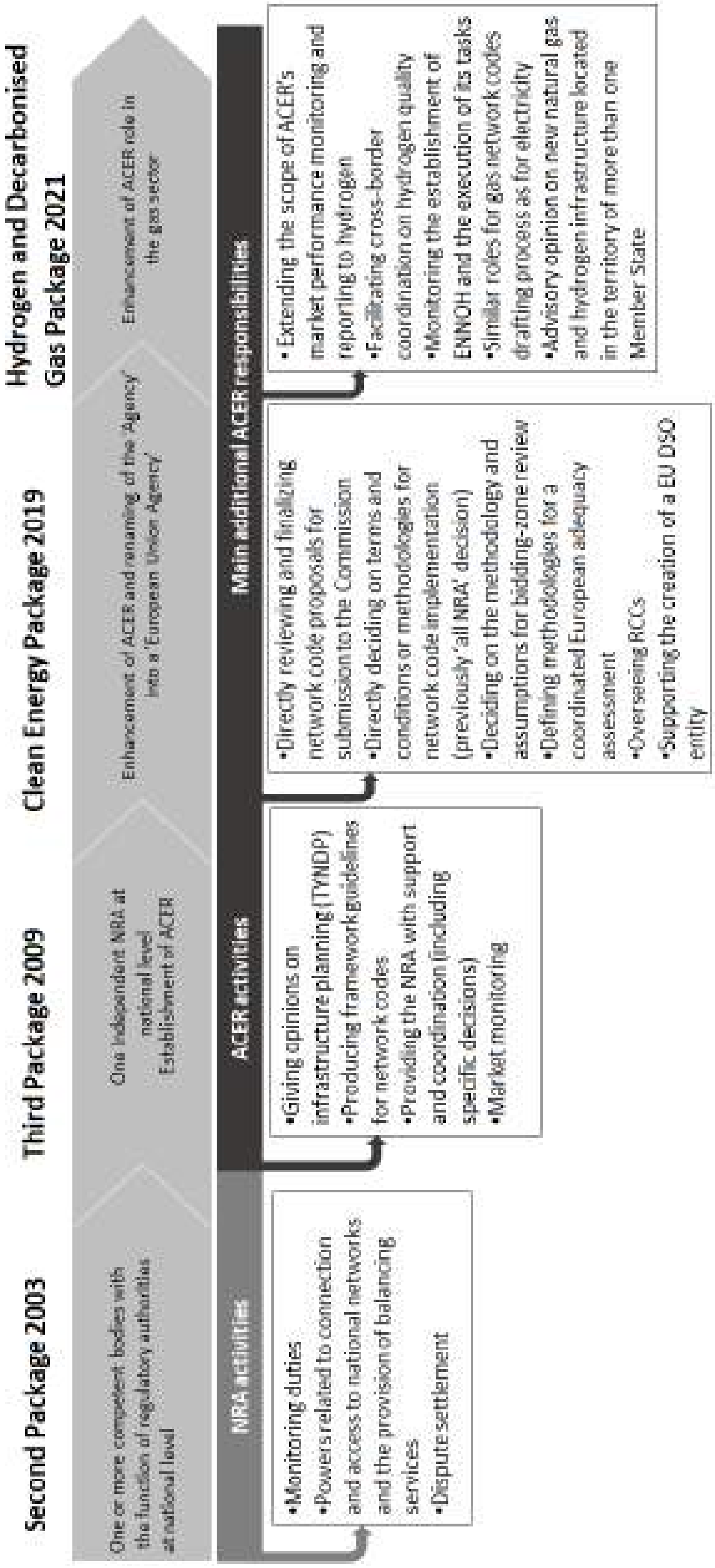

Figure 1.10: The development of regulatory authorities at the national and European levels and a selection of their tasks 2003-2021 (source: adapted from Meeus 2020)

The Clean Energy Package enhanced the tasks of ACER with Regulation (EU) 2019/942, which substantially amended Regulation (EC) No 713/2009. Regulation (EU) 2019/942 also renamed the 'Agency' as a 'European Union Agency.' Among ACER's tasks is participation in processes to develop, adopt and implement European network codes for electricity (see Section 4.1) and gas (see Section 4.2). Furthermore, ACER is empowered to give European institutions advice on energy-related issues. It is also competent to oversee ENTSO-E, ENTSOG, the EU DSO entity and ENNOH.[35] The reform of the European electricity market design in 2023-2024 enhances ACER's competences in investigating cases of cross-border market abuses.

1.5.2 The Council of European Energy Regulators (CEER)

CEER, the Council of European Energy Regulators, was established in 2000 for cooperation among the European NRAs. It is the NRAs' 'own' association and is directly funded by them. The Council proposes its own work programme and gets feedback on it through public consultations (Nies, 2020). Its role is different from and complementary to that of ACER. Like ACER, it seeks to facilitate the efficient functioning of the EU internal energy market, but while ACER focuses on what legislation is required and issues regulatory decisions, CEER has a role supporting stakeholders by providing position papers and views on energy regulation. It works in cooperation with ACER, for example, in the production of the Market Monitoring Reports (MMRs).[36] Additionally, CEER participates in European forums representing the NRAs' views, such as the Florence, Copenhagen, Dublin and Madrid Forums, which will be introduced later in this section.

1.5.3 The European Network of Transmission System Operators for Electricity (ENTSO-E)

In the European electricity system, TSOs are the national companies that operate the networks through which electricity is transported. Transmission networks are natural monopolies and are subject to regulation. Although their scope is national, TSOs have a pivotal role in the process of integrating national electricity markets into a single EU market for electricity. TSOs facilitate cross-border electricity exchanges and ensure the safe operation and reliability of the increasingly complex electricity network at all times. Figure 1.11 shows the development of TSOs' roles and governance in Europe.

European TSOs have been cooperating across geographical borders since the 1950s. In 1951, the Union for the Coordination of Production and Transmission of Electricity (UCPTE) was founded by TSOs from eight western European countries. UCPTE was later extended to include more TSOs from more European countries. Its role was to contribute to the development of economic activity through more effective use of energy resources, which was enabled by the interconnection of electricity networks. In 1999, the organisation changed its name to UCTE, dropping the 'P' for production. This shift of focus to the transmission grid was a result of the unbundling and restructuring of the electricity sector that followed the liberalisation of electricity markets.

35 If you want to know more about one of ACER's organs, the Board of Appeal, you can read the Policy Paper "The appeal procedure in the application of the EU energy law – experience from ACER's board of appeal 2016-2021", available at https://cadmus.eui.eu/handle/1814/75701

36 ACER-CEER MMRs consist of three volumes: an Electricity Wholesale Market volume, a Gas Wholesale Market volume and an Energy Retail and Consumer Protection volume.

The UCTE was later involved in founding the Association of European Transmission System Operators (ETSO) together with associations from other parts of Europe such as ATSOI (for Ireland), NORDEL (for Northern Europe) and the UKTSOA (for the United Kingdom). The UCTE focused on technical rules while ETSO developed economic and legal procedures to complete international electricity transits and trade. On 29 June 2001, ETSO became an international association with a direct membership of 32 independent TSO companies operational in the then 15 Member States of the European Union plus Norway and Switzerland. Following the Third Energy Package, ETSO was wound up and all its operational tasks were transferred to ENTSO-E in 2009.

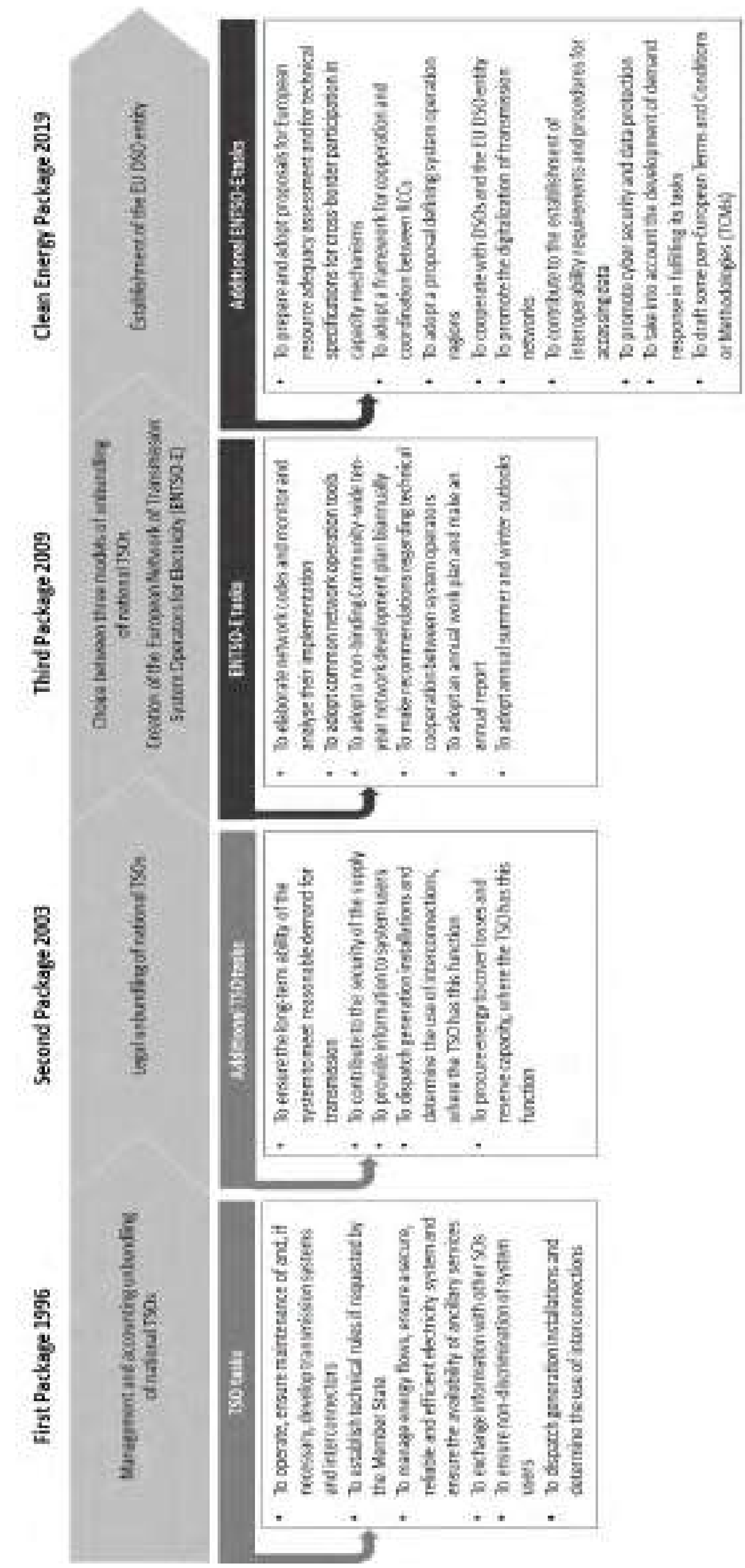

Figure 1.11: The development of electricity TSOs at the national and European levels and a selection of their tasks (1996-2019) (source: adapted from Meeus, 2020)

The creation of ENTSO-E enabled more effective cooperation among TSOs to address the shortcomings and limitations shown in TSOs voluntary initiatives. The Third Package tasked the ENTSOs with EU-level functions such as contributing to the development of EU-wide network rules, developing a ten-year network development plan (TYNDP) and carrying out seasonal resource adequacy assessments. The Clean Energy Package transferred additional tasks to ENTSO-E, such as preparation of the EU resource adequacy assessment and cooperation with DSOs and the EU DSO entity. The 2022 revision of the TEN-E Regulation (Section 3.5.1.) additionally tasked ENTSO-E with the development of a network development plan for offshore transmission networks.

1.5.4 The European Network of Transmission System Operators for Gas (ENTSOG)

Similarly to electricity systems, gas systems have gas TSOs. Nevertheless, unlike electricity, gas is transported via pipelines and via liquified natural gas (LNG) cargoes and ships if compressed and made liquid and then regasified in LNG terminals. Gas TSOs are therefore the companies that operate and own the gas transmission infrastructure such as the pipelines and LNG terminals.

The gas network infrastructure is considered a natural monopoly, like most network industries, due to high sunk costs and the inefficient duplicability of networks. This applies to gas and electricity transmission and distribution activities. The co-existence of regulated and competitive activities in an industry that meets essential needs requires supervision by regulation (EC, 2013).

With the liberalisation of the EU gas market, the number of system connections among network users has significantly grown, i.e. more gas shippers have started delivering gas to consumers across the continent. Gas TSOs have had to manage an increasingly complex system and face new challenges in network investment planning and capacity calculations.

The requirement for accounting unbundling of wholesalers and suppliers in the first Gas Directive (98/30/EC) increased the need to create an independent body speaking for gas TSOs. The directive, which had to be transposed at the national level by August 2000, aimed to create a competitive natural gas market with transparent non-discriminatory third-party network access.

Following the first Madrid forum in 1999, which was a consequence of the first Gas Directive, the European Commission requested further independent input on network issues from the gas TSOs. Therefore, Eurogas, the European gas industry association representing companies and associations engaged in the gas supply chain, decided to set up the Gas Network Interoperability Working Group. This group set the path towards the establishment of the Gas Transmission Europe (GTE) organisation in 2001. In 2005, Gas Storage Europe (GSE) and Gas LNG Europe (GLE) were grouped under the umbrella of Gas Infrastructure Europe (GIE) (GIE, 2012). In view of the Third Energy Package, GTE+ was established in 2007 as a GTE initiative with the aim of preparing the establishment of the ENTSOG. In December 2009, GTE+ was transferred into ENTSOG as required by the Third Energy Package, splitting therefore from GIE.

The main function of ENTSOG is to facilitate the cooperation of national gas TSOs across Europe and particularly on cross-border gas trading activities, as is shown in Figure 1.7. The aim is to ensure the development of a pan-European transmission system to support the achievement of EU energy policy goals.

The Clean Energy Package focused mainly on electricity regulation. It was not particularly relevant to ENTSOG except for some general regulatory provisions included in the ACER Regulation (EU) 2019/942. The Hydrogen and Decarbonised Gas Market Package includes additional tasks for ENTSOG, such as developing a gas quality monitoring report and cooperating with the EU DSO entity and ENNOH.

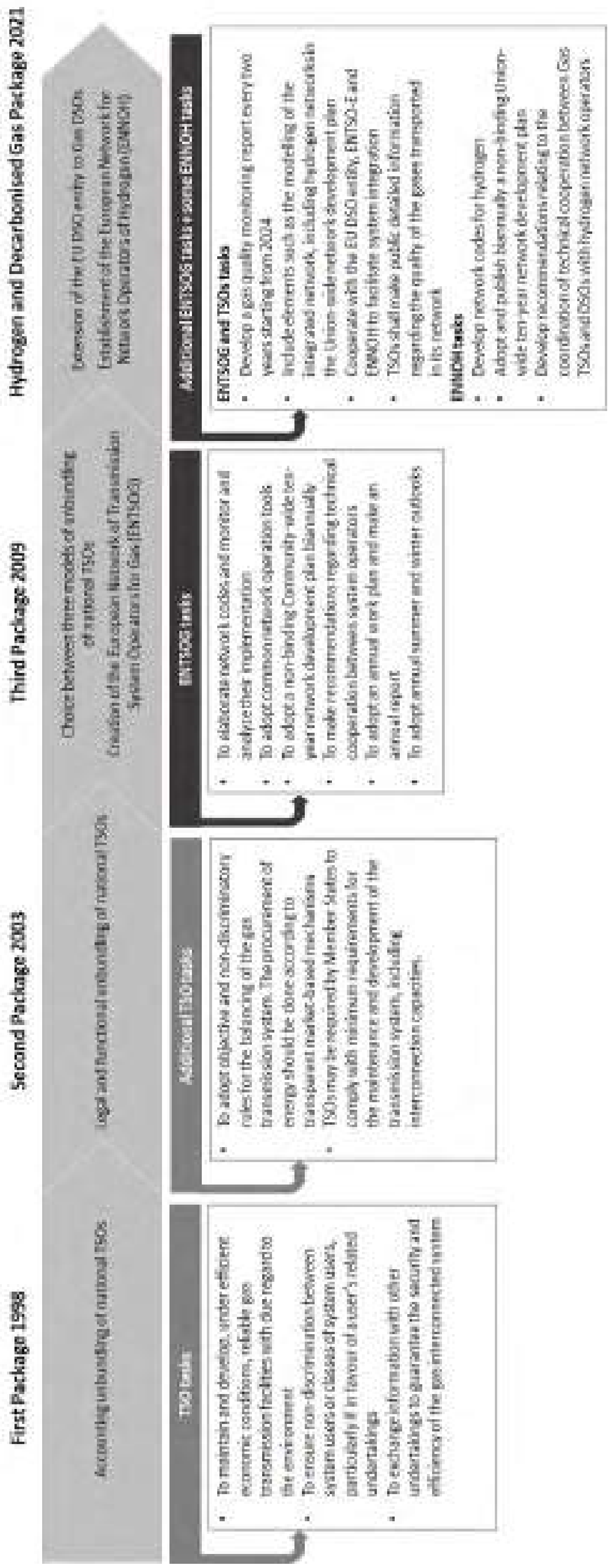

Figure 1.12: The development of gas TSOs at the national and European levels and a selection of their tasks (1998-2021) (source: own illustration)

1.5.5 European Network for Network Operators of Hydrogen (ENNOH)

A key provision in the Hydrogen and Decarbonised Gas Markets Package proposals was the establishment of a new entity, the European Network of Network Operators for Hydrogen (ENNOH). This new organisation will ensure optimal development and management of the EU dedicated hydrogen infrastructure, including cross-border coordination.[37] Among the tasks of ENNOH will be drafting network codes in areas relevant to hydrogen and developing non-binding ten-year network development plans (TYNDPs) for hydrogen. ENNOH will also cooperate with ENTSO-E and ENTSOG.

Hydrogen network operators will submit draft statutes, lists of members and draft rules of procedure for the ENNOH to the European Commission and ACER by 1 September 2024. Following this and after consulting relevant stakeholders, ACER will provide with its opinion the Commission, which, in turn, will deliver one of its own that, if positive, will mean that hydrogen network operators are to adopt and publish ENNOH's statutes, list of members and rules of procedure.

For a transition period until 1 January 2027, during which time ENNOH will be established, ENTSOG will take the lead on developing the 2026 hydrogen TYNDP in close cooperation with ENNOH. The 2028 hydrogen TYNDP will be developed solely by ENNOH.

1.5.6 The EU DSO entity

Electricity DSOs have traditionally organised themselves at the EU level through four associations: EURELECTRIC, GEODE, EDSO for smart grids and CEDEC. For gas DSOs, GD4S represents natural gas DSOs in seven EU Member States, while Eurogas has some gas DSOs among its members together with other companies and associations operating in the wholesale and retail sectors. GEODE and CEDEC have both electricity and gas DSOs among their members.

The Clean Energy Package for the first time contained a provision establishing a new EU structure for electricity DSOs, reflecting the pivotal role of DSOs in the energy transition. The entity aims to strengthen inter-DSO cooperation on the management of networks and enhancing technical dialogues with other stakeholders, e.g., TSOs, on technical issues. Membership of the entity was first opened to all electricity DSOs that wished to participate following the CEP provisions. In 2021, the Hydrogen and Decarbonised Gas Market Package proposals extended the membership of the entity to gas DSOs.

The DSO entity is an expert entity working for general European interests. It aims to promote the operation and planning of distribution networks in coordination with TSOs. Among its tasks in the electricity sector are facilitating the integration of distributed energy resources (DERs) and other embedded resources such as energy storage. The entity should also contribute to digitalising distribution systems, including deploying smart grids and smart metering systems. In addition, the entity participates in developing network codes in coordination with ENTSO-E when relevant to distribution grids. In 2024, the Hydrogen and Decarbonised Gas Market Package extends the membership of the EU DSO entity to gas DSOs with the aim of increasing the efficiency of distribution networks and enhancing cooperation with TSOs and ENTSOG. Optional cooperation through the DSO entity is also foreseen for hydrogen distribution network operators. The revised Gas and Hydrogen Regulation updated the principal rules and

37 If you want to know more about the regulation of hydrogen networks, watch the recording of the FSR Talk "When and how to regulate hydrogen networks? A European energy regulators'white paper", available at https://fsr.eui.eu/event/when-and-how-to-regulate-hydrogen-networks-a-european-energy-regulators-white-paper/

procedures for the EU DSO entity established in the electricity Regulation (EU) 2019/942 such as on the composition of the Strategic Advisory Group. The EU DSO entity will submit an updated statute, a list of registered members, draft updated rules of procedure and draft updated financing rules within a year of entry into force of the Gas Regulation.

The EU DSO entity will undertake most of the activities listed in Regulation (EU) 2019/942 Article 55 regarding gas distribution networks. The inclusion of gas DSOs provides the entity with additional tasks. Among these are participating in the development of network codes that are relevant to the operation and planning of gas distribution grids and contributing to mitigating methane leakage emissions from the natural gas system.

1.5.7 European Forums

Following the First Energy Package, the European Commission saw a need for increased interaction with stakeholders and institutional coordination to overcome omissions in legislation and possible regulatory gaps (Vasconcelos, 2005). The Commission decided to convene two regulatory forums following the First Energy Package, creating so-called regulation by cooperation (Eberlein, 2005). Indeed, with the European Union being a new venue for regulating energy markets, there was a need to develop further platforms to facilitate negotiation processes. In 1998, the first forum, called the 'European Electricity Regulation Forum,' was set up in Florence, Italy. This was followed by the European Gas Regulatory Forum in Madrid a year later. Further regulatory and energy system development led to the establishment of the London/Dublin and Copenhagen Forums. The forums include participation by the European Commission, Member State governments, Members of the European Parliament, representatives of NRAs, TSOs, DSOs, industry and consumer organisations, and other stakeholders which provide informal input and possible solutions to internal market issues.

1.5.7.1 The Florence Forum

In 1998, the European Electricity Regulation Forum, commonly referred to as the Florence Forum, was set up on the initiative of the European Commission to discuss the creation of an internal electricity market. Since its establishment, the Forum has met once or twice a year to discuss issues such as wholesale market integration, cross-border electricity trade and electricity market design to accommodate the integration of renewable energy sources (RES). The Florence Forum led to popularisation of electricity regulation by cooperation. It also led to the establishment of important 'by-products' such as the CEER and ERGEG (the predecessor of ACER) mini-fora and regional initiatives (Trinh and Meeus, 2009).

1.5.7.2 The Madrid Forum

The European Gas Regulatory Forum, commonly referred to as the Madrid Forum, was set up in 1999 following the adoption of the first Gas Directive (98/30/EC) to cover issues like market integration, competition, congestion management and interoperability and interconnection of networks. The forum has since met once or twice a year, providing input and viable solutions to gas market issues. This led to the establishment of institutions such as Gas Transmission Europe (GTE), representing gas TSOs (Herweg, 2016).

1.5.7.3 The Dublin Forum (previously called the London forum)

The first Citizens' Energy ('Dublin') Forum was held in 2008 in London on an initiative of the European Commission. It seeks to strengthen the role of consumer representative bodies in influencing decision-making on issues related to the functioning of the retail market. Its establishment followed the successful experiences of the Florence and Madrid forums. Due to

Brexit, the forum was moved from London to Dublin in 2018. With liberalisation of wholesale and especially retail markets and in particular following the adoption of the Clean Energy Package, consumers have been put at the centre of the energy transition and are adopting a key role in the changing energy markets. The forum aims to structure the debate and explore consumers' perspectives on a competitive retail energy market.

1.5.7.4 The Copenhagen Forum

The first Energy Infrastructure ('Copenhagen') Forum was held in 2015 in Copenhagen under the chairmanship of the European Commission. The forum was set up to discuss challenges relating to electricity and gas infrastructure development and EU energy policy. The idea of creating the Copenhagen Forum was part of the Energy Union strategy. The forum aims to discuss progress on major infrastructure projects with the Member States, regional cooperation groups and EU institutions (EC, 2015). The forum also hosted the launch of the Copenhagen School of Energy Infrastructure, which has been operational since 2017.

1.5.8 Regional Initiatives and coordination centres

In 2006 and at the request of the European Commission, ERGEG launched Regional Initiatives (RIs) to group market participants in a voluntary bottom-up process. These initiatives complement EU top-down measures on the integration of the Internal Energy Market. The Commission encouraged these initiatives as they act as platforms and pilot projects to test and implement solutions to EU cross-border issues. Seven electricity regions and three gas regions were created (EC, 2010). The RIs were conceived as building blocks of the internal energy market. In 2011, ACER took over the responsibilities of the RIs. Electricity RIs ceased to operate in 2015, while Gas RIs continued, especially in southern and south-south-eastern regions, focusing on implementation of network codes and completion of the internal gas market. The implementation of electricity network codes and guidelines continued to be monitored through other channels such as the Electricity Market Stakeholders Committee (ACER, 2016).

The Clean Energy Package mandated the establishment of Regional Coordination Centres (RCCs), which support coordination between TSOs on system security, risk preparedness, defence and restoration, and post-operation and post-disturbances analysis.[38]

1.5.9 Other relevant EU agencies

In this part we present three EU agencies that are relevant to the Green Deal roadmap: the European Environment Agency, the European Chemicals Agency and the European Securities and Markets Authority (ESMA). All three were established by EU legislation.

1.5.9.1 The European Environment Agency (EEA)

The European Environment Agency (EEA) is an agency of the European Union located in Copenhagen. It was formed in 1993 following Council Regulation (EEC) No. 1210/90[39] of 7 May 1990 and started its activities in 1994. The same regulation also set up the European environment information and observation network (EIONET) (EEA, 2021).

38 For more information about the tasks of RCCs and he history of regional cooperation, you may wish to consult the ENTSO_E website: https://www.entsoe.eu/regions/

39 Council Regulation (EEC) No 1210/90 was later amended by EEC Regulation 933/1999 and EC Regulation 401/2009.

The EEA has 32 member countries: the 27 EU Member States and five non-EU member countries. There are also six cooperating countries whose cooperation activities are integrated in EIONET. The Agency also engages in international cooperation with other bodies such as the Organisation for Economic Cooperation and Development (OECD) and United Nations agencies, following Art. 15(2) of Regulation 401/2009.

The EEA's mandate is to assist the EU, its members and cooperating countries in their decision-making regarding environmental policies and coordinate the EIONET network, which is responsible for collecting and assessing high-quality environmental data.

In the CEP, Article 42 of Regulation (EU) 2018/1999 introduces the role of the EEA in assisting the Commission in the governance of the Energy Union, with regard to decarbonisation and energy efficiency objectives. The Agency is to compile the information reported by the Member States regarding policies, measures and projections and perform quality checks on the information submitted.

Within the Green Deal, the EU Climate Law (Regulation (EU) 2021/1119) requires reinforcement of the Commission's and the EEA's human resources through a legislative financial statement. The EEA is to assist the Commission in preparing the national and Union five-yearly assessments of progress towards climate neutrality.

1.5.9.2 *The European Chemicals Agency (ECHA)*

The European Chemicals Agency (ECHA) is a European Union agency located in Helsinki. It started its activities on 1 June 2007 following Regulation (EC) No 1907/2006 on Registration, Evaluation, Authorisation and Restriction of Chemicals, commonly known as the REACH regulation.

The Agency's Management Board is composed of 27 members from the EU Member States, six representatives of the Commission, of which three represent interested parties and are without voting rights, and two independent representatives of the European Parliament.

The Agency's mission is to provide the Member States and the EU institutions with scientific and technical advice relating to chemicals that fall within its area of activity following the REACH regulation provisions. More specifically, it has the objectives of ensuring human health and environment protection, avoiding animal testing methods, guaranteeing the free circulation of substances on the internal market while enhancing competitiveness and innovation. REACH applies to manufacturing, putting on the market and using chemical elements or substances, with some exceptions.

The European Commission (2020) chemicals strategy for sustainability in the Green Deal aims to better protect human health and boost innovation in sustainable chemicals. The strategy consolidates and simplifies the EU regulatory framework, including the REACH regulation and Regulation (EC) No 1272/2008 on the classification, labelling and packaging (CLP) of hazardous substances, assessing how to best include legislative reforms.

1.5.9.3 *The European Securities and Markets Authority (ESMA)*

The European Securities and Markets Authority (ESMA) was set up through Regulation (EU) No 1095/2010 to respond to a need of coordinating financial supervision at EU level. ESMA's members are the national authorities dealing with securities markets of each EU Member State. It seeks to promote regulatory convergence among these authorities and to improve the transparency and stability of financial markets in Europe. As such, it has also been involved in monitoring and improving market-related activities of the Green Deal, acting as a link between financial energy markets and financial market regulation. In 2022, answering a request from the European Commission, ESMA (2022) published a comprehensive assessment of the Emissions Trading System (ETS, see Section 2.4.). ESMA also has a history of collaborating with ACER to ensure transparency, integrity and a consistent approach in both energy and energy derivative markets. Notably, both agencies established a Task Force in 2022 to combat market abuse and to enhance information exchange (ACER and ESMA, 2022)

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2. EU climate policy

In this chapter, we give an overview of EU climate policy in five sections. First, we outline different international climate agreements and explain how climate negotiations work and how they influence the EU's climate and energy policy. Second, we present the EU emission trading system. Third, we introduce the carbon border adjustment mechanism and how it is related to the World Trade Organization. Fourth, we give an overview of the EU's renewable energy policy. Fifth, we describe the EU's energy efficiency policy.

2.1 International climate agreements

Maria Olczak, Albert Ferrari

2.1.1 What is the UNFCCC?

The United Nations Framework Convention on Climate Change (UNFCCC) is the foundation of international efforts to address climate change (United Nations, 1992). It paved the way for both the Kyoto Protocol and the Paris Agreement. Signed at the Rio Earth Summit on 9 May 1992, the Convention entered into force on 21 March 1994. Currently, there are 198 parties – 197 countries and one regional economic integration organisation (the European Union) – to the Convention.[40]

With the adoption of the UNFCCC, parties around the world recognised for the first time that the climate system is changing as a result of human activity. Therefore, the ultimate objective of the Convention, highlighted in Article 2, is to achieve '*stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system*' (United Nations, 1992).

The UNFCCC covers major greenhouse gases (GHGs)[41] and recognises that developed countries should lead the way because of their responsibility for most past emissions. This group of countries is also known as Annex I countries and encompasses the Organisation for Economic Co-operation and Development (OECD) member countries, including countries transitioning to a market economy (the so-called economies in transition) in Central and Eastern Europe. The parties not mentioned in Annex I are sometimes referred to as *'Non-Annex I countries'*.

2.1.2 How do climate negotiations work?

The parties meet regularly to take stock of progress in fulfilling their obligations under the Convention and to discuss further efforts to address climate change. There are three governing bodies, which play major roles in the process of negotiation:[42]

- Conference of the Parties (COP) to the Convention;[43]

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40 See https://unfccc.int/process-and-meetings/the-convention/status-of-ratification-of-the-convention (accessed 01/08/2023).

41 Seven GHGs in total: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and nitrogen trifluoride (NF_3). NF_3 was added to this list later based on the Doha Amendment and the change applies from the beginning of the Kyoto Protocol 2nd commitment period.

42 See https://unfccc.int/process-and-meetings/bodies/the-big-picture/what-are-governing-process-management-subsidiary-constituted-and-concluded-bodies (accessed 08/02/2023).

43 See https://unfccc.int/process/bodies/supreme-bodies/conference-of-the-parties-cop#:~:text=All%20States%20that%20are%20Parties,Convention%2C%20including%20institutional%20and%20administrative (accessed 01/08/2023).

- Conference of the Parties Serving as the Meeting of the Parties to the Kyoto Protocol (CMP);
- Conference of the Parties Serving as the Meeting of the Parties to the Paris Agreement (CMA).

COP is the supreme decision-making body of the UNFCCC and oversees the implementation of both the Kyoto Protocol (through CMP) and the Paris Agreement (through CMA). CMP and CMA are specific bodies, each dedicated to monitoring the implementation of their respective protocols and agreements.[44] Decisions are taken at a plenary meeting under unanimity rule. Before the final text of a decision reaches this stage, it is negotiated in several lower-level technical groups (Wojtal, 2018). The governing bodies are supported by the Bureau, the Secretariat of the UNFCCC and two permanent bodies: the Subsidiary Body for Scientific and Technological Advice (SBSTA)[45] and the Subsidiary Body for Implementation (SBI).[46]

2.1.3 Who negotiates? Negotiating groups and main actors

Due to the complexity of negotiations, the negotiating positions are usually agreed on behalf of a group of countries (Wojtal, 2018). Even though the Paris Agreement departs from the bygone division between developed (Annex I) and developing (non-Annex I) countries as both of these groups have different affiliations with negotiation groups (Brunnée and Streck, 2013; Hurrell and Sengupta, 2013). The main negotiating groups, created in the early ’90s, remain similar, but new ones have emerged over the years.

There are five United Nations regional groups and ten key negotiating groups operating in various combinations (see Table 2.1). However, there are also individual countries which play leading roles in negotiations because of their economic and diplomatic influence: the US, China, India, South Africa, Brazil, Russia, Japan, Norway, Korea, Mexico, Canada, Japan, Switzerland and the major EU MSs (e.g. Germany and France[47]) (Wojtal, 2018).

44 See https://unfccc.int/process-and-meetings/what-are-governing-process-management-subsidiary-constituted-and-concluded-bodies (accessed 01/08/2023).

45 See https://unfccc.int/process/bodies/subsidiary-bodies/sbsta (accessed 08/02/2023).

46 See https://unfccc.int/process/bodies/subsidiary-bodies/sbi (accessed 08/02/2023).

47 In terms of legally binding commitments, the EU negotiates as a bloc on behalf of its member states. However, member states can submit their own NDCs and present their views.

<table>
<tr><td colspan="6">UN REGIONAL GROUPS</td></tr>
<tr><td colspan="2">African Group</td><td>Eastern European Group (EEG)</td><td>Western European and Others Group (WEOG)</td><td>Asia-Pacific Group</td><td>Latin American & Caribbean Group (GRULAC)</td></tr>
<tr><td colspan="6">NEGOTIATING GROUPS</td></tr>
<tr><td rowspan="3">Developing</td><td>G77&China 134</td><td>Least Developed Countries (LDCs)</td><td>Alliance of Small Island States (AOSIS)</td><td>Arab Group</td><td>Like-Minded Developing Countries (LMDCs)</td></tr>
<tr><td rowspan="2">Small Island Developing States (SIDS)</td><td rowspan="2">Independent Alliance of Latin America and the Caribbean (AILAC)</td><td>Bolivarian Alliance for the Peoples of our America (ALBA)</td><td rowspan="2">Organisation of Petroleum Exporting Countries (OPEC)</td><td rowspan="2">Brazil-South Africa-China-India (BASIC)</td></tr>
<tr><td>Coalition of Rainforest Nations</td></tr>
<tr><td>Developed & mixed</td><td>Umbrella Group (UG)</td><td>Environmental Integrity Group (EIG)</td><td colspan="3">European Union (EU)</td></tr>
</table>

Table 2.1: UN Regional Groups and negotiating groups (source: Wojtal, 2018)

The UNFCCC Secretariat ensures the continuity of and support for climate negotiations at both the organisational and technical expertise levels. The secretariat is located in Bonn (Germany) and led by the Executive Secretary. Since August 2022 this position is held by Simon Stiell of Grenada.[48]

2.1.4 What is the Kyoto Protocol?

The UNFCCC put in place a general framework, but only in 1997 did the parties agree on a Protocol to the Convention specifying concrete reduction targets: the Kyoto Protocol (KP). Based on the Kyoto Protocol, the Annex I countries committed to cut their greenhouse gas emissions by an average of about 5% compared with 1990 levels over the period 2008-2012 (United Nations, 1997).

However, the Protocol only officially entered into force on 16 February 2005 after it had been ratified by the Russian Federation. The US did not ratify the Kyoto Protocol after the election of George W. Bush as President. The US non-participation in the KP weakened its impact, in both political and economic terms (Pickering et al., 2017). Moreover, in 2011 Canada withdrew from the Protocol, while three other countries – Japan, New Zealand and the Russian Federation – did not participate in the KP's second commitment period. Currently, there are 192 Parties to the Kyoto Protocol.[49]

Since 2005, discussions have focused on the multilateral response to climate change post-2012, i.e. following the end of the Protocol's first commitment period (Wojtal, 2018). At that time, it was expected that a new climate agreement would be adopted by December 2009. However, the fiasco of negotiations at COP15 fuelled by disagreement between the US and China over the roles of developed and developing countries in addressing climate change

48 See <https://unfccc.int/about-us/about-the-secretariat> (accessed 08/02/2023).

49 See <https://unfccc.int/kyoto_protocol> (accessed 08/02/2023).

(Christoff, 2010) led the parties to endorse the extension of the Kyoto Protocol, which was already foreseen in the Bali Action Plan of 2007, for another commitment period.

On 8 December 2012, the Parties adopted the Doha Amendment to the Kyoto Protocol (United Nations, 2012), which extended the Protocol for a second commitment period (2013-2020). During this period, the remaining parties committed to reduce GHG emissions by at least 18% below 1990 levels. The amendment entered into force on 31 December 2020.[50]

2.1.5 What is the legacy of the Kyoto Protocol?

Despite the limited participation and lengthy negotiation process, the Kyoto Protocol brought about some significant changes (Nature, 2012). These include:

- adoption of national GHG emission reduction targets;
- reinforcement of national GHG inventories and reporting and verification mechanisms;
- creation of flexible market mechanisms: a Clean Development Mechanism (CDM), Joint Implementation (JI) and International Emissions Trading;
- following the creation of International Emissions Trading, development of national and regional cap-and-trade systems, such as the EU ETS (see also Section 2.2).

2.1.6 What is the Paris Agreement?

What had not been decided at COP15 in Copenhagen in 2009 turned out to be possible six years later, when the parties agreed on a new legally binding international treaty on climate change. The Paris Agreement was adopted on 12 December 2015 and entered into force on 4 November 2016 (United Nations, 2015). Currently, there are 195 parties to the Paris Agreement.[51]

The 2015 climate treaty introduces an emission reduction objective different to that of the Kyoto Protocol. Instead of setting domestic reduction targets for each party, it sets a global ‘temperature goal,’ to limit the increase in the average global temperature to well below 2, preferably 1.5, degrees Celsius above pre-industrial levels.[52] Moving beyond that level significantly increases the risks resulting from climate change, such as droughts, floods, extreme weather events, etc. (e.g., IPCC, 2018).

To achieve this 1.5°C temperature goal, greenhouse gas emissions must peak before 2025 at the latest and decline by 43% by 2030 according to the UNFCCC.[53] Article 2 of the Paris Agreement specifies two other goals – to increase adaptation to negative impacts of climate change and to make financial flows (both private and public) *‘consistent with a pathway towards low greenhouse gas emissions and climate-resilient development’*. In other words, the Paris Agreement objectives cover three areas: mitigation, adaptation and finance.

50 See <https://unfccc.int/process/the-kyoto-protocol/the-doha-amendment> (accessed 08/02/2023).

51 See <https://unfccc.int/process/the-paris-agreement/status-of-ratification> (accessed 01/08/2023).

52 Art 2: "Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels." Pre-industrial refers to any period of time before the start of large-scale industrial activity around 1750. For instance, the IPCC Special Report on Global Warming of 1.5ºC uses the reference period 1850-1900 to approximate pre-industrial global mean surface temperature. See <https://www.ipcc.ch/sr15/chapter/spm/> (accessed 08/02/2023).

53 See <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement> (accessed 08/02/2023).

2.1.7 What are the Nationally Determined Contributions?

To achieve its three objectives, the Paris Agreement introduced a 5-year ambition cycle. By 2020 the parties were expected to submit their climate action plans, the so-called nationally determined contributions (NDCs).[54] The NDCs can include GHG reduction targets and other actions to reach the Paris Agreement objectives such as renewable energy targets, building resilience to adapt to the impacts of climate change and financial flows, and also different forms of support for developing countries, including capacity-building, financial and technical support.

Over the five-year ambition cycle, every new or updated NDC is expected to be more ambitious than the previous one to ensure that countries work continually to achieve the Paris Agreement objectives (Figure 2.1). As of January 2024, 195 new or updated NDCs are reported in the official NDC Registry.

Moreover, the climate agreement invited the parties to communicate by 2020 their long-term low greenhouse gas emission development strategies (LT-LEDS), which would provide a long-term perspective on the NDCs. However, in contrast to NDCs, these long-term strategies are not mandatory. As of September 2023, 75 parties have submitted their strategies.[55]

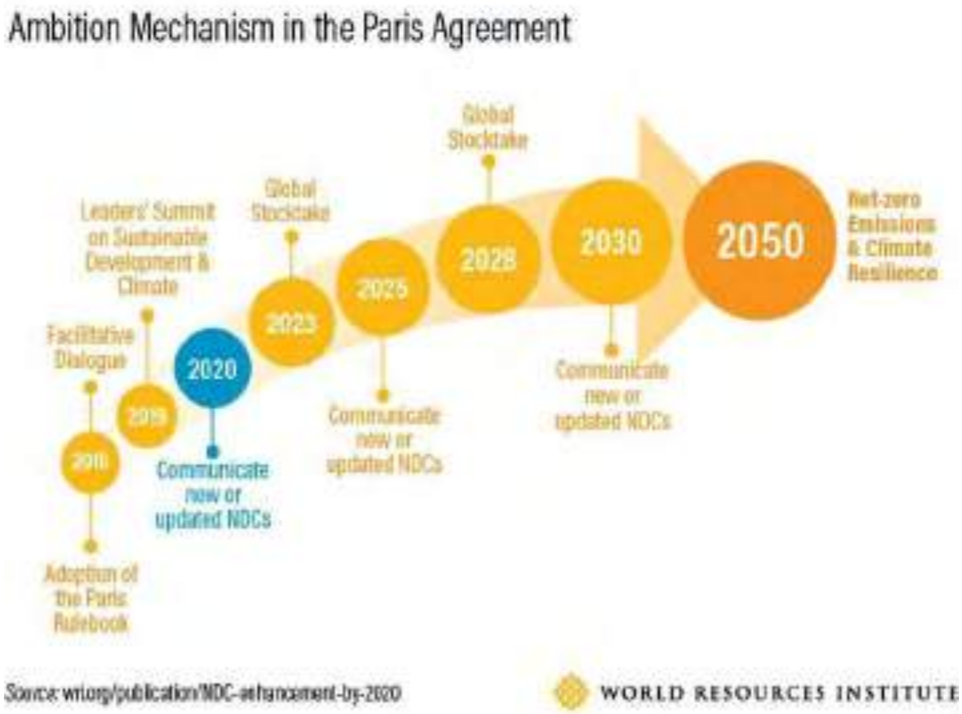

Figure 2.1: Ambition Mechanism in the Paris Agreement (source: WRI, 2017)

2.1.8 How to ensure compliance with the climate objectives?

The Paris Agreement does not specify any sticks or penalties for countries that do not fulfil their commitments. However, it contains a mechanism to track progress in terms of climate

54 See the NDC registry at https://www4.unfccc.int/sites/NDCStaging/Pages/All.aspx (accessed 08/02/2023). According to Climate Tracker, 31 parties have submitted NDC updates since 2022 covering 19% of global GHG emissions. See https://climateactiontracker.org/climate-target-update-tracker/ (accessed 08/02/2023).

55 See https://unfccc.int/process/the-paris-agreement/long-term-strategies (accessed 08/02/2023).

change mitigation, adaptation and financial flows. Under the Enhanced Transparency Framework (ETF) the parties will report on actions taken every two years and their progress towards meeting the Paris Agreement objectives. This information serves as a basis for a Global Stocktake (GST), which evaluates the collective progress and leads to a set of recommendations to set more progressive climate plans in the next 5-year cycle.[56]

The conclusion of the GST informs updated NDCs, which are due in 2025 for COP30 in Brazil. This first GST exercise was concluded at COP28 in Dubai in December 2023. The GST Synthesis Report of September 2023 pinpointed critical areas where immediate action is needed and provides a roadmap for the transformation needed to reduce emissions dramatically, build resilience, and safeguard our future.

These elements were discussed at COP28 during high-level events that inform the political outcome synthesising key political takeaways, identifying opportunities, good practices, and challenges for climate action. The First Global Stocktake High-level Committee Summary of High-level events at COP 28 emphasizes the need for the second round of NDCs to be more ambitious, economy-wide, and cover all GHGs and sectors to keep the 1.5°C goal within reach.[57] Mitigation efforts should involve the global tripling of renewable energy capacity and doubling of energy efficiency by 2030, as well as a transition away from fossil fuels. Meanwhile, progress should also be made in terms of adaptation to climate change. The call for doubling adaptation finance by 2025 would be a step in the right direction.

2.1.9 How does action on climate link with the Sustainable Development Goals?

The Paris Agreement is linked to other UN-led initiatives such as the 2030 Agenda for Sustainable Development. There are synergies between the efforts to tackle global warming and to achieve the Sustainable Development Goals, as climate change disproportionately affects the poorest and most vulnerable nations. The 2030 Agenda was adopted by the UN General Assembly in 2015 with 17 Sustainable Development Goals and 169 targets, including SDG13 on climate action. SDG13 is to *'Take urgent action to combat climate change and its impacts by regulating emissions and promoting developments in renewable energy'*.[58]

2.1.10 How do global negotiations influence EU climate and energy policy?

The international climate negotiations have had a significant impact on both EU and national climate and energy policies. Although the EEA estimated that the EU was responsible for roughly 8% of global GHG emissions in 2018 and 22% of overall historic emissions it has traditionally been one of the most active and progressive parties to climate conventions (Wojtal, 2018).

Moreover, multilateral climate negotiations are one of the fora in which the EU is able to speak with one voice on behalf of all 27 Member States, which, nonetheless, often have different views on the pace and depth of the clean energy transition. This requires strong internal coordination, e.g. during meetings of the Working Party on International Environment Issues in the Council, as EU external policy on climate change is a mixed competence shared between the Member States and the EU (Oberthür and Kelly, 2008).

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56 See <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement> (accessed 08/02/2023).

57 See <https://unfccc.int/topics/global-stocktake/components-of-the-gst/consideration-of-outputs-or-political-component-of-the-global-stocktake> (accessed 21/02/2024)

58 See <https://unfccc.int/topics/action-on-climate-and-sdgs/action-on-climate-and-sdgs> (accessed 08/02/2023).

Credibility at the negotiation table depends largely on the effectiveness of domestic action and legislation. The ambitious EU climate agenda helps the EU to lead by example and to provide greater certainty for Member States and investors regarding long-term EU policies (Wojtal, 2018).

EU COMMITMENTS AND LEGISLATION	
UNFCCC establishment	- Both the EU and the MSs are parties to the UNFCCC - The EU-15 and other industrialised countries (the so-called Annex II parties) agreed to provide financial and technological assistance to developing countries - Council Decision of 24 June 1993 for a monitoring mechanism of Community CO_2 and other greenhouse gas emissions - The proposal by the European Commission for a combined European CO_2/energy tax was rejected by the MSs - 1st and 2nd European Climate Change Programmes (2000, 2005) - EU ETS established (Emissions Trading Directive (2003/87/EC)), ETS phase 1 (2005-2007)
Kyoto Protocol 1st commitment period (2008-2012)	- The EU-15 agreed to reduce GHG emissions jointly (as the 'EU bubble') by 8% compared to 1990 levels - EU ETS phase 2 (2008-2012) - Other relevant legislation: Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources; Directive 2003/30/EC on the promotion of biofuels in transport; Directive 2004/101/EC on the linking of the EU ETS with the project mechanisms under the Kyoto Protocol
Kyoto Protocol 2nd commitment period (2013-2020)	- The EU-28 to reduce GHGs by 20% compared to 1990 levels by 2020 - 2020 climate and energy package (3x20% targets) - EU ETS phase 3 (2013-2020) and Effort Sharing Decision (covering non-ETS sectors)
Paris Agreement	- EU-28 (EU-27 since 1 January 2021) to reduce GHGs by at least 55% compared to 1990 levels by 2030 - 2030 climate and energy framework (55% GHG reduction target, 42.5% share of RES, 11.7% energy efficiency improvement compared to a 2020 business-as-usual projection for 2030 energy use - EU ETS phase 4 (2021-2030) and Effort Sharing Regulation (non-ETS sectors) - Land use, land use change and forestry (LULUCF) Regulation - Regulation on the Governance of the Energy Union and Climate Action - Carbon Border Adjustment Mechanism Regulation
Long-Term Strategies	- EU objective to reach climate neutrality by 2050 (European Green Deal) including: - European Climate Law to make the 2050 climate neutrality objective legally binding - European Climate Pact to engage citizens and all parts of society in climate action - 2030 Climate Target Plan to further reduce net greenhouse gas emissions by at least 55% by 2030 (Fit for 55 Package) - EU Strategy on Climate Adaptation to make Europe a climate-resilient society by 2050

Table 2.2: Major EU climate change commitments and legislation (source: own elaboration based on EU Commission, 2020: Wojtal, 2018; Oberthür and Kelly, 2008)

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2.2 The EU Emission Trading System (EU ETS)

Lea Heinrich and Albert Ferrari

Set up in 2005, the EU Emission Trading System (ETS) is the cornerstone of Europe's climate policy and covered about 36% of the EU's greenhouse gas (GHG) emissions in 2022 (European Commission, 2023). While the EU ETS was the first large emissions trading scheme in the world, many more countries have been adopting ETSs in the past years. As of the beginning of 2023, there were 28 operational emissions trading systems around the world (ICAP, 2023a).

The cap-and-trade scheme follows the 'polluters-pay-principle', which means that firms covered by the ETS must purchase an emission allowance for each tonne of CO_2-equivalents they inject into the atmosphere. In this respect, the EU ETS is a carbon pricing mechanism similar to a carbon tax. Two main features distinguish an ETS from a carbon tax (see Chapter 1.5). First, a carbon tax fixes the price for polluting but the amount of CO_2-equivalents abated by the measure is uncertain. The EU ETS follows the cap-and-trade approach: it sets an emissions cap, imposing an upper bound to emissions. The price of allowances is determined by the market and is thus variable. Secondly, firms covered by the EU ETS can trade allowances between themselves, so that less-polluting firms requiring fewer allowances can sell them to more carbon-intensive ones. As explained in more detail further below, some of the firms participating in the EU ETS also receive free allowances according to efficiency benchmarks which reward the most efficient installations.

The emissions cap of the EU ETS decreases at a yearly rate, called the Linear Reduction Factor (LRF).[59] The LRF was set at 2.2% of the 2010 baseline and increased to 4.3% from 2024 to 2027 and to 4.4% from 2028. Relatively to its launch in 2005, the EU ETS achieved a 21% reduction of regulated emissions in 2020 compared to 2005 levels.

As part of the EU 'Fit-for-55 package' the EU ETS was revised to align it with the EU's overall objective of reducing net emissions by at least 55% by 2030 compared to 1990 levels.[60] A set of legislative proposals relating to the EU ETS was adopted on 10 May 2023. The reformed EU ETS Directive increases the emissions reduction target and stipulates that emissions from the EU ETS sectors must be 62% below 2005 levels by 2030, a significant increase of the 43% required under previous legislation (European Parliament and Council, 2003).

2.2.1 Which gases and sectors are covered by the EU ETS?

The EU ETS covers greenhouse gases from specific activities, such as carbon dioxide (CO_2) from electricity and heat generation, from energy-intensive industry sectors (i.e. oil refineries, steel works, and production of iron, aluminium, metals, cement, lime, glass, ceramics, pulp, paper, cardboard, acids and bulk organic chemicals), from aviation within the European Economic Area and, since 2024, from maritime transport.[61] This concerns specifically 50% of emissions from maritime transport starting or ending outside the EU and 100% of emissions from transport between two EU ports and while ships are in EU ports. Additionally, the EU ETS covers nitrous oxide (N_2O) from production of nitric, adipic and glyoxylic acids, as well as from maritime transport since 2024, and glyoxal perfluorocarbons (PFCs) from the production of aluminium. Methane (CH_4) is included in the Monitoring, Reporting and Verification (MRV)

59 See https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/emissions-cap-and-allowances_en (accessed: 29/02/2024)

60 See https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/our-ambition-2030_en (accessed 29/02/2024)

61 See https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/scope-eu-emissions-trading-system_en (accessed 29/02/2024)

Maritime Regulation (European Parliament and Council, 2015a) since 2024 and in the EU ETS from 2026.

Furthermore, the revised directive foresees that a new separate EU ETS 2 for road transport and buildings fuels, as well as for process heat in small-scale industry, will come into force in 2027 (European Parliament and Council, 2003). The EU ETS 2 is meant to reduce greenhouse gas emissions in these sectors by 43% by 2030 compared to 2005 levels.[62] As compared to the existing EU ETS, under the EU ETS 2 all allowances will be auctioned, and none will be handed out for free.

The new EU ETS 2 will apply to fuel distributers, but it is likely that some of the costs will be passed on to consumers. For this reason, the start of the EU ETS 2 could be delayed to 2028 if energy prices are deemed exceptionally high.

By the end of 2026, the European Commission will also assess whether to introduce emissions from municipal waste incineration into the EU ETS from 2028.

2.2.2 What is the historical trend in allowance prices?

The price of EU allowances (EUAs) has undergone significant variations since its very first phases, as can be seen in the figure below. Firstly, in 2006, the first publication of verified emissions revealed that regulated installations had been overallocated, causing an abrupt fall in demand. Secondly, the 2008 global financial crisis hit the EU ETS hard, with the shrunken aggregate demand carrying over the carbon market. Subsequently, EUA prices further declined and then stagnated for some years, due to the combined effect of the overallocation and effective related policies that reduced demand for allowances. Indeed, national policies fostering the deployment of renewables and the increase in energy efficiency reduced the demand for allowances by polluting firms.

62 See https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/ets-2-buildings-road-transport-and-additional-sectors_en (accessed 29/02/2024)

Figure 2.2: EU Carbon Permits (EUR) from 2005 – 2023 (source: ICAP, 2023b)

Because of all these effects, by the start of Phase III (2013), the EU ETS had accumulated a surplus of about two billion allowances (more than the total volume of annual emissions under the EU ETS). As expected, this large allowance surplus severely depressed EUA prices. In 2012, the European Commission launched the idea of tackling the problem by postponing the auctioning of 900 million allowances from 2014-2015 to 2019-2020, a measure known as 'backloading'. After a contested process (it was first rejected in a vote in the European Parliament), this was eventually decided on in late 2013 (a process described in Jevnaker and Wettestad, 2017). However, as further action proved necessary the Market Stability Reserve (MSR) was proposed in 2015 and made operational in January 2019. The backloaded allowances were transferred to the MSR as an initial reserve (European Parliament and Council, 2015b).

The EUA price started to increase in 2020, reaching the symbolic value of 100 €/tonne in February 2023. This increase can be explained by many different factors, including the rise in gas prices, the more stringent rules in Phase IV of the EU ETS, and the announcement of the EU Green Deal with a higher climate target at 55% emissions reduction by 2030. A suspicion of price manipulation from financial actors emerged with the increased volatility that accompanied the rise in price. These claims do not appear to be substantiated so far (ECB, 2022; ESMA, 2022). The Covid-19 pandemic in 2020 and the beginning of the war in Ukraine in 2022 significantly impacted the energy supply and demand, contributing to a dramatic price drop. More recently, the EU ETS is experiencing a period of price instability.

2.2.3 How does the Market Stability Reserve control the volume of allowances available on the market?

Since 2019 the Market Stability Reserve (MSR) operates as a long-term mechanism to adjust the number of EU allowances in circulation.[63] The aim of the MSR is to improve the system's resilience to supply and demand imbalances and to prevent a growing surplus of allowances (i.e., the difference between the number of allowances available for compliance at the end of a given year, and the number of allowances effectively used for compliance with the emissions up to that given year). The surplus, known as the Total Number of Allowances in Circulation (TNAC), is published annually and determines whether the MSR recalls or releases allowances for auction.

In the context of the latest EU ETS revision, it was decided that the existing 24% rate of intake to be added to the reserve will be prolonged until 2030 (European Parliament and Council, 2003). Furthermore, the volume of allowances in the MSR which exceeds the volume auctioned in the previous year will be invalidated and the total number of allowances in the MSR will be limited to 400 million starting from 2023. These factors will effectively tighten the EU ETS cap. Additionally, the aviation and maritime sectors will be included in the calculation of the TNAC. The MSR is reviewed every five years by the European Commission, with the last review taking place in 2021.

2.2.4 How are allowances allocated?

The EU ETS has undergone many substantial reforms since its implementation.[64] One of the most relevant changes concerns the allocation of allowances, which in Phase I (2005-2007) and II (2008-2012) was decentralised and mainly relied on free allocation. [65]

Since Phase III (2013-2020), the total volume of emission allowances is determined at the EU level, a single set of rules governs their allocation, and auctioning[66] is the default method for allocating allowances. The rules for the remaining share of free allocation of allowances have been further revised for Phase IV (2021-2030). Free allowances are generally allocated according to the risk of carbon leakage for each sector, i.e. the risk of firms delocalising production in a country where environmental regulation is less strict.

According to the rules for Phase IV, free allocation focuses on those sectors most at risk of carbon leakage as determined by the European Commission. Only the sectors deemed to be at the highest risk of relocating their production outside of the EU receive all their allowances for free. Based on specific energy efficiency benchmarks, less exposed sectors will receive a decreasing number of free allowances starting from 2026 until the complete phase-out in 2030. Installations in the industrial sector are given free allowances depending on their efficiency relative to the 54 product-specific benchmarks (52 product and 2 fallback approaches based on heat and fuel) outlined by the European Commission. These benchmarks are based on 1) process emissions; 2) heat consumption; or 3) fuel consumption. As a rule, the benchmark corresponds to the average performance of the 10% most efficient installations. The benchmarked emissions are calculated by multiplying the relevant benchmark by the installation's recent output level. Furthermore, as there exists a maximum number of allowances that can be freely allocated at the EU level, a uniform cross-sectoral correction

63 See https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/market-stability-reserve_en (accessed 29/02/2024)

64 See https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/development-eu-ets-2005-2020_en (accessed 29/02/2024)

65 See https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/free-allocation_en (accessed 29/02/2024)

66 See https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/auctioning_en (accessed 29/02/2024)

factor is applied to all installations, so that the final allocation of free allowances does not fully cover all benchmarked emissions. As for the power sector, generators must buy all their allowances since Phase III, with derogations for three lower-income Member States (Bulgaria, Hungary, and Romania).

Finally, special allocation rules hold for the aviation sector,[67] with 82% of allowances freely allocated, 15% auctioned, and 3% withheld for new entrants and fast-growing companies. Several reasons can justify the special allocation treatment: the scarce availability of decarbonisation solutions, the international nature of the aviation business regulation, the highly competitive global environment and the gradual strengthening of the EU ETS rules in the sector.

The European Commission has repeatedly stated the need for the aviation sector to step up its contribution to the emission reduction target under the European Green Deal (European Parliament and Council, 2023c). The number of free allowances allocated to aircraft operators has been reduced progressively since 2013 and is expected to reach full auctioning by 2027. At the international level, the EU supports the development of a global measure by the International Civil Aviation Organization (ICAO) known as Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

It is estimated that, in Phase III, 43% of total allowances were freely allocated, the rest (57%) were auctioned by the Member States. In Phase IV (2021-2030), the share of allowances to be auctioned remains the same.

The auctioning revenues are distributed to Member States, once part of the auctions is used for financing the Innovation Fund and the Modernisation Fund. After 2026, part of the revenues from the auctions of EU ETS 1 and EU ETS 2 will be used to support vulnerable households and micro-enterprises through a dedicated Social Climate Fund (European Parliament and Council, 2023a). The Social Climate Fund[68] is expected to raise 65 billion EUR from the auctions of the EU ETS 2 which are to take place during the period 2026-2032. Approximately 5 billion EUR will be added from the auctioning of 50 million allowances under the EU ETS 1 and Member States will contribute 25% of their own resources, making a total of around 86.7 billion EUR available for social compensation. These revenues are to be used for investments in more efficient buildings and lower-emission mobility and to finance direct temporary income support to vulnerable households, transport users and micro-enterprises.

The ETS directive revised in 2023 states that Member States shall use 100% of the auctioning revenue or the equivalent financial value for climate and energy-related purposes (Borghesi and Ferrari, 2023).

2.2.5 Carbon leakage and the Carbon Border Adjustment Mechanism (CBAM)

So far, little scientific evidence supports the hypothesis that the EU ETS is directly linked to carbon leakage, mainly due to the past low–to–moderate allowance prices (Ekins et al., 2023). However, as the allowance price has risen significantly, the risk of carbon leakage could increase accordingly.

Until Phase III (2013-2020), the identification of the sectors at risk of carbon leakage relied on two sectoral indicators computed at the EU level: Carbon Cost Intensity (CCI) and Trade

67 See https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/free-allocation/allocation-aviation-sector_en (accessed 29/02/2024)

68 See https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/social-climate-fund_en (accessed 29/02/2024)

Intensity (TI). The former measured the carbon costs relative to gross value added, whereas the latter measured the trade value relative to the size of the European market. To be classified as at risk of carbon leakage, firms needed to exceed 30% in either of the two or 5% in CCI and 10% in TI.

As of Phase IV (2021-2030), a different rule is being applied to identify the sectors at risk of carbon leakage. Specifically, a sector is classified as being at risk of carbon leakage if the product of the Carbon Emissions Intensity Indicator (CEI) (expressed in terms of $kgCO_2$ per Euro of gross value added) and the TI indicator exceeds 20%. In addition, an adjustment to free allowances allocation is applied in cases of annual output variations exceeding +/-15%.

A first list of sectors at risk of carbon leakage – the 'carbon leakage list' – was defined in 2009 by the European Commission for the years 2013 and 2014.[69] Out of 258 sectors, 165 were classified as being at risk. The second list was defined in 2014 for the years 2015–2019 and later extended to cover 2020. A third list was adopted in 2019 to cover Phase IV, with only 63 sectors still being classified as being at risk (European Commission, 2019).

To address the risks of carbon leakage, the Council and Parliament introduced the Carbon Border Adjustment Mechanism (CBAM, see Section 2.3 for more details), a quasi-tariff on carbon-intensive goods imported from abroad, in the ETS reform. On 16 May 2023, the Regulation of the Council of the European Union and European Parliament establishing the CBAM came into force (European Parliament and Council, 2023b). Starting in 2026, importers in sectors covered by CBAM (cement, aluminium, fertilizers, electricity, hydrogen, iron and steel, along with some precursors and downstream products) will be required to surrender newly created CBAM certificates equivalent to the embedded emissions of their products unless the exporting jurisdiction has an equivalent carbon pricing system in place.

The free allocation of ETS allowances will be gradually phased out over a nine-year period (from 2026 to 2034) for sectors covered by CBAM. For non-CBAM sectors, the European Commission will determine the level of phase out of free allocations during the benchmark exercise. Under the current legislation, the Phase IV benchmarks were to be reduced by an annual minimum rate of 0.2% up to a maximum rate of 1.6%. In addition, installations receiving free allocation are obliged to implement energy audits or energy management recommendations. The 20% worst performers in a benchmark curve will be required to implement decarbonisation plans.

Furthermore, the ETS Directive enables Member States to adopt financial measures in line with State aid rules to compensate other companies of certain sectors at risk of indirect carbon leakage. The European Commission published in 2021 the Guidelines on certain State aid measures in the context of EU ETS that allow some national aids 1) for increases in electricity prices resulting from the inclusion of the emissions costs emissions due to the EU ETS (also known as indirect emission costs); and 2) involved in the optional transitional free allocation for the modernisation of the energy sector.

2.2.6 What is the role of offsets in the EU ETS?

At its inception, the EU ETS was designed to be part of a nascent international carbon market and thereby contribute to its development. The EU ETS was directly connected to the Kyoto system[70] and owners of regulated installations were allowed to use Certified Emissions

69 See https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/free-allocation/carbon-leakage_en (accessed 29/02/2024)

70 See https://unfccc.int/process/the-kyoto-protocol/mechanisms (accessed 29/02/2024)

Reductions (CERs) and Emission Reduction Units (ERUs) respectively generated by the Clean Development Mechanism (CDM) and Joint Implementation (JI) to meet their compliance obligations. CERs and ERUs certify the abatement of one tonne of CO_2 in a sector or jurisdiction not covered by the EU ETS, thus granting firms purchasing them the right to emit an additional tonne of CO_2 in their EU ETS-covered activities.

However, as the European carbon market was troubled by large oversupply, restrictions on the use of international credits were put in place quite soon: quantitative restrictions were introduced in Phase II and later tightened and complemented with qualitative restrictions in Phase III. As of Phase IV (2021-2030), the use of offsets is no longer allowed. Besides the need to curb oversupply to preserve the cost-efficiency of the EU ETS, the use of offsets has received much criticism from scholars and non-governmental organisations (NGOs) due to the low environmental integrity of most offset projects. According to a report commissioned by DG Climate Action (Cames et al., 2016), only 7% of the potential CER supply for the period 2013-2020 had a high likelihood of delivering real measurable additional emission abatement.

Although the EU does not currently intend to use international offsets for compliance under the EU ETS in Phase IV, the Paris Agreement opens a new chapter for global carbon markets to achieve national and European targets.[71] Parties to the Paris Agreement can use different instruments for trading emission reductions at the international level through mechanisms established in Article 6 of the Agreement. Article 6.2 allows countries to develop decentralised cooperative approaches under which they could trade mitigation units, so-called Internationally Transferable Mitigation Outcomes (ITMOs), to reach their own nationally determined contributions (NDCs). Article 6.4 opens the possibility of setting up a new centralised UN mechanism to trade emission reduction credits related to specific sustainable development projects. Article 6 also provides the opportunity to account for international cooperation and integration of non-market approaches. Following the deal reached on Article 6 at the COP26 in Glasgow in November 2021 (IISD, 2021), only time and actual implementation of the Paris rulebook will show how the EU intends to engage with the different mechanisms.[72]

71 See https://ec.europa.eu/clima/eu-action/eu-emissions-trading-system-eu-ets/international-carbon-market_en (accessed 29/02/2024)

72 In December 2021 the FSR organised a debate on the prospects for the global carbon market. The recording is available at https://fsr.eui.eu/the-global-carbon-market-after-cop26-is-the-glass-half-full-or-half-plenty/

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2.3 Carbon border adjustment mechanisms and the World Trade Organization

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In this section, we introduce carbon border adjustment mechanisms (CBAM) and the World Trade Organization by answering four questions. First, what is a carbon border adjustment mechanism? Second, why are carbon border adjustment mechanisms relevant to the European Green Deal? How does the CBAM work? Fourth, what is the World Trade Organization and why is it relevant to the EU carbon border adjustment mechanism?

2.3.1 What is a carbon border adjustment mechanism?

Carbon border adjustment mechanisms are a method to alleviate the negative impacts of uneven climate efforts between different jurisdictions. They seek to establish a level playing field between goods produced domestically and imported goods in terms of the cost of greenhouse gas (GHG) emissions associated with their production.

Carbon border adjustment mechanisms can basically come in two forms, as is described by the World Bank Group (2020). First, tariffs can be imposed on goods imported from countries where companies face a lower or no carbon cost. Second, rebates can be granted on the carbon cost of goods exported to markets where companies are competing with others that are not subject to equally stringent climate policies. This can happen, for example, through tax or regulatory relief or a refund of the cost of buying allowances. When integrated into an Emissions Trading System (ETS), a CBAM can require an importer to purchase emission allowances to cover the embedded GHG emissions from production of its imported goods. Alternatively, it can be imposed as a jurisdiction-wide tax that targets both foreign and domestic producers, or as an import levy.

2.3.2 Why are cross border mechanisms relevant to the European Green Deal?

The European Green Deal represents Europe's ambitious path towards climate neutrality by 2050. However, the fight against climate crises needs global action, which is still lagging in many parts of the world. The EU is concerned about the risk of carbon leakage as many international partners do not share the same ambitions as the EU (see Section 2.2.5). Carbon leakage can occur because production is transferred from the Member States to other countries that are less strict about emission reduction or because EU products are replaced with more carbon-intensive imports (EC, 2019).

Carbon leakage in large amounts is considered to risk global emissions not being reduced, climate-related efforts by the EU and its industries being less or not effective, and the competitiveness of EU industry being jeopardised. It may also have important unemployment implications. For these reasons, the European Commission proposed the introduction of a carbon border adjustment mechanism (CBAM) for selected sectors as part of the Fit for 55 Package to reduce the risk of carbon leakage stemming from differences in levels of ambitions worldwide.

While the CBAM is the world's first carbon border tax, the EU is not the only jurisdiction to ever consider introducing a CBAM. Some other countries such as Canada and Japan are planning similar initiatives. U.S. President Joe Biden also announced in his 'Plan for a Clean Energy Revolution and Environmental Justice' that his administration would impose carbon adjustment fees or quotas on carbon-intensive goods from countries that are failing to meet their climate and environmental obligations.[73] However, despite several attempts to introduce legislation creating a US CBAM (see, for example, Whitehouse, 2022), no such legislation has yet been passed(on the difficulties of introducing a CBAM for the US, see also McWilliams and Tagliapietra, 2021). In December 2023, the United Kingdom Announced that it will introduce its own Carbon Border Adjustment Mechanism. The UK government intends to implement this mechanism by 2027.[74]

In the carbon pricing literature, the option of introducing a CBAM has been repeatedly discussed. In practice, only California has so far implemented a CBAM. This applies to electricity imports from neighbouring states provided they are not linked to the Californian ETS. Mehling et al. (2017) explain that '*legal uncertainties, implementation challenges, and fear of backlash from trading partners'* have in most cases led policymakers to abolish any plans to implement a cross-border mechanism and to favour carbon pricing alternatives that are only applicable within the jurisdiction's geographical borders. A policy tracker of carbon pricing mechanisms[75] by the World Bank Group (2023) confirms that countries have so far used purely domestic measures to address both environmental and competitiveness risks. At the time of writing, 73 carbon pricing initiatives are in place worldwide: 36 ETS and 37 carbon tax schemes covering about 23% of global GHG emissions.

In the EU, carbon leakage concerns have so far been addressed by compensating for two types of costs that firms and businesses face under the EU ETS (see also Section 2.2). First, direct costs stem from obligations for businesses to buy CO_2 certificates equivalent to their industrial emissions. The EU mandates compensation of direct costs by Member States granting free allowances under the ETS Directive 2003/87/EC (though these are being phased out, see Section 2.2). Second, indirect costs are additional costs that a firm incurs because a supplier is also subject to direct costs, which it then includes in the electricity price and passes on to consumers. Compensation of indirect costs is optional for Member States and subject to compliance with EU state aid rules. Empirical evidence does not confirm the existence of significant carbon leakage under the EU ETS so far. However, there is concern that more stringent climate policies foreseen under the Green Deal may lead to carbon leakage in the future.[76]

2.3.3 How does the CBAM work?

The European Commission primarily expects that the introduction of a CBAM will ensure that the price of imports accurately reflects their carbon content (EC, 2019). Various options for introducing a CBAM were considered by the EC (2020), for example the introduction of a

73 See https://joebiden.com/climate-plan/. See also https://www.nytimes.com/2021/07/19/climate/democrats-border-carbon-tax.html for an update on the matter.

74 For more information, consult the UK government's online factsheet on the UK CBAM:
https://www.gov.uk/government/consultations/addressing-carbon-leakage-risk-to-support-decarbonisation/outcome/factsheet-uk-carbon-border-adjustment-mechanism

75 Carbon emission pricing exists in various forms. The two main approaches fall within the category of 'explicit carbon pricing,' which puts a price directly on GHG emissions (EP, 2020a). The first such approach is introduction of an emissions trading system (cap and trade), which is a quantity-based instrument. The second approach is carbon taxing, which is a price-based instrument. There is also 'implicit carbon pricing,' which refers to policies that implicitly price GHG emissions, like removal of fossil fuel subsidies or fuel taxation, and other mechanisms such as carbon crediting and internal carbon pricing.

76 See Verde (2020) for a detailed review on carbon leakage under the EU ETS and Verde et al. (2020) for a discussion of the potential of carbon leakage in the future.

carbon tax on selected products (both imported and domestic), a new carbon customs duty or tax on imports, or extension of the EU ETS to imports.

In July 2021, the European Commission adopted its proposal for a CBAM, which essentially involves application to imports of a system that replicates the EU ETS regime applicable to domestic production (EC, 2021c). After lengthy interinstitutional negotiations, the European Parliament and the Council reached political agreement in December 2022, and the CBAM Regulation was adopted in May 2023.

Under the CBAM scheme, importers will buy carbon certificates corresponding to the carbon price that would have been paid had the production taken place in the EU under the EU's carbon pricing rules. The CBAM is not a 'cap and trade' system like the ETS. Instead, CBAM certificates would mirror the ETS price. The price of CBAM certificates would be calculated depending on the weekly average auction price of EU ETS allowances expressed in €/tonne of CO_2 emitted. When a non-EU producer can show that it has already paid a price for the carbon used in production in a third country, the EU importer can fully deduct the corresponding cost.

The CBAM is an 'own resource' of the EU, just like customs duties. The application of the CBAM is directly linked to EU customs laws and it is through this system that the CBAM will be enforced. Imported goods must first be classified correctly (as CBAM application is linked to the customs classification code) and their origin must be determined correctly (in accordance with the customs rules on non-preferential origin), as only products from countries that are not exempted are covered. The person authorised for import must be the declarant in the customs meaning of the term (this means that a declarant that is not authorised, even by mistake, will have to pay the CBAM certificates and penalties). Then, EU importers must correctly calculate the embedded emissions and submit the calculation in the CBAM declaration. This will require detailed carbon accounting for the whole supply chain, which will be an exercise quite similar to what is required to claim preferential customs origin, though with the added complexity of how to calculate the carbon footprint.

Seven days after its adoption in May 2023, CBAM came into effect (EP and the Council, 2023).[77] From 1 October 2023 to 31 December 2025, a transition period applies, during which EU importers will need to comply with new obligations. These obligations involve reporting the carbon quantities in imported products. In 2023, the Commission adopted an Implementing Act (EC, 2023a) and Guidance (EC, 2023b; EC, 2023c) setting out the detailed requirements of this reporting obligation. Starting from 1 January 2026, these same operators will be required to purchase CBAM certificates corresponding to the embedded emissions of imported goods. Free allowances will phase out completely by 2034. Initially, certificates will be necessary for importing cement, fertilisers, iron and steel, hydrogen, aluminium, and electricity.

The EU Commission intends to assess whether to extend CBAM to other goods at risk of carbon emission relocation, broadening the range of products subject to the measure. Furthermore, by the end of 2025, the European Commission will evaluate the potential carbon emission relocation resulting from exporting CBAM goods to third countries. If necessary, it will propose legislative measures to address this risk.

77 See https://fsr.eui.eu/carbon-border-adjustment-mechanism-raising-climate-ambitions-and-ensuring-fair-competition/

2.3.4 What is the World Trade Organization and why is it relevant for the EU carbon border adjustment mechanism?

There is consensus among the European authorities that the design of a CBAM needs to comply with the rules of the World Trade Organization (WTO) and other international obligations of the EU such as free trade agreements. Compliance with international trade rules aims to ensure that the mechanism is not discriminatory and does not constitute a disguised restriction on international trade (EC, 2019; EP, 2020b).

How to design a WTO-compatible CBAM has been subject to discussion. On the one hand, WTO rules are designed to lower barriers against trade between countries and generally do not favour the introduction of trade restricting measures. More concretely, the fundamental principles of the WTO that are laid down in the general rules of the General Agreement on Tariffs and Trade (GATT) leave only a thin margin of possibility for the EU to implement a CBAM.[78] The GATT only allows for an exception of the general rule of non-discrimination between domestic and imported products on the grounds of human health and natural resources protection. It is on this ground that the CBAM Regulation, in recital 15, makes it clear that CBAM should not be deemed a trade protectionism measure but rather a *'climate measure'*. On the other hand, there is an ongoing debate about whether international trade rules, and specifically those of the WTO, are fit for an age with increased global climate ambitions under the Paris Agreement. Note that this is part of a wider debate about the suitability of the WTO system that predates the Paris Agreement.

2.3.4.1 Introducing the WTO

The World Trade Organization is a global international organisation dealing with the rules on trade between nations. It was established in 1995 as a successor of the General Agreement on Tariffs and Trade (GATT), which had been established in the wake of World War II and currently has 164 members.[79] The WTO operates a system of trade rules (known as the multilateral trading system) and offers a place where governments can negotiate trade agreements and settle trade disputes. The WTO system's overall objective is to help trade flow as freely as possible as long as there are no undesirable side effects.

2.3.4.2 The multilateral trade system[80]

At the heart of the multilateral trading system are WTO agreements, which are negotiated and signed by the majority of the world's trading nations and ratified by their parliaments. They cover goods, services and intellectual property. WTO agreements are essentially contracts among governments that provide the legal ground rules for international trade. Currently, there are 16 multilateral trade agreements to which all WTO members are parties and two plurilateral trade agreements to which only some WTO members, including the EU and its Member States, are parties.

The WTO agreements are lengthy and complex but there are several fundamental principles that are common to all documents. The trading system should be:

- Non-discriminatory. Two principles apply here. First, probably the most important is the most-favoured-nation (MFN) treatment, which means that countries cannot normally discriminate between their trading partners. If one trading partner is granted a special

78 For the point of view of the WTO, see for example a speech by the Deputy Director-General from September 2021, available at https://www.wto.org/english/news_e/news21_e/ddgjp_16sep21_e.htm (last consulted 28 April 2022).

79 The GATT was both an agreement, i.e. a set of rules, and an unofficial de facto organisation that was born out of that agreement. The GATT organisation was substituted by the WTO in 1995, while the GATT set of rules is still in place.

80 The following is mainly based on <https://www.wto.org/english/thewto_e/whatis_e/tif_e/fact2_e.htm>.

condition, that condition must apply to all other WTO members as well. Second, national treatment means that a country should not discriminate between its own and foreign products, services or nationals. However, equal treatment of imported and locally produced goods only applies once the foreign goods, services, trademarks, copyrights and patents have entered the market. This means that charging customs duties on imports is not a violation of the national treatment principle.

- Freer. Members aim to gradually lower trade barriers such as customs duties (or tariffs), import bans or quotas through negotiations in order to encourage trade.
- Predictable. Trading rules should be clear, transparent and predictable to make the business environment stable and encourage investment. In the WTO system, this is ensured through countries 'binding' their commitments, for example with ceilings on customs tariff rates. A country can change its bindings only after negotiating with its trading partners, which can result in a need to pay compensation.
- More competitive. In principle, trade conditions and practices should be fair, yet despite best efforts it is complex and often challenging to establish what is fair and unfair and how governments can respond to unfair practices by trading partners.
- More beneficial for less developed countries. WTO agreements contain special provisions on developing countries to give them more time to adjust and to implement agreements and commitments, greater flexibility and special privileges. There are also measures to increase their trading opportunities and provide support for building their trade capacity, handling disputes and implementing technical standards. Note in this regard the special status of China as a 'developing country,' which is a major issue including regarding more general reforms of the WTO.

WTO rules are evolving as agreements are renegotiated from time to time, and new agreements can be added to the legal body. The current set of rules are largely the outcome of the 1986-94 Uruguay Round negotiations, which included a major revision of the original General Agreement on Tariffs and Trade (GATT). There are many agreements, annexes, decisions and understandings that form the WTO legal texts. To simplify matters, they fall in six categories: the umbrella agreement that established the WTO; agreements for each of the three broad areas of trade that the WTO covers (goods, services and intellectual property); dispute settlement; and reviews of governments' trade policies (Table 2.3). Note that many of the agreements are currently being negotiated under the Doha Development Agenda, which was launched in 2001.

Umbrella	Agreement establishing the WTO		
	Goods	***Services***	***Intellectual Property***
Basic principles	General Agreement on Tariffs and Trade (GATT)	General Agreement on Trade in Services (GATS)	Trade-Related Aspects of Intellectual Property Rights (TRIPS)
Additional details	Other goods agreements and annexes	Services annexes	
Market access commitments	Countries' schedules of commitments	Countries' schedules of commitments (and MNF exemptions)	
Dispute settlement	Dispute settlement		
Transparency	Trade policy reviews		

Table 2.3: The basic structure of WTO agreements (source: WTO, 2021)

2.3.4.3 *Why is the General Agreement on Tariffs and Trade (GATT) relevant to the European CBAM?*

Hillmann (2013) and Krenek et al. (2020) explain that it is necessary to distinguish between, on the one hand, the general rules for WTO members and parties to the GATT on introducing trade restricting measures and, on the other hand, exceptions to these rules. General rules relevant to the introduction of a CBAM include the MFN principle (Article I), the *pacta sunt servanda* principle, which means that existing laws that include national tariff schedules are to be respected (Article II), the national treatment principle (Article III), the rule that quantitative trade restrictions (quotas) are to be avoided above all (Article XI) and rules on (export) subsidies (Article XVI).

Regarding exceptions, Article XX allows a party to the GATT to deviate from the abovementioned general rules. This could be the key provision regarding implementing a CBAM. Indeed, Article XX includes provisions on acting in pursuit of interests greater than trade, such as protecting the environment, public health, animal or plant life and natural resources. This article could be used as an argument to demonstrate the necessity of a CBAM even though it violates general principles (Krenek et al., 2020). Making the case that a CBAM is necessary based on Article XX is not straightforward, however. Note that there are few precedents and little guidance on its application. Another way could be to leverage Article II.2(a) of the GATT, which allows the introduction of a tax or a tariff on imports as long as it is equivalent to the burden imposed on domestic (European) producers by an internal tax or the like (Krenek et al., 2020; Lowe, 2019).

The design of a European CBAM has been subject to heated political debate, the details of which go beyond the scope of this chapter. Among the key issues involved in determining the compatibility of a CBAM with international trade rules are an environmental nexus (i.e. reducing carbon leakage must be the main purpose of the CBAM), its relation with the EU ETS and the system of free allowances, the use of revenues generated by a CBAM, questions of fairness when it comes to climate obligations for the least-developed countries and the need to avoid a design that qualifies as an export subsidy and violates the most-favoured-nation treatment and national treatment principles. Overall, given the political reality and existing international trade law, it remains a complex political and legal challenge to design a CBAM in a way that adequately prices the amount of GHG emissions stemming from producing goods imported into the EU (Bacchus, 2021).

2.3.4.4 *Why is there a debate on a reform of the WTO?*

In parallel with discussion on how to design a WTO-compatible CBAM, there is a more fundamental ongoing debate on the nature of the WTO and the effectiveness of its multilateral trading system. For some time now, the WTO has been facing a crisis that affects all three of its functions as described by the EC (2021b): *'negotiations have failed to modernise the rules, the dispute settlement system has de facto reverted to the days of the GATT where panel reports could be blocked, and the monitoring of trade policies is ineffective'*. There are multiple reasons for the crisis that go beyond the scope of this chapter, for example the trade relationship between the U.S. and China. The organisation's Appellate Body has been under enormous strain due to new appointments being blocked (Howse, 2023). In essence, the WTO members have become increasingly divided over what they expect from the WTO and (re-)discovering a common sense of purpose is deemed necessary to determine a way forward that allows the WTO to evolve in line with changes in global trade (EC, 2021b).

The European authorities see enhancing the WTO's contribution to sustainable development as one way to restore trust and a sense of common purpose. In Europe, there has been growing consensus on the need for the Paris Agreement to become one of the main guiding principles in trade policy, with all trade initiatives and policy tools being adjusted to reflect this. Note in this context that the Paris Agreement does not include a system of sanctions, which means that aligning it with WTO rules is important for it to be effective. The European Parliament is convinced that a multilateral WTO reform is needed to bring international trade law into line with the aims of the Paris Agreement and other aspects of international law (EP, 2020). Indeed, the effectiveness of the WTO system, and in particular the GATT, in terms of sustainability and its relation to national and global climate ambitions has been subject to debate for some time now.

The WTO ruling that first exposed the weaknesses of the GATT system was related to renewable energy subsidies in Canada, namely Ontario's feed-in tariff (FIT) programme, which was challenged at the WTO by Japan and the EU in 2011 and 2012.[81] The complainants claimed that the FIT programme discriminated against foreign suppliers of equipment and components for renewable energy facilities, because it included a 'buy local' component that required power generating companies that were participating in the FIT programme to source a certain percentage of their equipment in Ontario. Canada argued that the very purpose of the FIT programme was to incentivise the construction of renewable energy generation facilities that would otherwise not have been built and to create green jobs. In 2013, the Appellate Body of the WTO reaffirmed the initial ruling of a WTO panel that Canada was indeed violating the GATT and the Agreement on Trade-Related Investment Measures (TRIMs). In 2014, Canada informed the WTO Dispute Settlement Board that the Government of Ontario had complied with the recommendations and rulings by no longer subjecting large renewable electricity procurement to domestic requirements and significantly lowering the domestic content requirements for small and micro-FIT procurement of wind and solar electricity under the FIT programme.[82] This dispute attracted the attention of many scholars, both legal and not. Legal scholars have repeatedly recognised that there is a mismatch between international

81 For a comprehensive overview of the case, see <https://www.citizen.org/wp-content/uploads/ontario-feed-in-tariff-briefing-paper.pdf>.

82 See the related WTO file at <https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds426_e.htm>. A similar case is the dispute between the United States and India relating to domestic content requirements for solar cells and solar modules. The WTO file is available at <https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds456_e.htm>.

climate change mitigation goals and WTO (subsidy) law (Espa and Marín Durán, 2018) and that a reform of the WTO's subsidy rules to enable government support for renewable energy may be needed. However, other academic work shows that local content requirements do not always work the way they are intended to (Bazilian et al., 2020), that the impact on domestic welfare is ambiguous and the total amount of renewable energy produced may even decrease under a FIT programme with local content requirements (Bougette and Charlier, 2015).

In February 2021, the European Commission presented a revision of the bloc's trade policy putting sustainability at its core and prioritising WTO reform (EC, 2021a). The EC wants to put a focus on reinforcing the WTO's capacity to tackle competitive distortions and enhancing its contribution to sustainable development with initiatives that include liberalising trade in selected green goods and services, greening of aid-for-trade, transparency, including on CBAMs, and agreements to reduce fossil fuel subsidies (EC, 2020). Going forward, the EU also plans to support an interpretation of WTO provisions in international trade negotiations that '*recognises the right of Members to provide effective responses to global environmental challenges, notably climate change and the protection of biodiversity'* (EC, 2021b). Many attempts have been made to start discussions on WTO reforms in the past, and it remains to be seen how effective the new attempts by the European authorities will be.

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2.4 Renewable energy policy

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In this section, we first give an overview of what renewable energy is and explore why the EU cares about it. We then look at how renewable energy is used in different sectors. Finally, we describe the most relevant strategies and legislation to mainstream renewable energy in the EU.

2.4.1 What is renewable energy?

According to the EU's Renewable Energy Directive (2018/2001,Art. 2), as it is currently in force, wind, solar (thermal and photovoltaic) and geothermal energy, osmotic energy, ambient energy, tide, wave and other ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogas are renewable energy.[83] It is important to note that renewable and non-greenhouse gas (GHG) emitting energy sources are not synonyms according to this definition. For example, nuclear power plants do not pollute the air or emit GHG when producing electricity, but the material most often used to generate nuclear energy, uranium, is generally a non-renewable resource and as a consequence nuclear energy is not considered renewable. The 2023 amendment of the Renewable Energy Directive through Directive (EU) 2023/2413, which we will discuss more extensively below, included new definitions of renewable energy sources (RES) and some modifications of the existing ones. One of the main updates was a 'generalisation' of the definition of renewable fuels of non-biological origin (which replaces the previous renewable liquid and gaseous transport fuels of non-biological origin).

The (increasing) penetration of RES in an energy system is typically measured using metrics such as the RES share in primary energy demand or in gross final consumption of energy.[84] Regarding the power system, other metrics such as electricity production (in GWh) and installed capacity (in GW) are typically used.

2.4.2 Why does the EU care about renewable energy?

Several reasons justify the EU's interest in promoting RES. Among them is the aim to achieve a more environmentally sustainable energy system. This is seen in how RES contribute to reducing GHG emissions and local pollutants and consequently to climate change mitigation and improvement of air quality.

Furthermore, penetration of RES in the energy mix can also help with other traditional aims of EU energy policy, such as competitive energy prices and reducing reliance on fossil fuel imports. Such considerations are linked with the objectives of ensuring security of supply and price affordability, which became very pressing as a result of the energy crisis. Moreover, promoting renewable energy can create new opportunities for employment in the EU, help ensure the leadership of EU manufacturers in green technologies and contribute to overall economic growth. The benefits and risks related to decarbonisation of the energy sector are also considered in a Communication from the EC that updates the 2020 New Industrial Strategy (EC, 2021). Among other things, the document aims to promote investment in

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83 A discussion of what renewable gas is can be found in the March 2018 FSR Topic of the Month, available at https://fsr.eui.eu/what-is-renewable-gas/ (accessed 10 February 2023). A more recent discussion on renewable gases is provided in Conti (2020).

84 Gross final consumption of energy is defined in Article 2(4) of Directive (EU) 2018/2001 as the "*the energy commodities delivered for energy purposes to industry, transport, households, services including public services, agriculture, forestry and fisheries, the consumption of electricity and heat by the energy branch for electricity, heat and transport fuel production, and losses of electricity and heat in distribution and transmission*."

renewables and increase the ambitions of Member States but without overlooking dependency on foreign countries for raw materials that are strategic in new technologies (see Section 3.5 for further details).

The EU's commitment to renewable energy has long been established and is attested by Art. 194 of the Treaty on the Functioning of the European Union (TFEU), which states that Union policy on energy shall promote the development of new and renewable forms of energy in a spirit of solidarity between the Member States. However, the same article specifies that the promotion of RES shall be without prejudice to the right of Member States to determine the conditions for exploiting their energy resources, their choices between different energy sources and the general structure of their energy supply (see Section 1.2).

2.4.3 How is renewable energy used in different sectors?

The use of RES has experienced rapid growth in recent years in the EU, driven by falling costs and policy support. Through appropriate technologies, RES can be used in different sectors, namely electricity, transport and heating and cooling. For the time being, RES penetration in the electricity sector has attracted most attention due to the availability of relatively more mature technologies like solar photovoltaics (PV) and onshore wind. According to Eurostat, the share of RES in the EU electricity sector in 2022 was 41.2%.[85]

However, electricity currently represents only a quarter of European final energy consumption. The transport sector and the heating and cooling sector represent about 20% and 50% respectively.[86] These sectors cannot be ignored if one aims to achieve significant decarbonisation of the energy system, but efforts to increase the use of RES have so far obtained limited results. Among the sparse success stories are Sweden in general, or Finland and the Baltic states when it comes to the use of RES in heating and cooling. The overall EU picture looks very different, however. According to Eurostat, the share of RES was only 9.6% in the EU transport sector and 24.8% in heating and cooling in 2022. To reach decarbonisation objectives, electrification of the transport and heating and cooling sectors should go hand in hand with mainstreaming the use of RES in these sectors.

85 See Eurostat's renewable energy statistics, available at https://ec-europa-eu.eui.idm.oclc.org/eurostat/statistics-explained/index.php?title=Renewable_energy_statistics (accessed 5 March 2024).

86 See Eurostat's energy statistics, available at https://ec.europa.eu/eurostat/statistics-explained/index.php/Energy_statistics_-_an_overview#Final_energy_consumption (accessed 5 March 2024) and https://energy.ec.europa.eu/topics/energy-efficiency/heating-and-cooling_en#:~:text=Heating%20and%20cooling%20plays%20a,of%20both%20transport%20and%20electricity (accessed 5 March 2024).

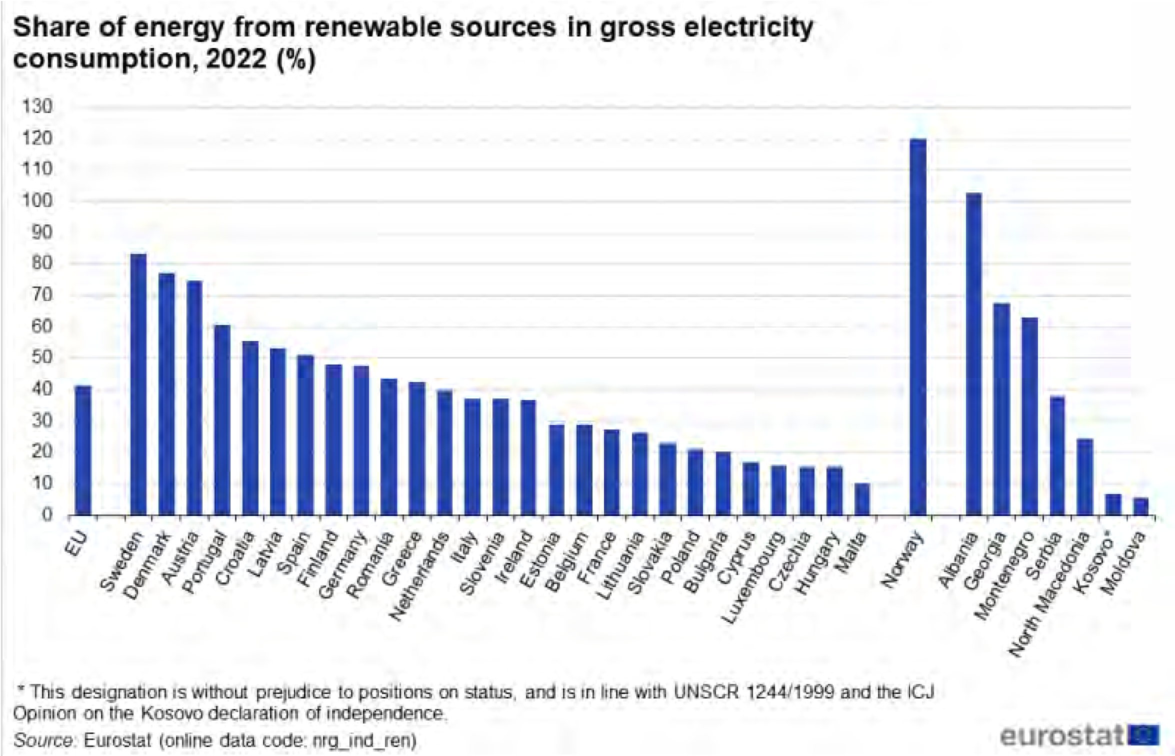

Figure 2.3: Share of energy from renewable sources in gross electricity consumption, 2022 (source: Eurostat, 2023)

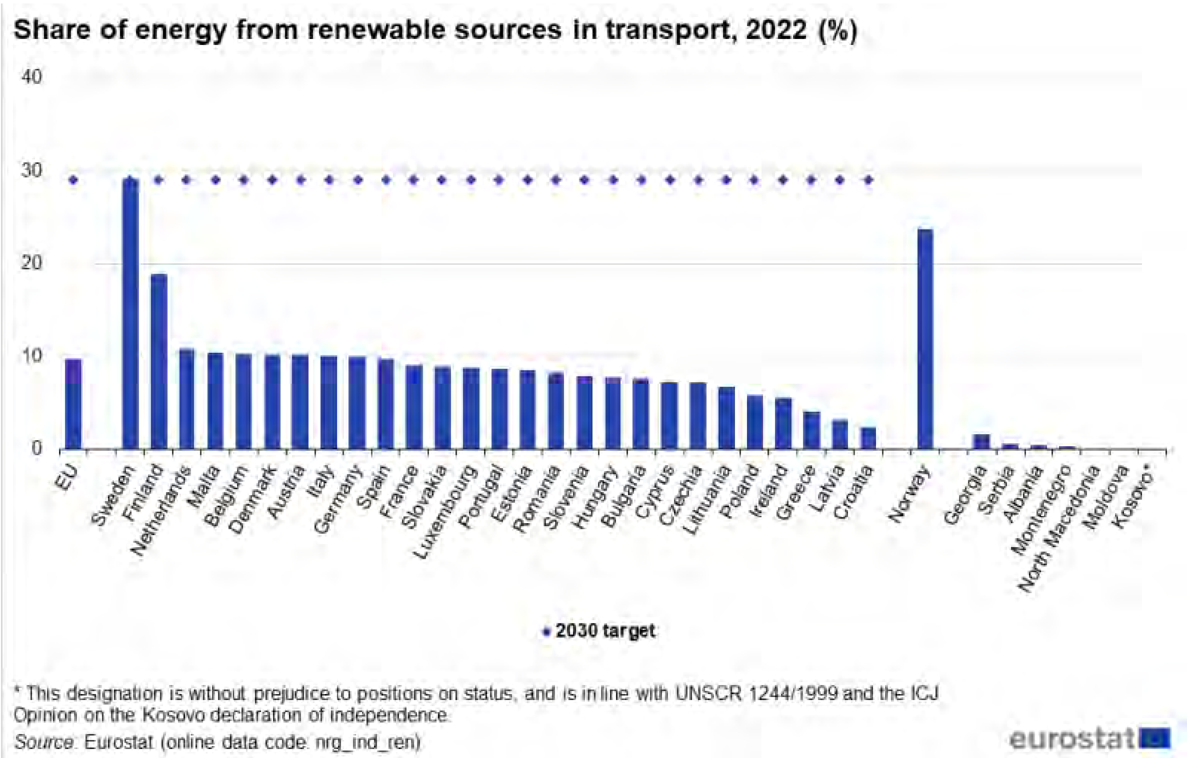

Figure 2.4: Share of energy from renewable sources in transport, 2022 (source: Eurostat, 2023)

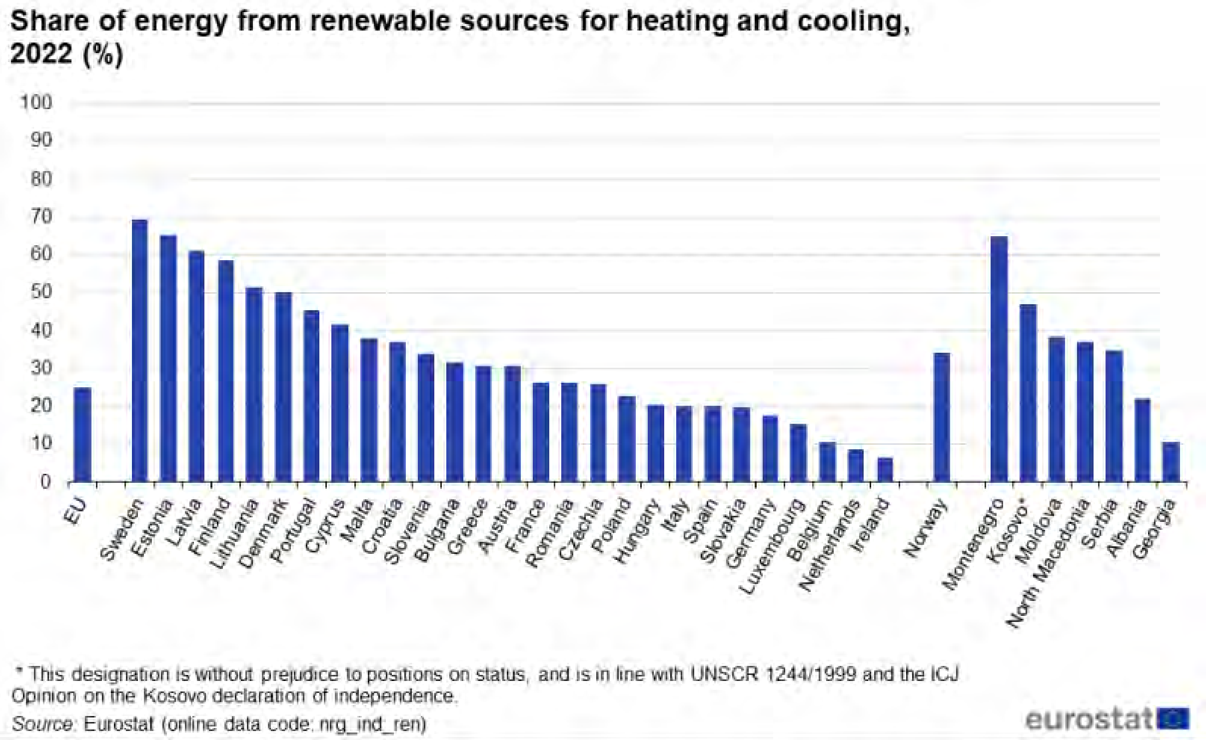

Figure 2.5: Share of energy from renewable sources for heating and cooling, 2022 (source: Eurostat, 2023)

2.4.3.1 RES in the electricity sector

In the electricity sector, RES are used to produce electricity with negligible or zero direct GHG emissions. The most relevant sources in this regard are bioenergy, hydro, solar and wind energy. Their penetration in the electricity system depends on several factors, such as the availability of primary energy resources, their cost-effectiveness vis-à-vis other energy sources and the presence of other environmental and power system constraints. Hydropower and bioenergy are considered flexible as their inputs (water and biomass) can be stored cost-effectively. In contrast, wind and solar energy are known as Variable Renewable Energy (VRE) or non-dispatchable or intermittent renewables due to their intermittent availability, which makes electricity generation not fully controllable. Therefore, a massive uptake of VRE challenges the traditional approach to electricity system operation, based on the idea that supply follows demand.

2.4.3.2 RES in the transport sector

In the transport sector, the penetration of RES is driven by the switch to renewable transport fuels and by the uptake of electric mobility (electrification), subject to the electricity being generated from renewable sources. Renewable transport fuels can be biofuels, power-to-fuels (e.g., hydrogen and synthetic liquid fuels) or biomethane. Biofuels are frequently divided into three categories or generations: first-generation biofuels are directly produced from food crops; second-generation biofuels are derived from a set of different feedstocks and do not generally involve food crops; third-generation biofuels – still at an early development stage – are obtained from algae and other such micro-organisms.

2.4.3.3 RES in the heating and cooling sector

In the heating and cooling sector, RES are used in various forms. Traditionally, biomass was utilised as fuel for space and water heating and cooking. More recently, heat pumps are being installed to provide heating and cooling with the use of ambient or geothermal energy and (renewable) electricity. Today, most of the heating and cooling needs in the EU are still satisfied with the use of fossil fuels. The European Commission has recognised the decarbonisation of the heating and cooling sector as a priority in the years to come. Further electrification, the development of highly efficient cogeneration and district heating, and the uptake of power-to-gas are considered among the main pathways to achieve the decarbonisation of the sector.

2.4.4 What are the most relevant strategies and legislation to mainstream renewables in the EU?

The promotion of RES is a long-term EU strategy, and several legislative initiatives have been taken over the years to achieve it. Among them are the establishment of an Emission Trading Scheme (ETS) (see Section 2.2), the adoption of targets to limit GHG emissions from sectors not covered by the ETS, the introduction of an electricity market design that better reflects the specificities of RES-based generation, the deployment of measures supporting energy efficiency and the definition of long-term Energy and Climate Plans (NECPs)[87] at the national level.

In addition to these policies, the EU has adopted a series of specific measures and targets for RES penetration in the energy mix. These measures and targets, which reflect the conditions in the various countries and end-use sectors, have evolved over time and aim to provide clear signals to Member States, investors, firms and energy consumers. They can be grouped according to the target year they refer to: 2010, 2020, 2030.

2.4.4.1 Targets and policies to 2010

After some early and limited attempts to promote ‘alternative energy sources’ in the 1970s and 1980s, the EU started to draw up a common policy on RES in the second half of the 1990s. In 1997, the European Commission issued a ‘White Paper for a Community Strategy and Action Plan’ (EC, 1997), which was later followed by adoption of Directive 2001/77/EC (EP and Council, 2001). The directive established two indicative targets for the use of RES in the energy sector: by 2010, 12% of gross domestic energy consumption was expected to be satisfied with RES; for electricity, the aim was set at 22.1%. Each Member State received an indicative target, which, combined with those of all the other Member States, would enable the EU to reach the overall Community target. Although national targets were not binding, Member States were expected to provide detailed justification if they had failed to meet them. With the 10 new Member States joining the Union in 2004, the 22.1% target initially set for electricity was reduced to 21%.

2.4.4.2 Targets and policies to 2020

Disappointment with the results of earlier policies, the increasing threat posed by climate change and the urgency to ensure security of supply led to the adoption of the Renewable Energy Directive 2009/28/EC (so-called ‘RED I’; EP and Council, 2009). The directive was part of the 2009 EU Climate and Energy Package, also known as the ‘2020 Package,’ and set an EU-wide binding target of a RES share of at least 20% of gross final energy consumption by 2020. This target was then allocated to individual Member States by means of binding and differentiated national targets. Note that the 20% target by 2020 for the EU was met, although not all Member States managed to meet their national individual target. The directive also set

87 For a brief overview of the NECPs, see for example a FSR blog post available at https://fsr.eui.eu/national-energy-and-climate-plans-necps/ (accessed 3 February 2023).

a minimum 10% target for the total share of RES in the transport sector that each Member State needed to ensure. However, only about half of the Member States had reached this target by 2020, while a few of them were significantly lagging behind.[88]

The RED I did not include extensive requirements for the heating and cooling sector. These were later introduced in Directive 2012/27/EU (EP and Council, 2012) on energy efficiency, which provided specific measures aiming at increasing the efficient use of cogeneration and district heating. Beyond setting targets for 2020, RED I is also important because it defined a set of policies that Member States could, or were encouraged to, implement to support the deployment of RES (e.g., support schemes, guarantees of origin, etc.). The directive also foresaw mechanisms to ensure cooperation between the Member States and third countries, such as joint projects to enhance cross-border exchanges of renewable energy, and to facilitate the achievement of national and European targets in a cost-effective manner, though little such cross-border cooperation materialised in reality.

2.4.4.3 *Targets and policies to 2030*

Discussions on strategies for the post-2020 era began soon after the 2009 Conference of the Parties (COP) 15 in Copenhagen. Notably, in 2011 the European Commission published a roadmap to 2050[89] and later issued a green paper on an energy and climate framework for 2030 (see Section 1.1). Building on the expected results of the 2020 Package but at the same time departing from some of its elements, the European Council adopted a clear set of goals and policy choices in October 2014 (Council, 2014). In particular, it was agreed that the EU should cover at least 27% of its final energy consumption with RES by 2030. It was also agreed that the 2030 target would not be broken down into binding targets for each Member State.

The political decisions taken in October 2014 were later turned into legislative proposals and subjected to the ordinary legislative procedure. As part of the Clean Energy Package, the Renewable Energy Directive (EU) 2018/2001 (so-called 'RED II'), which was adopted after intense political negotiations, set a target of at least 32% share of energy from renewable sources in the Union's gross final consumption of energy in 2030. The set target showed a higher ambition compared to the abovementioned 27%, but it was still a compromise, given that the European Parliament had proposed a target of at least 35%. The legislative process of finalising a revised Renewable Energy Directive thus resulted in an increase in ambition when compared to the preceding policy documents.[90]

A major difference from the RED I is that under the RED II the target is set at the EU level, and no allocation of individual binding targets for the Member States follows. However, Member States are obliged to define NECPs under Regulation 2018/1999 in which they explain in detail how they plan to contribute to the common European targets and what measures they expect to put in place (see Section 1.2.4.2). To promote RES, Member States typically use 'support schemes.' These are different instruments, including fiscal incentives, such as tax instruments, direct price schemes, such as guaranteed tariffs (feed-in tariffs) and market premiums, and quota obligations.[91] In practice, the use of direct price support, normally allocated following a

88 'EU energy statistical pocketbook', available at https://ec.europa.eu/energy/data-analysis/energy-statistical-pocketbook_en (accessed 3 February 2023).

89 https://www.roadmap2050.eu.

90 Note also that the EC's adoption of guidelines on State Aid for environmental protection and energy (EEAG) in 2014 already anticipated the more market-oriented approach to renewables support schemes that was introduced by RED II in 2018. The EEAG have since been amended and are now termed guidelines on State aid for climate, environmental protection and energy (CEEAG). For more information, see https://ec.europa.eu/commission/presscorner/detail/en/qanda_22_566.

91 On the rationale and application of support schemes in the EU, see Iliopoulos (2020).

competitive bidding procedure, has prevailed. In addition, Member States promote the development of RES through simplifying the administrative procedures (e.g. for permits or grid connection), facilitating the participation of investors in RES in the energy markets, properly disseminating information, etc.

However, the Commission soon recognised that an increased ambition and enhanced targets were necessary to reach the long-term goal of net-zero GHG emissions by 2050. The arrival of the European Green Deal and the 2030 increased greenhouse gas reduction target of 55% made a corresponding revision of the RES target inescapable. In July 2021, the Commission thus published the 'Fit for 55' Package and submitted a proposal for an early amendment of the RED II. It included an upward revised RES target of 40% by 2030. The energy crisis that began in late 2021 and was exacerbated by Russia's February 2022 invasion of Ukraine, added a powerful energy security rationale to the need for a rapid expansion of the share of renewable energy in gross final energy consumption. The 'REPowerEU Plan' of May 2022 (EC, 2022a; see Section 1.1) thus also included several measures to increase the roll-out of renewable energy. In December 2022, emergency Regulation 2022/2577 was enacted, specifying strict deadlines that Member States must respect during the permit-granting process for RES plants installations, and explicitly recognising that their planning, construction and operation, as well as their connection to the grid, is in the overriding public interest, which has practical consequences in the balancing with classic environmental interests (Council, 2022). In November 2023, having evaluated the performance of the emergency regulation, the Commission proposed a prolongation of Regulation 2022/2577 until June 2025 (EC, 2023a), which was subsequently adopted by the Council. In October 2023, an amendment to the Renewable Energy Directive was adopted, which raised the target share of RES in the EU's overall energy consumption to 42.5% by 2030 with an additional 2.5% indicative top up that would allow to reach 45%. This increase in ambition, too, was a result of the REPowerEU Plan, leading to a 2030 target that was higher than the originally-proposed 40% contained in the Fit for 55 legislative package. Each Member State is expected to contribute to the common target. Further, the amendment also inserted the acceleration and simplification of permitting procedures for RES projects into the directive, meaning that these provisions will remain in force even after the expiry of the aforementioned emergency measures.

By the end of June 2023, Member States had to submit draft updates to their NECPs, showing how they plan to contribute to the increased 2030 target. An assessment by the Commission of draft updates to NECPs in December 2023 revealed a gap to target, with proposed measures adding up to a 38.6-39.3% share of RES in gross final energy consumption (EC, 2023b).[92] At the time of writing, less than half of final NECPs have been submitted.

2.4.4.4 *RES in the electricity sector*

Apart from the above initiatives, the Commission has also highlighted the need for a better planning of locations for RES projects, and the facilitation of renewable energy purchase agreements. In addition, it has stressed the importance of the participation of citizens, households, local communities, and energy communities in renewable energy projects, and the optimisation of grids' use and management, including the provision of information on grid capacities by TSOs and DSOs (EC, 2022b).

In addition, in accordance with the European Parliament's amendments to the RED II revision, by 31 December 2025 each Member State shall enter into cooperation agreements to establish at least two joint projects for the production of renewable energy. In particular, countries

92 Note, however, that the Commission was only able to review 21 draft updates since six Member States did not submit their updated plans in time.

bordering a sea basin will cooperate to jointly define the amount of offshore renewable energy they plan to produce in the sea basin by 2050, with intermediate steps in 2030 and 2040 (EP, 2022). This is in line with the EU strategy on offshore renewable energy (EC, 2020), which aims to further foster the deployment of offshore renewable energy. More details are discussed in Section 3.3. Moreover, in the revised RED II, the role played by biomass as a sustainable primary energy source is reconsidered. In fact, the amendment introduced an obligation to phase out support to the production of electricity from forest biomass in electricity-only-installations (with limited exceptions), while other measures aim to reduce the risk of market distortions and of biodiversity degradation resulting from support schemes for biomass.

The amended directive strengthens the sustainability criteria for biomass use for energy, in order to reduce the risk of unsustainable bioenergy production. It ensures the application of the cascading principle, with a focus on support schemes and with due regard to national specificities.

2.4.4.5 *RES in the transport sector*

Regarding the transport sector, the revision of the RED II obliges Member States to impose new obligations on fuel suppliers. Accordingly, they shall ensure that

- the amount of renewable fuels and renewable electricity supplied to the transport sector leads to a greenhouse gas intensity reduction of at least 14.5% by 2030,
- the combined share of advanced biofuels and biogas produced from certain feedstock and of renewable fuels of non-biological origin (i.e., mainly hydrogen) will reach a minimum of 1% in 2025 and 5.5% in 2030, of which at least 1% should be of non-biological

In this regard, the directive encourages the use of advanced biofuels and biogas by limiting the amounts of first-generation biofuels that can be counted towards the target. It introduces an additional obligation for fuel suppliers: from 2030, they shall deliver at least 1.2% renewable fuels of non-biological origin and renewable hydrogen, to the hard-to-abate maritime in Member States that have maritime ports.

The amended directive gives the possibility for Member States to choose between:

- a binding target of 14.5% reduction of greenhouse gas intensity in transport from the use of renewables by 2030,
- or a binding target of at least 29% share of renewables within the final consumption of energy in the transport sector by 2030.

2.4.4.6 *RES in the heating and cooling sector*

For the heating and cooling sector, the amended directive sets an indicative target of at least a 49% renewable energy share in buildings in 2030. It provides for a gradual increase in renewable targets for heating and cooling, with a binding increase of 0.8% per year at national level until 2026 and 1.1% from 2026 to 2030. The minimum annual average rate applicable to all Member States is complemented with additional indicative increases calculated specifically for each Member State. The starting point is the RES share in the heating and cooling sector recorded in 2020. RED II already included provisions on the efficiency of district heating and cooling. It allows consumers with non-efficient district heating and cooling systems to terminate or modify their contracts. In this respect, the proposal to revise RED II emphasises provision of consumer access to information on energy performance, the share of RES and the energy efficiency of their district heating and cooling systems.

2.4.4.7 *RES in the industry sector*

The amended directive provides that industry should increase their use of renewable energy annually by 1.6%. 42% of the hydrogen used in industry should come from RFNBOs by 2030 and 60% by 2035.

Member States may reduce the contribution of RFNBOs in industry use by 20% under two conditions:

- if the member states' national contribution to the binding overall EU target meets their expected contribution; and
- the share of hydrogen from fossil fuels consumed in the Member State is not more than 23% in 2030 and 20% in 2035.

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2.5 Energy efficiency policy

Valerie Reif and Daniele Stampatori

In this section we first give an overview of what energy efficiency is and explore why the EU cares about it. We then look at areas in which energy efficiency measures are most relevant. Finally, we describe the most important strategies and legislation to mainstream energy efficiency in the EU.

2.5.1 What is energy efficiency?

According to Article 2 of the Energy Efficiency Directive (EU) 2023/1791, energy efficiency means '*the ratio of output of performance, service, goods or energy, to input of energy'*. In simple words, energy efficiency means using less energy to perform the same task by eliminating energy waste.

Energy efficiency brings a variety of benefits. It helps reduce greenhouse gas (GHG) emissions, demand for energy imports, dependence on suppliers of fossil fuels, lower the energy bills of individual households and firms, and cut costs at an economy-wide level. Improving energy efficiency is a no-regret option and often the easiest and cheapest way to reduce the use of fossil fuels. Enormous opportunities for improvements in energy efficiency can be found in all sectors of the economy, from buildings to transport, industry and energy.

2.5.2 Why does the EU care about energy efficiency?

Saving energy has been a policy objective of the European institutions and EU Member States since the oil crises in 1970s. When those crises passed, however, so did a great deal of the effort to improve energy efficiency. Over time, a realisation emerged that it was possible to delink economic growth and energy consumption, which would allow an increase in Gross Domestic Product (GDP) without a commensurate increase in energy consumption. Different energy efficiency measures were passed by the Council in the 1970s and 1980s but they did not meet expectations.

In 1998, the Commission noted that '*market barriers and falling prices […] have limited the scope and extent to which delinking has occurred, especially regarding the final or end-use of energy*' and that many of the market barriers to the rational use of energy from the 1970s had persisted to that day (EC, 1998). This was the beginning of more than two decades of sustained effort to design common co-ordinated policies and measures at both the EU and Member State levels to increase energy efficiency.

Today, energy efficiency is recognised as a guiding principle in EU energy policy and a prerequisite for reaching the Green Deal objectives. It allows ensuring cost-effective achievement of the EU's current and future climate ambitions and contributes to other EU policy objectives. Moreover, using energy more efficiently and thereby consuming less can contribute to lowering energy bills and making energy more affordable for all consumers, help protect the environment, mitigate climate change, enhance competitiveness and improve energy security by reducing the EU's reliance on external suppliers of fossil fuels.

This requires the EU and its Member States to improve energy efficiency along the full energy value chain from production to final consumption. It also means that the benefits of energy savings must outweigh the costs, for example those that result from renovations. EU measures therefore focus on sectors with the greatest savings potentials (e.g., heating and cooling, industry, energy services) and in which a harmonised approach across Member States is necessary (e.g., energy labelling).

2.5.3 In which areas are energy efficiency measures most relevant?

In the following, we briefly describe the relevance of energy efficiency measures in the areas of buildings, heating and cooling, cogeneration, energy labelling and ecodesign.

2.5.3.1 *Energy efficient buildings*

Today, buildings are responsible for about 40% of the EU's total energy consumption and for 36% of its GHG emissions from energy. Buildings are therefore the single largest energy consumer in Europe. At present, about 35% of the EU's buildings are over 50 years old and almost 75% of the building stock is energy inefficient. The renovation of the building sector is therefore crucial in achieving the EU's energy and climate goals. Better and more energy efficient buildings can also help to improve the quality of life of EU citizens and bring additional benefits for the economy and society.[93]

2.5.3.2 *Heating and cooling*

Heating and cooling in buildings and industry accounts for half of the EU's energy consumption, making it the biggest energy end-use sector, ahead of both transport and electricity. While cooling still accounts for a fairly small share of total final energy use, demand from both businesses and households usually increases during the summer months and is expected to generally increase due to climate change and rising temperatures. In 2022, renewable energy accounted for only 24.8% of total energy use for heating and cooling in the EU (Eurostat, 2023: see also Section 2.4.3.). Reducing energy consumption in the heating and cooling sector and cutting its use of fossil fuels is therefore important to reach the EU's climate goals.

2.5.3.3 *Cogeneration of heat and power*

Cogeneration is the simultaneous generation in one process of thermal energy and electrical or mechanical energy. In a traditional power plant, heat is viewed as a useless by-product of electricity generation and is released into the environment, for example through cooling towers or cooling water. In a combined heat and power (cogeneration) plant, the heat is recovered for use in homes, businesses and industry. Cogeneration plants can achieve much higher energy efficiency levels of up to 90%. Note that there are also trigeneration plants, or combined cooling, heat and power (CCHP) plants, which produce cooling for air conditioning as well as heat and electricity.

2.5.3.4 *Energy labelling and ecodesign*

The EU has set up a legislative framework for ecodesign and energy labelling to help improve the energy efficiency of products on the EU market. Ecodesign sets common EU-wide minimum standards to eliminate the least performing products from the market. [94] Energy labels provide an indication of the energy efficiency and other key features of products that aim to help consumers to reduce their household energy bills and contribute to overall EU

93 See https://commission.europa.eu/news/focus-energy-efficiency-buildings-2020-02-17_en.

94 Specific harmonised standards are the objects of other directives and regulations specific to each kind of technology. For examples, ecodesign requirements for air conditioners are regulated by Regulation (EU) No. 206/2012, which specifies, among other things, COP and EER values for minimum energy efficiency requirements and the maximum power consumption of devices in standby mode. See also https://commission-europa-eu.eui.idm.oclc.org/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/rules-and-requirements_en (accessed 2 March 2022).

climate efforts. The EU estimates that energy savings resulting from the implementation of ecodesign and energy labelling will amount to up to 230 Mtoe by 2030.

Several regulations on ecodesign and energy labelling were adopted in 2019 and were subsequently modified by so-called ‘omnibus regulations’ in 2021: Regulation (EU) 2021/341 on ecodesign and Regulation (EU) 2021/340 on energy labelling. Note also that since 1 January 2019 suppliers have been mandated to register appliances which require an energy label in the European Product Database for Energy Labelling (EPREL) before selling them in the European market. On 1 March 2021, a new A to G scale started to apply for fridges, dishwashers, washing machines and televisions in order to guide consumers towards choosing efficient products. In fact, the energy efficiency of products has continued to improve, leaving lower classes virtually empty. However, at the same time surveys show that differences between A+ and A+++ are unclear to consumers. In addition to the four product groups mentioned above, the energy labels for light sources such as light bulbs were rescaled on 1 September 2021 and other product groups will follow. Each new energy label is designed so that the A class is initially empty in order to leave room for innovation and development of new, more energy efficient models.

2.5.4 What are the most relevant strategies and legislation to mainstream energy efficiency in the EU?

This subsection provides an overview of the most relevant strategies and legislation to mainstream energy efficiency in the EU with a view to its objectives for 2010, 2020, 2030 and 2050. Note that it is not the aim of this subsection to be exhaustive due to the broad range of areas that are relevant to energy efficiency measures.

2.5.4.1 *Targets and policies to 2010*

In 1998, the Commission published a Communication on energy efficiency and the rational use of energy (EC, 1998). It recognised an urgent need to strengthen both Union and Member State commitments to promote energy efficiency more actively, especially but not only in the light of the Kyoto agreement to reduce CO_2 emissions (see Section 2.1). The available potential for energy savings between 1998 and 2010 in all sectors combined (industry, transport, domestic and tertiary) was estimated to be 18% of final annual energy consumption in 1995.

The Communication was followed by an Action Plan to improve energy efficiency two years later (EC, 2000). The initiatives planned were, among others, related to transport efficiency, an energy efficiency labelling scheme, minimum efficiency standards for equipment manufacturers, energy services offered by utilities and SMEs, and buildings. The action plan also highlighted the potential for the use of cogeneration as a way to save energy, avoid network losses and reduce emissions. It included an aim to double the use of combined heat and power (CHP) to 18% of EU electricity production by 2010. This later led to the adoption of Directive 2004/8/EC on the promotion of cogeneration, under which EU countries were required to publish national reports on cogeneration every four years.

Under the Energy Services Directive 2006/32/EC, Member States were for the first time required to prepare energy efficiency action plans, in which they described how they planned to achieve a 9% (or higher) energy efficiency improvement by 2016.

2.5.4.2 *Targets and policies to 2020*

In the 2000s, the EU was facing significant energy challenges resulting from increased import dependence, concerns over available supplies of fossil fuels worldwide and the effects of climate change. Moreover, the EU was still wasting considerable amounts of energy due to inefficiencies.

To boost the energy performance of buildings, the Energy Performance of Buildings Directive 2010/31/EU ('2010 EPBD') was introduced. Together with the later Energy Efficiency Directive 2012/27/EU, it promoted policies that aimed to achieve an energy efficient and decarbonised building stock by 2050, create a stable environment for investment decisions and enable consumers and businesses to make more informed choices to save energy and money. The 2010 EPBD introduced a definition of 'nearly zero energy buildings (nZEBs)' and required all new buildings in the EU to meet the standard by the end of 2020, and all new public buildings already by the end of 2018. It also required energy performance certificates (EPCs) based on a common and easily identifiable A-G scale to be used when advertising, selling and renting buildings.

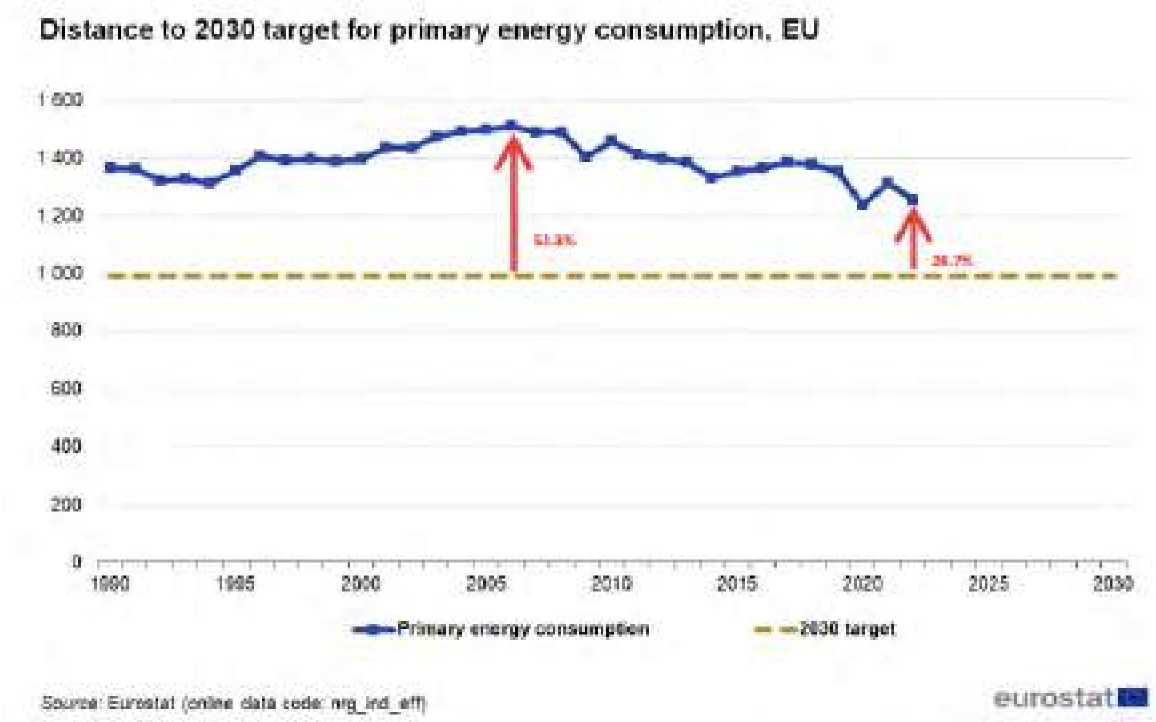
As part of the 2009 EU Climate and Energy Package (also '2020 Package'), the Energy Efficiency Directive 2012/27/EU ('2012 EED') set a target for improving energy efficiency by 20% by 2020. In other words, this was a commitment to a 20% reduction in energy consumption compared to a business-as-usual scenario. The main features of the 2012 EED are still relevant today and include (EP, 2021):

- setting upper limits on EU final and primary energy consumption;
- requiring all Member States to use energy more efficiently at all stages in the energy chain, including generation, transmission, distribution and end-use consumption;
- seeking to deliver annual energy savings through obligation schemes or alternative measures;
- prioritising energy efficiency renovation of public sector buildings;
- introducing mandatory energy efficiency certificates for the sale or rental of buildings;
- promoting energy efficient products and services; and
- upholding energy consumer rights, especially in terms of accurate and frequent consumption data.

Data show that the effects of the Covid-19 pandemic contributed to the achievement of the 2020 EU energy efficiency target.[95] In fact, the restrictions imposed on citizens' mobility led to the EU outperforming its targets by 5.8% and 5.4% in terms of primary and final energy consumption respectively. However, the termination of those restrictions led to a rebound in energy consumption. Consumption level in 2022 was 26.7% away from the 2030 target for primary energy consumption and 13.3.% for final energy consumption (Figure 2.4).[96] In addition, the update of the 2030 GHG target as part of the European Climate Law means that Member States will need to make more effort to curb energy consumption if the EU is to meet the 2030 target and the overall goal of carbon neutrality by 2050.

95 For more details look at: https://www.eea.europa.eu/ims/primary-and-final-energy-consumption.

96 The European Environmental Agency made an assessment of progress at the individual Member State level, which is available at https://www.eea.europa.eu/ims/primary-and-final-energy-consumption-1 (accessed 4 March 2022).



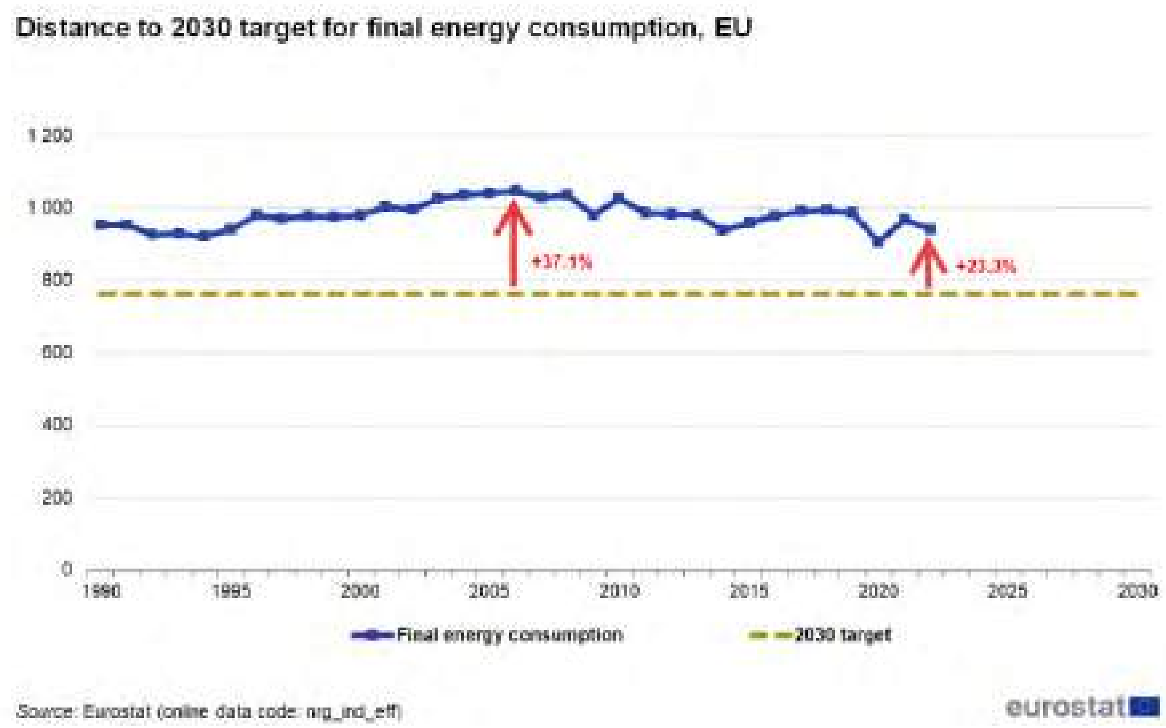


Figure 2.6: Distance to 2030 targets for primary and final energy consumption (source: Eurostat, 2023)[97]

2.5.4.3 *Targets and policies to 2030 and 2050*

A first step towards 2030 was made by the Clean Energy Package, which included three legislative acts that are relevant to energy efficiency:

- Energy Efficiency Directive (EU) 2018/2002;
- Energy Performance in Buildings Directive (EU) 2018/844;
- Governance Regulation (EU) 2018/1999.

A revision of the first two directives was proposed in the Fit for 55 Package to align them with the updated 2030 GHG target. In the following, we first describe the changes brought by the Clean Energy Package and then the changes under the Fit for 55 Package.

2.5.4.3.1 *Energy Efficiency in the Clean Energy Package*

The Energy Efficiency Directive (EU) 2018/2002 (2018 EED) increased the 2030 energy efficiency target to at least 32.5% compared to a business-as-usual scenario. As had already been the case under the previous directive, it did not impose binding national targets. Instead, the targets were to be met collectively across the EU.

An enhanced integrated framework to assess and enforce Member State progress towards the 2030 targets was agreed in the form of Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action. The regulation requires each Member State to establish a 10-year National Energy and Climate Plan (NECP) for the period from 2021 to 2030, outlining how it intends to contribute to the 2030 targets for energy efficiency, renewable energy and GHG emissions. The measures laid down in these plans include:

- Long-term building renovation strategies and targets;
- Roll-out of infrastructure for electro-mobility;
- Supporting and pushing SMEs to introduce energy management systems;
- More efficient management and use of commercial and industrial waste heat;
- Educational and awareness-raising initiatives (also involving the public sector);
- Support for local energy communities to implement energy efficiency measures.

The European Commission’s assessment of the final NECPs showed that the cumulative energy efficiency ambition would amount to a reduction of 29.7% for primary energy consumption and 29.4% for final energy consumption by 2030. This revealed a gap compared to the EU’s 2030 target of at least 32.5%, which is 2.8 percentage points for primary energy consumption and 3.1 percentage points for final energy consumption (EC, 2020a). To address the gap, Member States were encouraged to speed up building renovation, which would also provide recovery stimulus at the levels of local economies and small and medium enterprises.

The Energy Performance of Buildings Directive (EU) 2018/844 (2018 EPBD) updated its predecessor, aiming to send a strong political signal about the EU’s commitment to modernise the buildings sector in the light of technological improvements and to increase building renovations. It included updated measures related to the national long-term renovation strategies that had previously been covered under the 2012 EED. In these, each Member State was required to provide a roadmap with measures, progress indicators and indicative interim

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97 Note that primary energy consumption typically fluctuates over the years due to economic developments, structural changes in industry, the implementation of energy efficiency measures and specific weather situations. Diverging trends between primary and final energy consumption are often the result of fundamental changes in the energy system such as the switch (and therefore the increase in efficiency) between electricity generation from fossil fuels and nuclear power to wind and solar.

milestones towards the 2050 horizon to meet the Union's climate targets and facilitate the cost-effective transformation of existing buildings into nZEBs.

The 2018 EPBD also set rules on energy performance certificates, ICT use, smart automation and control technologies in buildings, infrastructure for electric vehicle recharging, national financial measures to support energy efficiency and a 'smart readiness indicator' to rate the capacity of buildings to adapt to the needs of the occupant, optimise operation and interact with the grid.

2.5.4.3.2 *Energy Efficiency in the Fit for 55 Package*

To align with the updated 2030 GHG emission target set in the European Climate Law, the European Commission (EC) proposed an update to the 2030 energy efficiency target as part of the Fit for 55 Package.

The recast of the Energy Efficiency Directive as Directive (EU) 2023/1791 introduced a new energy efficiency target that must collectively ensure a further reduction in energy consumption of at least 11.7% by 2030 compared to projections made in the EU's 2020 reference scenario. It should be noted that, in the Fit for 55 Package, the Commission had initially proposed only a 9% energy efficiency improvement. However, as with the renewable energy target (see Section 2.4.4.4.), energy security concerns following the Russian invasion of Ukraine resulted in an increase of the 2030 target, given that energy savings would make the EU more independent from Russian fossil fuel imports. This resulted in an increase of ambition, and the higher, final target of an 11.7% energy efficiency improvement by 2030. This signifies a significant step-up compared to the CEP energy efficiency target. While the CEP target corresponded to limiting primary energy consumption to 1128 Mtoe and final energy consumption to 846 Mtoe by 2030, the target of the recast directive revises these figures downward to 992.5 Mtoe and 763 Mtoe, respectively.

As in previous versions of the directive, the target is binding at the European level with only indicative national contributions. In some cases, the EC could require Member States to adopt further energy efficiency measures if their actions are evaluated as not in line with their indicated trajectories.

The recast EED gives special attention to the 'energy efficiency first' principle,[98] according to which energy efficiency (including energy saving and demand response initiatives) should be a priority in any policy or investment decisions regarding the energy system development. Moreover, whenever efficiency improvements prove to be more cost-effective or valuable than investing in supply-side infrastructure, such improvements should be prioritised. The principle should ensure that energy production is only related to real needs, investments in stranded assets are avoided, and demand for energy is reduced and managed in a cost-effective way.

This principle was already included in the 2018 EED and the Governance Regulation (EU) 2018/1999 but lacked a clear legal definition. The recast EED established, in article 3, a clear legal basis for applying the principle to the energy system and all non-energy sectors that have an impact on energy consumption and energy efficiency, public procurement processes (contracts and concessions) above a certain value, and energy transformation, transmission and distribution systems. The recast EED also includes an obligation for EU countries to ensure that energy efficiency solutions are considered in energy system and non-energy sector planning, policy and investment decisions.

98 For more discussion on the Energy Efficiency First principle under the Green Deal, see, for example, a recording of an FSR debate on 31 March 2021, available at https://fsr.eui.eu/event/implementing-the-energy-efficiency-first-approach/ (accessed 1 April 2021).

The EC has published a recommendation to EU Member States (EC, 2021b) and detailed guidelines (EC, 2021c) on proper application of the principle. The principle has also gained further momentum in the light of the REPowerEU initiative (EC, 2022a) to reduce dependence on Russian fossil fuels.

The recast EED also includes:

- a significant increase in the annual energy savings obligation: Member States must achieve new savings each year of 1.3% in 2024-2025, 1.5% in 2026-2027, and 1.9% in 2028-2030 the previous obligation was 0.8% per year);
- measures to address energy poverty, boost building renovation rates, increase uptake of energy efficiency investments, and empower and protect consumers;
- an obligation for Member States to disclose the energy consumption of their data centres;
- definitions of efficient heating and cooling systems based on minimum shares of RES that the system uses (and requirements for a gradual increase in these shares) and of efficient cogeneration to ensure fully decarbonised heat or cooling supply in efficient district heating and cooling systems by 2050;
- a requirement for Member States to carry out comprehensive assessments of the potential for high-efficiency cogeneration and efficient district heating and cooling that is coherent with the NECPs and long-term renovation strategies.

The public sector is expected to lead by example: Member States must ensure the final energy consumption of all public bodies combined is reduced by at least 1.9% per annum compared to 2021, and that at least 3% of the floor space in public buildings is renovated annually to at least nZEB or zero-emission building (see the discussion of the EPBD below) standards.

The recast of the Energy Performance of Buildings Directive (EC, 2021a), introduced by the Fit for 55 Package, set the vision and outlines the tools to achieve a zero-emission building stock by 2050. It was formally adopted in April 2024 as Directive (EU) 2024/1275. These developments build on a wider initiative to accelerate the building renovation process which was first initiated by the Commission through the Renovation Wave strategy in 2020 (EC, 2020b).[99] The recast directive refines existing definitions such as of 'nearly-zero energy buildings' (nZEBs) and 'deep renovation' and introduces a new definition of a zero-emission building. This is a building with very high energy performance in line with the energy efficiency first principle, which has its very low amount of energy required fully covered by energy from the building itself or from locally produced renewables. Zero-emission buildings should replace nZEBs as the standard for all new publicly-owned buildings from 2028 and for all buildings from 2030.

The recast EPBD aims to trigger an increase in the renovation rate of the worst-performing buildings, where the potential for efficiency improvements is greatest and the risk of energy poverty is highest. Additionally, new provisions related to energy performance certificates (EPC) have been introduced with the aim of making them more stringent and comparable across the EU. In future, they will be rescaled with a view to achieving a zero-emission building stock by 2050.

Currently-existing long-term renovation strategies will be replaced by national building renovation plans. These are more operational with a stronger monitoring framework and concrete targets for renovation by 2030, 2040 and 2050. They will be scrutinised by the EC

99 See the FSR online debate on the Renovation Wave from 18 February 2021 available at https://fsr.eui.eu/buildings-need-to-get-to-the-centre-of-the-net-zero-stage-and-we-are-all-actors-in-this-play/ (last consulted 2 April 2021).

and fully integrated into the ten-year national energy and climate plans (NECPs) prepared under the Governance Regulation (EU) 2018/1999.

Other provisions in the revised EPBD are related to:

- calculation of the life-cycle global warming potential of new buildings;
- renovation passports;
- a smart readiness indicator for buildings;
- mandatory installation of building automation and control systems for non-residential buildings; and
- phasing out of national subsidies for fossil fuel boilers.

The renovation of the building stock will be carried out according to criteria established at Member State level. For non-residential buildings, maximum energy performance thresholds, based on national primary energy use, will be set. For residential buildings, minimum energy performance standards will be set according to national trajectories.

Lastly, note that a proposal for a revised Construction Products Regulation (CPR) was published in March 2022 (EC, 2022b), and is now close to adoption. The CPR should ensure that the design of new and renovated buildings is in line with the needs of the circular economy, and leads to increased digitalisation and climate-proofing of the building stock.

Regarding the Governance Regulation, Member States needed to update their NECPs by the end of June 2023 in draft form and needed to finalise these by 30 June 2024 in order to reflect the increased climate ambitions at the EU level (i.e., the new GHG emissions target under the Climate Law and the proposed new energy efficiency target under Fit for 55). An assessment by the Commission of draft updates to NECPs in December 2023 revealed a significant gap to target, with proposed measures adding up to a 5.8% energy efficiency improvement (EC, 2023).[100] At the time of writing, less than half of all Member States had submitted their final updated NECPs by the deadline.

100 Note, however, that the Commission was only able to review 21 draft updates since six Member States did not submit their updated plans in time.

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3. EU security of supply policy

In this chapter, we focus on EU security of supply policy in five sections. First, we discuss the concept of security of supply and its perhaps most traditional area of application, the oil and gas sector. Second, we explore how security of supply considerations manifest in the electricity sector. In this context we also explain the concept of resource adequacy and the use of capacity mechanisms in Europe and their history in the electricity sector. Third, we provide an overview of how security of supply has been addressed regarding the EU's energy infrastructure. Fourth, we look at road transport and (electro) mobility infrastructure before concluding by considering the EU's strategic autonomy regarding critical minerals and technologies that will be crucial for the achievement of the Green Deal's objectives.

3.1 Security of supply and its application to oil and gas

Athir Nouicer, Daniele Stampatori, Max Münchmeyer and Andris Piebalgs

Energy security, or security of supply given the nature of net energy importer of the EU, was one of the three pillars in the first EU energy policy in 2007.[101] The Energy Union Strategy in 2015 reconfirmed the importance of this pillar by including energy security, solidarity and trust among its five dimensions. In this section, we investigate the topic in four subsections. First, we introduce the concept of security of supply. We then discuss the EU energy mix. Subsequently, we discuss security of supply of oil and natural gas.

3.1.1 The concept of security of supply

Before diving into how the European Union, and the EU Green Deal in particular, have sought to ensure energy security, it is worth briefly dwelling on the concept itself. The International Energy Agency (IEA) defines energy security as *'the uninterrupted availability of energy sources at an affordable price'* (IEA, 2023). This definition is close to that provided in the European context, for example by the European Environment Agency, which states that *'[e]nergy security or security of supply can be defined as the availability of energy at all times in various forms, in sufficient quantities, and at reasonable and/or affordable prices'* (EEA, 2004). However, it is noteworthy the precise content of the definition of energy security is debated to this day (Azzuni and Breyer, 2018), and that the short, supply-focused definitions by the IEA and the EEA may obscure the complexity of the issue. Table 3.1 below shows a synthesis of the multifaceted aspects of energy security that policymakers need to consider when thinking about how to formulate policies that guarantee a secure and affordable supply of energy.

101 For a clear understanding of what security of gas supply is and what it entails see the Cover of the Basics of 31 January 2023: https://fsr.eui.eu/security-of-supply-gas/.

Dimension	Aspects
Availability	resources, means of transport, infrastructure, energy markets, diversity of resources, diversity of technologies, fuel conversion, energy cost (affordability), energy consumers, timeframe (long-term/short-term security), interconnection network of energy systems
Resilience	the adaptive capacity of the energy systems
Energy efficiency	energy system efficiency, energy conservation, energy intensity
Environmental issues	exploitation rate of resources, the impact of environmental change
Technology	technology advancement, technological progress, energy sector integration based on electricity
Energy transition	shift to renewables; renewable electricity technologies
Energy infrastructure security	infrastructure failures, cost of securing energy system, cost of disruption, terrorist attacks
Cyber security of the infrastructure	cyberattacks on infrastructure, IT skills, software failures
Economy	impact of energy security on economic growth and development, unemployment rate, economic competitiveness
Social issues	social impact on energy production and consumption, consumption patterns and lifestyle, social acceptance of changing development patterns, literacy, social transformation and "De-growth" transition
Military	energy as a material for military purposes, energy as "a weapon"
Policy	governance, regulations, political system, energy policy, carbon tax, carbon pricing
Geopolitics and global energy governance	the geographical location of energy sources, population settlement, industrial intensity, conflicting political interests of states

Table 3.1: Dimensions of energy security in academic literature (source: Strojny, Krakowiak-Bal, Knaga, Kacorzyk, 2023)

The IEA distinguishes between short-term energy security, referring to the ability of the energy system to adapt to supply shocks, and long-term energy security, referring to the steps taken to make sure that the energy system will be able to continue to supply sufficient and affordable energy in the future. Resilience, defined in the table above as 'the adaptive capacity' of energy systems, is of key importance in managing both of these dimensions, and a determinant of how readily the energy system is able to bounce back from a sudden shock, and how well prepared it is for the structural changes brought about by the energy transition.

Throughout this chapter, we will see how these different aspects of energy security manifest in the Green Deal and interact with each other. In the rest of this section, we explore what is perhaps the most traditional notion of energy security, that of sufficient resources of fossil fuels and of dealing with the EU's high import dependence. Particularly in the area of natural gas, we see how long-term energy security and short-term energy security can interact in this regard. The structural, high dependence of the EU on Russian fossil fuels, particularly natural gas, made it vulnerable to a sudden supply shock threatening its short-term security of supply. We investigate how the EU has sought to secure its short-term energy security following the Russian invasion of Ukraine through the REPowerEU set of emergency measures and how the EU's energy mix and energy imports are changing as a result, In Sections 3.2 and 3.3, we return to the idea of long-term energy security by studying how the electricity sector is seeking to adapt to the increasing penetration of renewables in generation. In Sections 3.4 and 3.5, meanwhile, we look at two aspects of energy security that perhaps do not come to mind as readily when reflecting on this concept, but are nonetheless an important part of security of supply considerations in the EU Green Deal. We first look at the rules governing how the transport sector will adapt to the greenhouse gas reduction objectives of the Green Deal. Energy security here means ensuring the availability of sufficient transport capacity while conforming to the decarbonisation objective of the Green Deal. Finally, we consider the EU's strategic autonomy in the supply of technologies and minerals that are crucial to enabling the decarbonisation of the energy sector. That is, to enable both decarbonisation and system resilience, a precondition is the availability of technologies and commodities, for which the EU is subject to the risk of overdependency on a single supplier not dissimilar to its dependency on fossil fuel imports, but with different implications.

3.1.2 The EU energy mix

EU gross energy consumption has been relatively steady over recent decades, especially between 1990 and 2010, with a decrease following the 2009 financial and economic crisis. In 2022, EU gross energy consumption was 1,258 Mtoe, dropping from 1,313 Mtoe in 2021.[102] The EU energy mix has a diverse portfolio. Nevertheless, fossil fuels accounted for 68.4% of all energy in the EU in 2021 ('gross available energy').[103] Crude oil and petroleum products represented the biggest EU energy source with a 34.5% share. Natural gas came second with 23.7%, while solid fossil fuels accounted for 10.2%. The share of renewable energy has been increasing and accounted for 17.4% in 2020, surpassing solid fossil fuels. Finally, nuclear energy accounted for 12.7% of the gross available energy in the EU in 2020 (Eurostat, 2023). These shares differ widely among the energy mixes of the different Member States.

Energy consumption dropped in 2020 due to the Covid-19 crisis. This drop, while not driven by successful structural energy efficiency measures, led to an overachievement of the 2020 energy efficiency target by 5.8% (energy consumption was still 9.6% away from the 2030 target though). The drop also led to lower levels of CO_2 emissions. At the beginning of 2020, EU coal demand fell by 20% while RES shares reached record levels.

The energy consumed in the EU comes from locally produced energy and energy imported from non-EU countries. In 2022, the EU's import dependency rate, i.e. the ratio between net imports and gross energy consumption, was at a 63% (Eurostat, 2024). The EU imports mostly come from a few supplying countries in the form of crude oil, natural gas and coal.[104] Until recently, Russia has been the main supplier of different forms of energy. In 2020, it supplied 25.7% of EU crude oil, 45.6% of EU coal and 38.1% of EU gas needs. This has changed dramatically after the February 2022 Russian invasion of Ukraine. As of the third quarter of 2023, Russia accounts for a 3.9% share in oil imports, a 16% share in pipeline gas, and an 8.8% share of liquefied natural gas (LNG). Russia's share of EU coal imports dropped to zero in 2023 as a result of sanctions (see figure 3.1).

102 For the most recent figures, see: https://ec-europa-eu.eui.idm.oclc.org/eurostat/databrowser/view/nrg_bal_c/default/table?lang=en.

103 Gross available energy refers to the gross inland energy consumption and international maritime bunkers. More recent comparable data is not yet available.

104 The EU also imports limited amounts of electricity from neighbouring countries, such as Morocco and the Western Balkans (IEA, 2020).

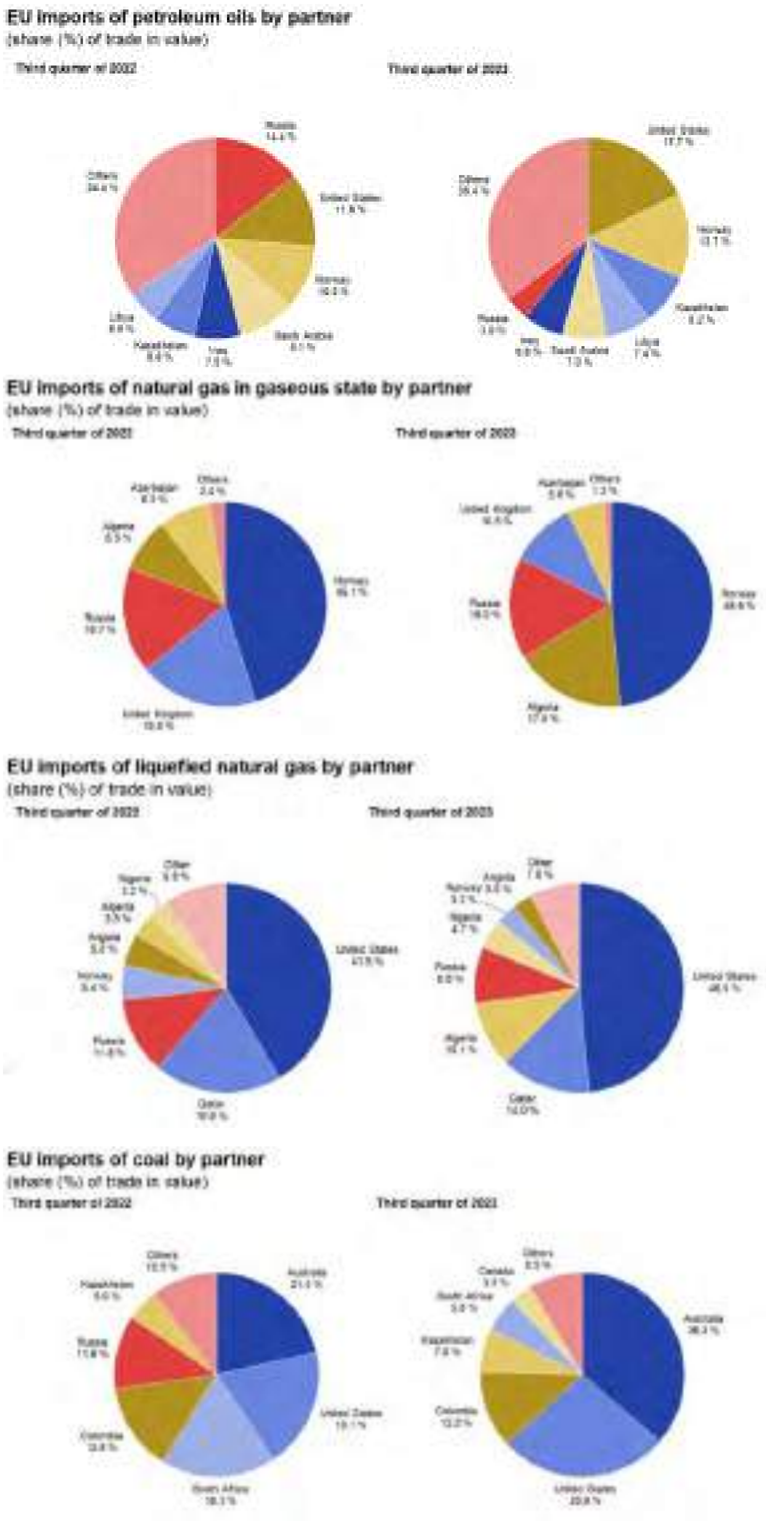

Figure 3.1: EU energy dependence by supplying country, comparison between third quarter 2022 and third quarter 2023 (source: Eurostat, 2023)

3.1.3 Security of oil supply

In the EU, oil is the largest energy source, with a relatively strong but slightly declining trend in use. Oil supply consists of crude oil, which the EU mostly imports, and refined oil products, of which the EU is a net exporter (IEA, 2020). Due to the high EU reliance on oil, it is crucial for EU Member States to maintain emergency oil stocks to guarantee security of supply.

The European Commission's (2007) Energy Policy for Europe communication highlighted the need to enhance the security of energy supply at the EU and Member State levels by reviewing the EU's oil stock mechanism to guarantee availability in the event of a crisis.

The EU's Oil Stocks 2009 Directive (2009/119/EC) requires the Member States to maintain a minimum emergency stock to cover at least 90 days of net imports or 61 days of consumption, whichever is higher. These stocks are to be kept available so they can be used during the event of a crisis. The Member States are to send a monthly statistical summary of their stocks stating how many net import or consumption days the stocks cover. They also have to put in place emergency measures for the use of these stocks. In the case of a supply crisis, the Commission is to organise a consultation between the Member States. Following this, withdrawals from the stocks are permitted. In very urgent circumstances, the withdrawal can happen before the consultation.

Other emergency measures include demand restraining programmes (e.g., driving bans, car-pooling and speed limits in the transport sector), fuel switching where possible in transport and industry, surge production of spare crude, and the allocation of available supply to prioritised consumer groups (IEA, 2020). Coordination of security of supply actions across the Member States is managed by the Oil Coordination Group.

There have been a few times in recent years when these oil reserves have been used by some Member States. For instance, summer 2018 was particularly dry and led to low water levels in the Rhine and Danube rivers. Particularly in some places these low levels were not sufficient for the passage of fully loaded barges with energy commodities such as coal, oil and biomass (IEA, 2020) and therefore reserve stocks were used to cover the shortages.

3.1.4 Security of natural gas supply

The EU is the largest importer of natural gas in the world. Natural gas represents its second most important energy source after oil (IEA, 2020a). In the period 1990-2020 imports of natural gas more than doubled, which was due to, *inter alia*, a decrease in EU natural gas production (Eurostat, 2023). EU gas imports reached their highest level in 2019. Russia has historically been the largest source of EU natural gas imports, but its share in EU gas imports has declined drastically after the 2022 Russian invasion of Ukraine (see Section 3.1.2. above).

The European Commission's (2007) Energy Policy for Europe Strategy introduced measures to promote diversification of supply for Member States that depend on one gas supplier. The Commission committed to monitoring the implementation and effectiveness of the measures included in the Gas Security Directive 2004/67/EC. The Commission added that more projects were to be developed to bring natural gas from new regions, establish new gas hubs in central Europe and the Baltic countries, optimise the use of strategic storage and promote the construction of new liquefied natural gas (LNG) terminals. The Commission also highlighted the role of mechanisms, such as the Energy Correspondents Network and the Gas Coordination Group, in strengthening solidarity between the Member States. Furthermore, more investment in storage capacity and pipelines was needed to enhance gas supply security, yet the cost should be justified to consumers.

This occurred in a period with high geopolitical tension regarding the 2006 and 2009 disruptions in the supply of Russian gas to the EU through Ukraine, which exposed some fragilities of the Gas Security Directive 2004/67/EC. Regulation (EU) 994/2010 repealing and replacing Directive 2004/67/EC on measures to safeguard natural gas supply security was the answer to these crises. It aimed to put in place the basic building blocks of security of gas supply at the national level and improve the Member States' resilience in the case of a crisis, requiring them to put in place appropriate tools to manage gas shortage effects. For instance, it introduced the so-called protected customer category and included detailed protective measures for them. In addition, it required Member States to develop full assessments of security of gas supply risks. Regulation (EU) 994/2010 also took the first steps in establishing links and consultation between the Member States to develop more coordination regarding security of gas supply.

However, the issue of security of gas supply became very relevant again in 2014 following renewed tension between Russia and Ukraine, as a result of the annexation of Crimea. In June 2014, Russian gas giant Gazprom interrupted exports to Ukraine because of the latter's non-payment of debts. In September of that year, some Member States, such as Austria, Poland and Slovakia, suffered from supply cuts due to non-delivery of ordered gas volumes, which might have been implemented to try to prevent Ukraine from purchasing gas from European traders at border points between Ukraine and the EU (De Micco, 2014). These events required further efforts at the EU and Member State levels to guarantee security of supply in winter 2014/2015 and beyond.

In 2015 as part of the Energy Union Strategy the Commission announced a revision of the Security of Gas Supply Regulation (EU) No 994/2010, further promoting resilience and diversification of gas supply. This resulted in the Security of Gas Supply Regulation (EU) 2017/1938. The revised regulation allowed Member States to assess common risks and enhance regional resilience. It also expanded gas risk assessment to the regional dimension by creating regional risk groups and introducing EU-wide simulations of gas disruption scenarios (IEA, 2020a). Furthermore, the regulation asked ENTSOG to carry out a Union-wide gas supply and infrastructure disruption simulation to produce an overview of the possible major supply risks for the EU. It also included detailed rules to safeguard solidarity among Member States as they are to help each other preserve security of supply, in particular for vulnerable consumers.

As in the oil sector, there have recently been some security of supply crises in the gas sector. For instance, in winter 2017/2018 and soon after the Security of Gas Supply Regulation (EU) 2017/1938 entered into force, Austria's Baumgarten facility suspended operations following an explosion and a fire. As a consequence, the Trans Austria Gas (TAG) pipeline, through which half of Italian imports flow, ceased operation entirely for several hours putting some parts of Northern Italy on red alert. A state of emergency was declared in Italy, which was already in a situation of tight supply-demand balance because of the cold winter. The state of emergency allowed the country to use extraordinary measures to meet energy demand, such as allowing coal and oil power plants to function at maximum capacity. Italy also increased its imports from all remaining supply routes, in particular from Switzerland and Algeria. There was also an increase in LNG supply from the Adriatic LNG facility. In this disruption, gas storage reactivity played a key role in maintaining the necessary gas supply volume (IEA, 2020; EC, 2018).

In 2021 and 2022 security of supply, in particular of natural gas, was again under the spotlight. Gas prices increased, both worldwide and in the EU. Gas prices surged for various reasons, among which were an increase in industrial activities following the Covid pandemic, lagging investments in the upstream segment of the gas supply chain, and the war in Ukraine. Dutch

TTF prices reached over 200 €/MWh in March 2022, while they had not exceeded 30 €/MWh in 2019 and 2020. During winter 2021-22, there were fears that a worst-case situation with increasing demand would lead to demand curtailment and trigger the Security of Gas Supply Regulation, such as via the solidarity mechanism.

The main objective of the Hydrogen and Decarbonised Gas Market Package, adopted in May 2024, is to promote the deployment of renewable and low-carbon gases. However, it also includes provisions aiming at improving energy security and positively impacting gas prices in the medium term. For instance, the promotion of domestic production of renewable gases would decrease import dependence.

The package extends the scope of the Security of Gas Supply Regulation to cover renewable and low-carbon gases. It also includes specific measures to improve cooperation and resilience in response to the EU-wide energy price increase in the form of more effective and coordinated use of storage facilities and facilitation of operational solidarity arrangements between Member States. Indeed, Member States must explicitly include storage in their security of supply risk assessments and state the risks linked to the control of such facilities by entities from third countries. In addition, the package sets conditions for establishing voluntary joint procurement of strategic gas stocks that can be used in emergency situations.

3.1.4.1 *REPowerEU*

In March 2022, following Russia's invasion of Ukraine, the European Commission (EC) issued a communication on 'REPowerEU', a joint European action to reduce the EU's dependence on Russian fossil fuels well before 2030, starting with gas (EC, 2022a). According to the EC, this joint action could also respond to rising energy prices, which further increased with the conflict due to uncertainty of future supply, and ensure the refilling of gas stocks for the 2022-23 winter.

Concretely, REPowerEU aims to diversify EU gas supply sources, accelerate the uptake of renewable gases and replace gas use in heating and electricity generation. As anticipated above, the diversification of gas supplies can be done by resorting more extensively to old and new external sources of LNG (e.g., Qatar and the US respectively) and pipeline imports (e.g., Azerbaijan, Algeria and Norway) and by increasing EU production of biomethane. According to the REPowerEU communication, the production and use of additional renewable hydrogen can further reduce the use of imported Russian gas.

In May 2022, the EC presented the REPowerEU Plan with concrete actions to be taken (EC, 2022b). The plan is a follow-up of the March communication and aims to outline the strategy to achieve energy independence from Russian fossil fuels by 2027. Building on the Fit for 55 Package, the plan puts forward an additional set of actions to save energy, diversify supplies, accelerate Europe's clean energy transition and smartly combine investments and reforms.[105]

3.1.4.2 *EU emergency gas measures*

To cope with the reduction of Russian gas imports and on the basis of the REPowerEU Plan, the EC proposed several emergency measures on both gas supply and demand. Some

105 For more details on the legislative developments under REPowerEU, see https://fsr.eui.eu/first-look-at-repowereu-eu-commission-plan-for-energy-independence-from-russia/.

proposals were directly related to security of natural gas supply, such as storage filling levels and burden sharing, demand-reduction measures and price caps.[106]

In June 2022, Regulation (EU) 2022/1032 was introduced. The regulation amended some articles of the previous regulation on security of supply (Regulation (EU) 2017/1938), deals with market imbalances for energy and aims to ensure well-filled gas storage in the EU before the start of the winter season. Among others, the new regulation includes a mandate for underground gas storage on EU countries' territory to be filled to at least 80% of their capacity before the winter of 2022/23 and to 90% before the following winter periods (EP and the Council, 2022). Member States that do not have storage capacities must ensure that at least 15% of their annual gas consumption is stored in another EU country by 1st November. Alternatively, Member States without storage capacities may jointly develop a burden-sharing mechanism with Member States with storage facilities.

In August 2022, Regulation (EU) 2022/1369 was adopted to coordinate measures to reduce gas demand in the EU. The regulation aimed to reduce gas demand voluntarily by 15% between August 2022 and March 2023. In the case of a severe gas supply disruption, the regulation foresaw the possibility for the Council to make the gas demand reduction compulsory by declaring a 'Union alert' on the security of supply (Council, 2022a). In March 2023, the Council reached a political agreement on a proposal to extend the Member States' voluntary 15% gas demand reduction target for one year. The regulation maintains the possibility for the Council to trigger a Union alert on security of supply, in which case the gas demand reduction becomes mandatory (Council, 2023). In March 2024, Member States in the Council agreed to let the regulation expire and replaced it with a recommendation encouraging a continuation of the measures aimed at reducing gas consumption (Council, 2024).

In December 2022, Regulation (EU) 2022/2578 was adopted, establishing a market correction mechanism to protect EU businesses and households from episodes of excessively high gas prices in the EU. The regulation entered into force in February 2023 for a one-year period (Council, 2022b). In November 2023, the Commission proposed to extend the measure for one year, which was subsequently done through Council Regulation (EU) 2023/2920.

A major novelty brought in by the REPowerEU Package was the introduction of demand aggregation and joint purchasing of natural gas through the so-called AggregateEU mechanism established pursuant to Council Regulation 2022/2576. Companies may submit part of their demand to the platform, which a service provider then seeks to match through tendering rounds. Over the course of 2023, AggregateEU matched 42 bcm of gas demand.[107]

106 For a general overview of the emergency measures introduced at the EU level, see this FSR Insight: https://fsr.eui.eu/lessons-learned-from-the-crisis-insights-on-three-newly-introduced-eu-emergency-gas-measures/ and https://fsr.eui.eu/crisis-as-a-challenge-for-the-eus-treaty-framework-for-energy-security/.

107 More information about AggregateEU can be accessed here: https://energy.ec.europa.eu/topics/energy-security/eu-energy-platform_en#aggregateeu and here: https://energy-ec-europa-eu.eui.idm.oclc.org/topics/energy-security/eu-energy-platform/aggregateeu-questions-and-answers_en

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3.2 Security of supply in the electricity sector and capacity mechanisms

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In this section, we first present the electricity mix in the EU. We then introduce the concept of security of electricity supply. We further discuss legislation relating to network security of supply. Where policymakers have been concerned that resource adequacy cannot be guaranteed through the electricity market alone, they have sometimes introduced so-called capacity mechanisms (CMs). We introduce the different types and modes of operation of CMs and then consider in detail the reasons why some countries implement them. We then present recent regulatory developments in the European Union which will impact the use of CMs.

3.2.1 Security of electricity supply

In this subsection we first present the electricity mix in the EU. We then introduce the concept of security of electricity supply. Finally, we discuss legislation relating to network security of supply.

3.2.1.1 The EU electricity mix

In the EU, electricity plays an increasingly central role in the energy transition. Considerable shares of the energy used in EU transport and heating are expected to be electrified in the future. In the past two decades, the EU's electricity supply peaked at 2,999 TWh in 2008, before falling in 2009 due to the economic crisis. In 2019, the EU's electricity supply slightly decreased by 1.2% compared with 2018 and by 2.6% compared with the 2008 peak value.[108] In 2020, electricity supply declined by 4% due to the pandemic, for a total of 2,789 TWh.[109] In 2021, electricity supply had bounced back to pre-pandemic levels (2,916 TWh), but declined to 2,824 TWh by 2022.[110]

Regarding the EU electricity mix, in 2020 renewables became the largest source of electricity in the EU, generating 38% of electricity (compared to 34.6% in 2019) and for the first time overtaking fossil-fired generation, which fell to 37%. This trend continued in subsequent years, with renewables reaching a 44% share of power generation in 2023 (Ember, 2024). In 2023, coal power generation also reached its lowest-ever levels, accounting for just 12.3% of the electricity mix. Nuclear energy made up a 22.9% share and gas a 16.8% share.

3.2.1.2 The concept of security of supply in electricity systems

Security of electricity supply is a very crucial concern in electricity systems in the context of the energy transition. It has several dimensions. On a time scale we can distinguish four dimensions,[111] which are shown in Figure 3.2: strategic energy policy; adequacy; firmness; and flexibility.

- *Strategic energy policy* is a long to very long-term issue. It relates to the availability of energy resources and infrastructure. This entails adopting measures for fuel provision and energy mix diversification. It also has to take into account the evolution of fuel prices, environmental constraints and development of interconnections.

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108 For access to the data, consult: https://ec.europa.eu/eurostat/databrowser/view/nrg_ind_peh__custom_13010789/default/line?lang=en

109 Ibid.

110 Ibid.

111 There is no common taxonomy relevant to security of supply in the literature or legislation. Rodilla and Batlle (2013) distinguish four dimensions of security of supply while Fulli (2016) adopts five dimensions. Also, AF Mercados et al. (2016) report to the European Commission and Rodilla and Batlle (2013) refer to security of electricity supply as a synonym to system reliability, while Léautier (2019) divides security of supply into adequacy and system reliability.

- *Adequacy* is a long-term issue. It refers to the existence of sufficient available resources in terms of generation, storage, demand response and network capacity to meet expected demand at all times. Note that some reports refer to flexibility for long-term needs, that is optimising network capacity investment, which would fall in this category.
- *Firmness* is a short to mid-term issue. It is the ability of the power system with already installed facilities to keep the balance between generation and demand.
- *Flexibility* is a short-term to real-time issue. It is the ability of electricity systems to cope with short-term variability, due, for instance, to intermittent renewable generation, and unexpected events and disturbances.

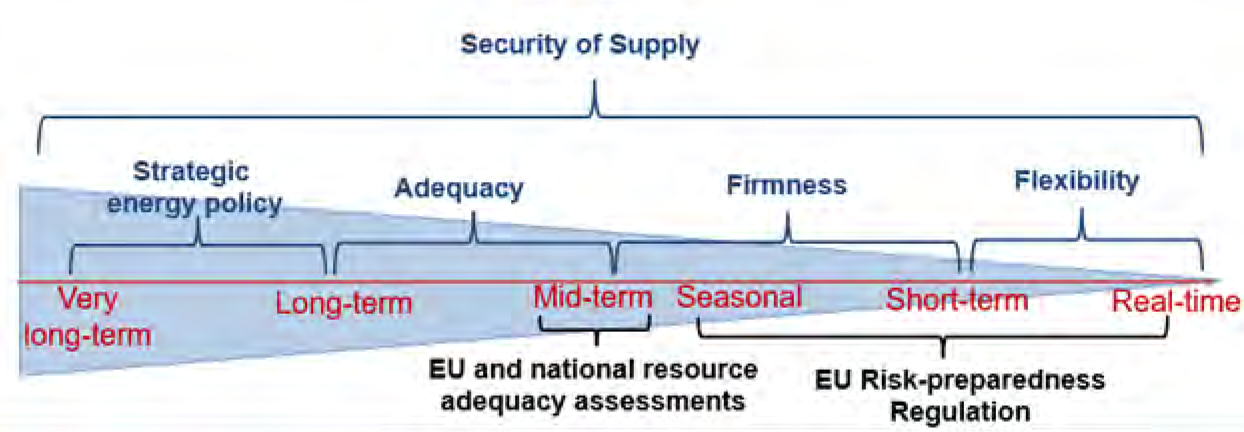

Figure 3.2: Security of supply dimensions (source: own illustration)

In the remaining part of this section, we focus mostly on measures to enhance network security of supply, i.e. measures relevant to transmission and distribution. The adequacy of the resources connected to the network, both on the generation and demand side, will be discussed in more detail in Section 3.2.2 on capacity mechanisms in the electricity sector.

3.2.1.3 Legislation relevant to electricity network security of supply in the EU

Directive 2005/89/EC, called the Security of Electricity Supply Directive, established the main framework for security of electricity supply. It required the Member States to adopt measures ensuring security of supply but, being a directive, it left implementation to the Member States. The directive aimed to set an adequate level of generation capacity, appropriate interconnections between the Member States and an adequate balance between supply and demand.

The experience with the Italian blackout in 2003 was one of the reasons that action was taken at the European level on security of electricity supply.[112] For network security, Directive 2005/89/EC asked the Member States to ensure that transmission system operators (TSOs) set minimum operational rules, and to comply with them. For generation adequacy, Member States were allowed to take additional measures to facilitate the entry of new generation capacity and promote interruptible supply contracts.

The Third Energy Package clarified the role of national regulatory authorities (NRAs) and TSOs. It made ENTSO-E responsible for adopting an EU-wide ten-year network development plan (see Section 3.3). The CEP Regulation (EU) 2019/941 on risk preparedness in the

112 The final report of the investigation committee on the 2003 Italian blackout is available at https://www.entsoe.eu/fileadmin/user_upload/_library/publications/ce/otherreports/20040427_UCTE_IC_Final_report.pdf (last accessed 30 March 2022).

electricity sector eventually repealed Directive 2005/89/EC. Instead, it established a common framework for rules on risk identification and assessment. ENTSO-E was tasked with establishing a common methodology to identify regional electricity crisis scenarios and assess possible seasonal and short-term adequacy issues. The process is subject to public consultation and approval by ACER (see Section 1.5 for more information on the various entities mentioned in this paragraph). The regulation also established an EU-level monitoring of electricity crises. When there is a crisis, the Member State's competent authority is mandated to carry out an ex-post evaluation of the crisis and its impact.[113]

3.2.2 Capacity mechanisms

Capacity mechanisms remunerate generation, storage, or demand side resources for their availability rather than for their energy production. They typically award payments based on resources' capacity availability during scarcity situation (or 'de-rated MW'). The contracts awarded in the context of these mechanisms can last from one to 20 years and are typically concluded from 1 to 5 years ahead of delivery.

These mechanisms can differ in several key respects. First, they can be price-based or volume-based. In price-based mechanisms, policymakers set the price for the capacity allocated in advance, ideally stimulating investment in this capacity. In volume-based mechanisms, the central authority, e.g. the TSO, defines the total required capacity while the price is set by the market. The latter is more in line with Regulation 2019/943 on the internal market for electricity (Electricity Regulation), which stipulates that the remuneration of CMs should be determined through a competitive process.

CMs can be an additional source of revenue for all market participants or can be targeted at specific resources. The typical form of targeted mechanism is the strategic reserve. It consists of compensating a restricted amount of peak capacity providers, selected through a competitive auction. The contracted power plants cannot participate in the electricity market and are only activated in the case of extreme conditions. The 2016 European Commission Sector Inquiry highlighted strategic reserves as the most appropriate mechanism for circumstances in which temporary or local adequacy concerns are identified (EC, 2016). The Electricity Regulation stipulates that Member States should consider the implementation of a strategic reserve in priority.

When a strategic reserve is not capable of addressing their national adequacy issue, Member States can alternatively implement a market-wide CM. Such CM can be centralised or decentralised. In a centralised CM a designated buyer, typically the CM operator or TSO, purchases the capacity required on behalf of suppliers or consumers, e.g. via a capacity auction. In a decentralised CM an obligation is put on certain parties (typically suppliers) to contract the capacity they require.

Finally, market-wide centralised mechanisms are differentiated by the type of contracts auctioned. The basic contract type consists of a fixed payment to capacity providers, over a fixed period, and subject to penalties for non-availability. The other main contract type is the reliability option. It offers the CM operator the option to procure electricity at a predetermined strike price. In practice, the capacity provider receives a fixed payment, and must pay-back the difference between the energy market price and the strike price when the latter is reached.

113 An example of the mandated ex-post evaluations is provided in the report issued in July 2021 regarding the Continental Europe Synchronous Area separation that took place on 8 January 2021. More information is available at https://www.entsoe.eu/news/2021/07/15/final-report-on-the-separation-of-the-continental-europe-power-system-on-8-january-2021/.

This provides a strong incentive for capacity providers to be available during scarcity situations. In the 2016 Commission Sector Inquiry, reliability options were highlighted as the most appropriate mechanism when long-term adequacy concerns are identified.

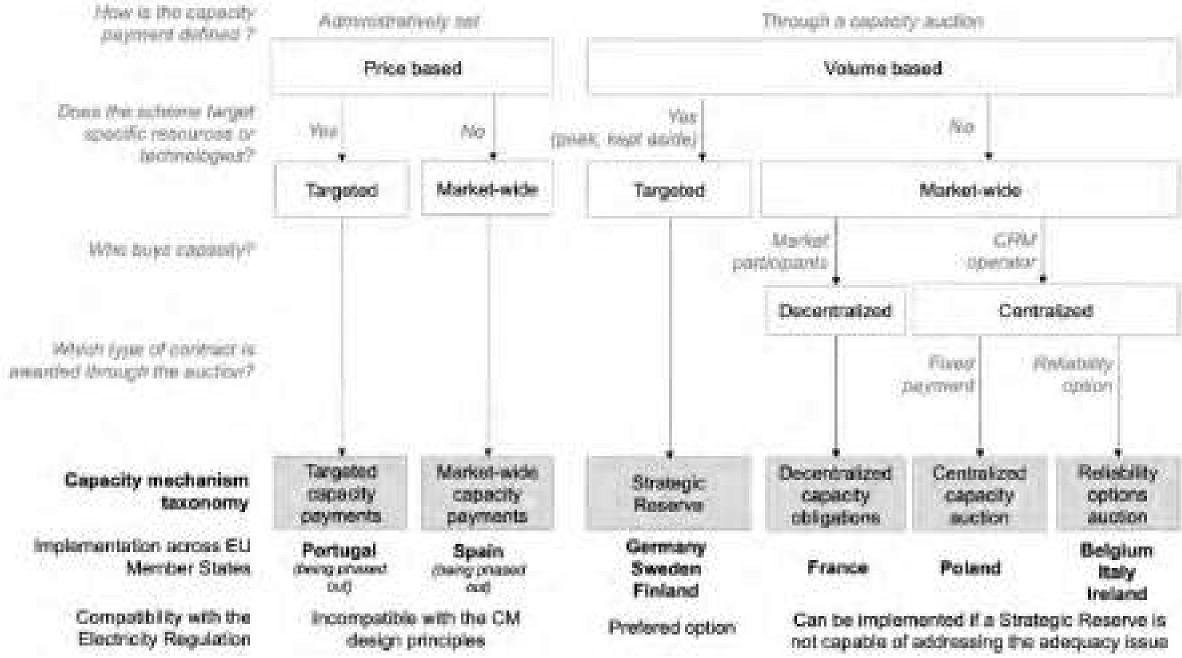

Figure 3.3: Taxonomy of capacity mechanisms, their implementation across EU Member States and their compatibility with the Electricity Regulation (source: own illustration based on ACER, 2023)

3.2.2.1 Current implementation of CMs in the EU

In the EU, eight Member States currently operate some form of CM (Figure 3.4; ACER, 2023). Strategic reserves are used in Finland, Germany and Sweden. Reliability options are in place in Ireland, Belgium and Italy (approved under State Aid rules respectively in 2021, 2021 and 2018). Meanwhile, decentralized capacity obligations are used in France. Finally, CMs in Spain and Portugal only apply to select legacy installations.

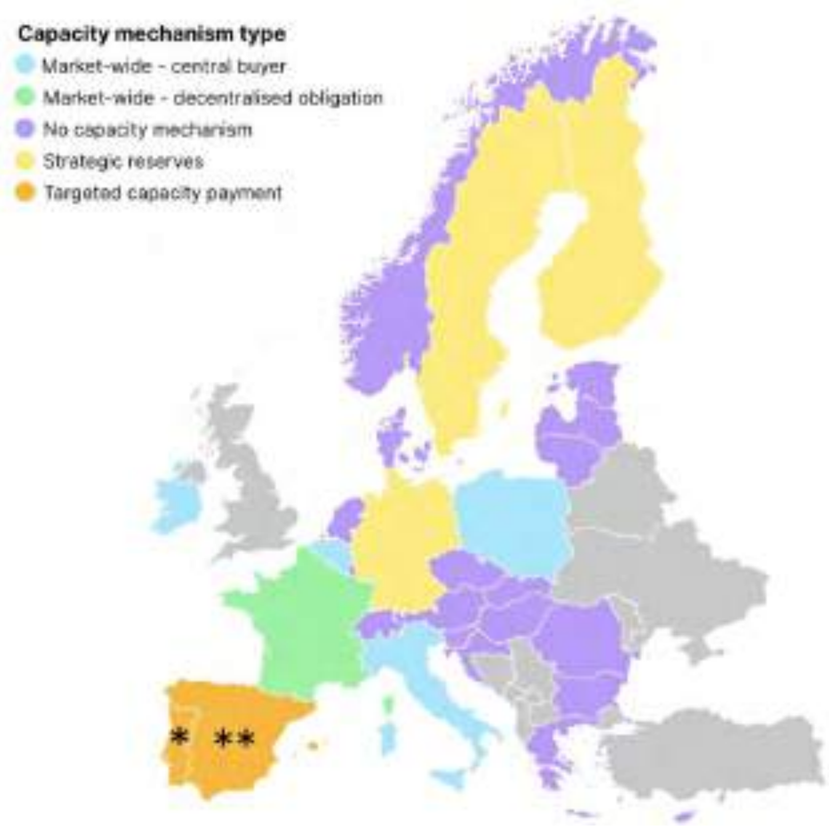

Figure 3.4: Status of capacity mechanisms in the EU – 2022 (source: ACER, 2023)

In 2022, 176 GW of generation capacity was remunerated through CMs, corresponding mostly to gas-fired, nuclear, hydro and coal-fired plants. The perimeter of CMs has increased over the past years, as well as their cost which is expected to reach above €7 billion per year in 2023. The ACER provides detailed information on the current implementation of CMs in its annual Security of EU electricity supply report (ACER, 2022 and 2023).

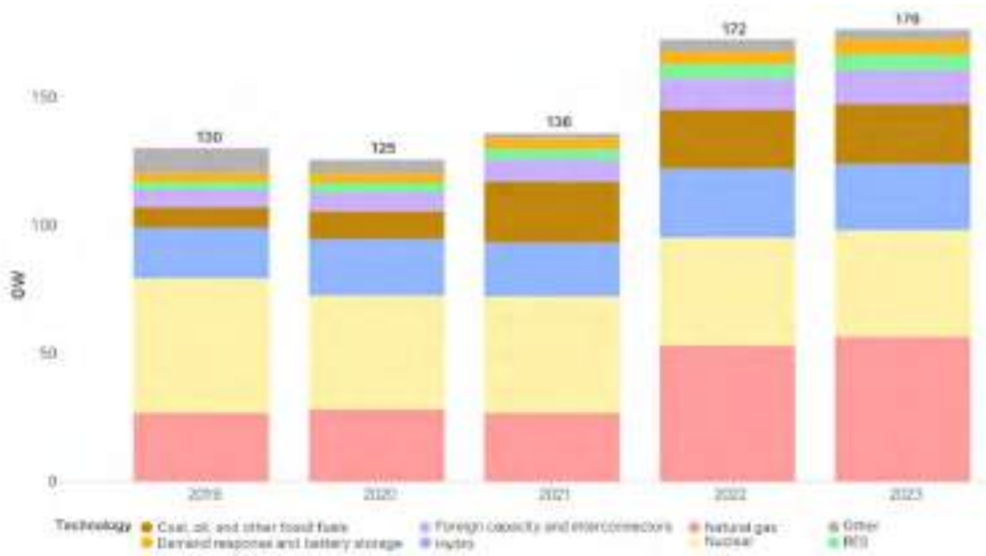

Figure 3.5: Total capacity remunerated in EU capacity mechanisms, per type of technology — 2019–2023 (GW) (source: ACER, 2023)

3.2.2.2 *Reasons for the implementation of capacity mechanisms*

The question of resource adequacy and the need for CMs has been extensively debated in academia (see, for instance, Batlle and Pérez-Arriaga (2008), Hancher et al. (2022), Schittekatte and Meeus (2021) and Pototschnig et al. (2022)).

Economics-based arguments in favour of the adoption of CMs range from a missing money argument to a missing markets argument. The missing money problem refers to the situation where marginal generators do not receive enough revenue to cover their investment costs. In the early 2000s, the California crisis, which involved severe electricity shortages and blackouts, showed that companies might sometimes abuse their market power, driving up electricity prices and earning windfall revenues. Therefore, most US electricity markets introduced price caps to limit this abuse, which in turn could create a missing money problem if the caps were applied too strictly. This problem can also emerge because of market interventions other than price caps. For instance, operating reserve targets and system operators' reliability constraints may also complicate price formation processes in a situation of scarcity (Joskow, 2006). Furthermore, with the increasing penetration of RES, the missing money problem has been aggravated due to the price impact of subsidised RES at the expense of other technologies with higher variable costs (Roques, 2019). Indeed, subsidised RESs with close-to-zero marginal production costs drive down wholesale prices to a level where technologies with higher variable costs, such as coal and gas, have no incentive to produce electricity. An example of missing markets is that companies would like to hedge their exposure to volatile power prices in the long term, but the contract length of transmission rights across borders is typically limited to one year (Meeus and Nouicer, 2020).

Others have argued that CMs can be explained by political economy rather than microeconomics. After the financial and economic crisis of 2008/2009, many new gas-fired power plants that required substantial investments were not running much because of the drop in demand and the penetration of renewables. CMs paying these plants were seen by some as state aid to national companies that made wrong investment decisions, while others see them as essential to ensure backup capacity. Furthermore, Léautier (2019) argues that in most countries employees of system operators, regulators and governments favour implementing CMs as they do not want to be blamed in the case of a blackout.

Schittekatte and Meeus (2021) and Pototschnig et al. (2022) look at the future of resource adequacy in the context of more frequent extreme weather events and volatile prices. Pototschnig et al. (2022) state that high sudden prices may be worrying for investors as they might attract government intervention, potentially introducing price caps. They suggest that hedging requirements for suppliers in combination with CMs could provide stabilize revenue streams for the entities selling electricity. However, they question whether CMs will be a temporary measure as presented in EU legislation and what the preferred CM would be to address long-term adequacy concerns. They argue that reliability options are a mechanism that meets all the requirements for CMs stated in EU legislation. This was highlighted in the 2016 European Commission Sector Inquiry as the most appropriate mechanism to address long-term adequacy concerns (EC, 2016). They add that when combining reliability options and hedging instruments the latter should not provide coverage for prices above the reliability option's strike price.

Schittekatte and Meeus (2021) argue that continuing to consider resource adequacy to be a public good would lead to over-procurement of capacity in fully centralised CMs and therefore high costs for consumers. With the increasing fluctuations in the supply-demand balance and the asymmetry of information between regulators and consumers adopting behind-the-meter technologies, they suggest that the time has come to start considering resource adequacy to be a private good. This would be translated into letting consumers individually choose their reliability levels. Several priority service schemes have been proposed in the literature with different levels and durations of guaranteed supply and for different prices. However, the implementation of such a scheme has not yet taken place.

3.2.2.3 Clean Energy Package: limiting the use of capacity mechanisms

CMs risk fragmenting the internal market, distorting competition and creating market entry barriers. In 2014, the Guidelines on State Aid for environmental protection and energy (EEAG) 2014-2020 for the first time adopted criteria to be applied by the Commission when assessing CMs. In 2015, the Commission launched a state aid sector inquiry into the national CMs, which provided information on CM implementation, their contribution to security of electricity supply and the distortions they create (EC, 2016). It complemented the Commission Energy Union Strategy and provided input for the CEP, which created a legal framework to introduce CMs, principally through a recast of the Electricity Regulation, adopted as Regulation (EU) 2019/943.

The CEP preserves the Member States' national competencies in the matter of security of supply and the implementation of CMs. Nevertheless, CMs are only to be implemented if the need for them is demonstrated by an EU-wide adequacy assessment,[114] which can be complemented by national adequacy assessments.[115] When CMs involve state aid, they are subject to the EU state aid rules, i.e., they must be compatible state aid under Art 107(3)c) TFEU (see Section 4.8 of the 2022 Climate, Energy and Environmental Aid Guidelines (CEEAG)).

If adequacy assessments identify adequacy concerns, the concerned Member States are first to adopt an implementation plan that includes measures to eliminate the causes of the

114 The Electricity Regulation (EU) 2019/943 sets the high-level characteristics of the European resource adequacy assessment (ERAA). It is to identify resource adequacy concerns by assessing the electricity system's overall adequacy for the current and projected electricity demand and covers each year in a ten-year period. The ERAA's methodology was drafted by ENTSO-E and approved by ACER in 2020 for implementation as of 2021 (ACER, 2020). The Member States are to assess the adequacy assessment outcome against their reliability standards in order to identify adequacy concerns.

115 See the Commission approval process of the Belgian capacity mechanism which investigated whether it was in line with the EU State aid rules or not (EC, 2021).

adequacy problems, i.e. regulatory distortions and/or market failures, by increasing interconnection and internal grid capacity with a timeline for adopting these measures. If there are residual concerns, meaning there are problems that market reforms cannot solve, then CMs can be introduced as a measure of last resort. The CEP Electricity Regulation provides implementation principles for CMs. Among the principles to be followed, the Member States are to conduct a study of the cross-border effects of such mechanisms and consult with neighbouring countries. Member States are also to first assess the alternative of strategic reserves. Moreover, CMs must be temporary, i.e. the Commission can approve them for no more than ten years. In addition, they are to be open to participation by all suitable resources, including DERs and mechanisms other than strategic reserves, and open for explicit cross-border participation.[116]

The CEP Electricity Regulation also introduced measures aiming to align CMs with the EU's climate neutrality objectives. It sets emission limits for Member States willing to subsidise generation units, reflecting the principle that CMs shall not be a vector for the most polluting coal power plants in Europe to receive state aid. An Emission Performance Standard (EPS) for CMs was introduced in the Electricity Regulation. Generation capacities that went online after 4 July 2019 can only participate in CMs if they emit less than 550 g of CO_2 of fossil fuel origin per kWh. A grandfathering clause was also introduced for mechanisms that were concluded before 31 December 2019. Generation capacities that went online before 4 July 2019 will not be able to receive capacity payments or commitments for future payments starting from 1 July 2025 if they emit more than 550 g CO_2 of fossil fuel origin per kWh of electricity and more than 350 kg CO_2 of fossil fuel origin on average per year per installed kWe.

In addition to these emission limits, other requirements were introduced in the CEEAG (EC, 2022) to better align CMs with the Union's climate targets. When new investments in energy generation based on natural gas are incentivized, Member States must explain how they contribute to meeting the Union's climate targets. In particular, Member States must explain how they will avoid a lock-in effect.[117]

3.2.2.4 Electricity Market Design Reform: reinforcing and extending the role of capacity mechanisms

The Electricity Market Design (EMD) reform (specifically, EP and Council, 2024) recognizes that CMs can '*play an important role in ensuring resource adequacy, in particular during the transition towards a carbon-free system*'. Article 21 and 22 of the Electricity Regulation were amended, so that CMs are *'no longer considered to be measures of last resort*'. Moreover, the reform tasks the Commission with addressing the possibility of streamlining and simplifying the CM approval process..[118] As a result, the introduction and approval of CMs is expected to be made easier and faster for Member States.

The streamlining process is also expected to mark a step towards more harmonisation of CMs. The CEP obliges Member States to respect key overarching principles when designing CMs. However, considerable leeway remains in the design choices (de-rating factors, capacity

116 Cross-border participation in capacity mechanisms is not very common. Nevertheless, this situation is changing. For instance, France and Ireland are developing plans to allow cross-border participation in their capacity mechanisms (RTE, 2019). The Electricity Regulation also sets cross-border participation rules in capacity mechanisms, which are to be open to explicit cross-border participation to limit distortions to cross-border trade and to provide incentives for interconnection investments to ensure EU security of electricity supply at the least cost.

117 See paragraph 369: "For example, this may include binding commitments by the beneficiary to implement decarbonisation technologies such as CCS/CCU or replace natural gas with renewable or low-carbon gas or to close the plant on a timeline consistent with the Union's climate targets" (EC, 2022).

118 The Commission is expected to come forward with a proposal in 2025.

demand definition, cost recovery, availability checks, penalty rules, eligibility procedures, contract length and definition, auction types, calendar and frequency, etc.). This has resulted in a relative heterogeneity among the national CMs introduced. The additional guidelines provided by the Commission through the streamlining approach have the potential to set a basis for more harmonisation among national CMs.

Another major novelty of the EMD reform is the possibility for Member States to introduce flexibility support schemes. Such schemes do not fit into the typical definition of CMs which are focused on procuring firm capacity. However, the energy transition requires extending the usual perimeter of CMs to include flexibility needs. A decarbonized system is characterized by a high penetration of variable renewable generation and a reduction in the availability of dispatchable resources. The need for flexibility is therefore expected to increase, while the availability of resources providing such services is expected to decrease. In other words, flexibility may become scarce in the electricity system, thereby resulting in inadequacy (i.e. the inability to equalize supply and demand at all times). Dedicated support schemes may be needed to ensure that non-fossil flexibility resources are adequately deployed to maintain Member States security of supply.

Following the EMD reform, Member States should periodically assess the need for flexibility at national level over the next 5 to 10 years, using a common European methodology.[119] Based on this assessment, Member States must define an indicative target for non-fossil flexibility, precising the specific contributions of demand response and energy storage. These objectives should be included in the Member States NECPs. Based on these objectives, the Commission should moreover define a Union strategy on flexibility, and put forward an accompanying legislative proposal. When the objective cannot be reached by the removal of market barriers and existing investments, Member States are able to apply '*non-fossil flexibility support schemes*'. These schemes consist of payments to the available capacity of non-fossil flexibility and must respect some overarching principles. The support schemes should, inter alia, only support new investments, and endeavour to take into consideration locational criteria. Member States already applying a CM should consider redesigning its criteria or features to promote the participation of non-fossil flexibility. Alternatively, they can choose to introduce a separate dedicated support scheme.

Finally, the EMD reform adds the possibility for Member States to derogate from the CO_2 emission limits introduced in the CEP. The derogation can only be granted for existing generation capacity that started commercial production before the entry into force of the CEP (July 2019) and can only apply to CMs already approved before that date. This derogation is temporary and last resort. In particular, the procurement of generation capacities exceeding the CO_2 emission limits should be preceded by a procurement process aimed at maximizing the participation of capacity that meets the CO_2 emission limits.

119 The methodology must be jointly developed by the ENTSO-E and EU-DSO entity, submitted within 9 months following the entry into force of the EMD reform, and approved by ACER.

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3.3 Energy infrastructure

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This section first presents the state of electricity, natural gas and hydrogen transmission planning in the EU and the main recent developments. Second, we present CO_2 networks and storage and the recent relevant provisions about them. Third, we introduce the impact of offshore generation on the transmission grid infrastructure. Fourth, we describe the latest developments in electricity and gas distribution network planning. Finally, we discuss the European Commission's recent publication of a dedicated Action Plan on grids.

3.3.1 Transmission planning: electricity, natural gas and hydrogen

Across EU Member States there are significant differences in the size and topology of electricity and gas networks. National transmission system operators (TSOs) typically prepare their National Development Plans (NDPs) in a process that can, for instance, involve the National Regulatory Authority (NRA) or the relevant ministries. NDPs, which are binding for TSOs, include the network upgrade needs for the medium to long term and typically consider different development scenarios.

TSOs are normally the promoters of new transmission lines, both within their franchise and cross-border. However, available cross-border capacity used to be fairly limited, especially for electricity, with TSOs been slow in adding new capacity in the first years after the liberalisation of energy markets in the late 1990s. In order to address this issue, one important regulatory innovation in the EU was allowing commercial parties to invest in new electricity cross-border infrastructure. More specifically, Regulation EC 1228/2003 opened the door for third party investment in transmission, which is referred to as merchant transmission line investment, under certain conditions listed in Article 7 of the above-mentioned regulation. In return, private investors are not subject to third-party access obligations and receive congestion rents, i.e. the price difference between the two bidding zones at each end of the interconnector multiplied by the congested capacity of the interconnector. To date, only seven exempted projects have been carried out in the EU (Gautier, 2020). The actors behind these projects are different in nature. Examples are BritNed, which is a joint venture of two TSOs, and ElecLink, an owned subsidiary of Getlink, the company owning the Channel Tunnel (Schittekatte et al., 2020).

Europeanisation of network planning came in the Third Energy Package with the establishment of ENTSO-E and ENTSOG, requiring them to develop Ten-Year Network Development Plans (TYNDPs) for electricity and gas on a biennial basis and building on the NDPs. Although they are non-binding, TYNDPs aim to provide market participants with a vision of the evolution of European transmission systems over a ten-year period and indicate the key infrastructure that needs to be built or upgraded (Glachant et al., 2017).

Probably the most important tool to allow the establishment of a truly European transmission network for energy is the development of Trans-European Networks, which were established by Regulation (EU) 347/2013, referred to as the TEN-E Regulation. The TEN-E Regulation made the TYNDP the unique basis for transmission projects to be included in the Projects of Common Interest (PCI) list. A PCI is defined as a necessary project to implement energy infrastructure priority corridors and areas that are listed in Annex I of the same regulation. Priority corridors established by the TEN-E Regulation are, for instance, the Northern Seas offshore grid for electricity and the North-South gas Interconnections in Western Europe (NSI West Gas). Besides electricity cables and gas pipelines, the regulation also considers smart grids and cross-border carbon dioxide (CO_2) networks. The PCI list has been updated every two years since the publication of the first list in 2013. Projects that obtain PCI status benefit from enhanced transparency and public consultation on the permit granting process, i.e. via one single national competent authority, improved environmental assessment, a permit-granting process that should not exceed 3.5 years and the possibility of receiving financial assistance under the Connecting Europe Facility (CEF).

In December 2020, the European Commission published its proposal for a revision of the TEN-E Regulation as part of the Green Deal. A political agreement was reached in December 2021. The European Parliament adopted its position in first reading on the Regulation in April 2022. Then, the Council adopted its position in May 2022 (Council, 2022). The final text of the revised TEN-E Regulation was published in June 2022 on the Official Journal of the European Union.[120] This revision aims to better align the regulation with the Green Deal climate objectives. The revised regulation targets supporting the infrastructure that serves clean energies and should stop supporting infrastructure projects transporting fossil fuels in general. Candidate projects should, for instance, meet mandatory sustainability criteria.

With the revision of the TEN-E Regulation, a new focus is given to offshore electricity grids, hydrogen infrastructure, smart electricity and gas grid investment, certain types of electrolyser facilities and CO_2 infrastructure. Natural gas infrastructure and oil pipelines lose their PCI status eligibility under the revised TEN-E Regulation. Although it is recognised that natural gas will play a role in the energy transition during the next decade, in the longer term it will be replaced by renewable gases, as described in Section 5.4., e.g. biogas and hydrogen. So far, the TEN-E Regulation has promoted the development of a European secure interconnected natural gas network. After completion of ongoing projects, the Member States will benefit from diversified supply, and the Commission does not see further needs to support cross-border natural gas projects (EC, 2020d). In addition, some part of the natural gas infrastructure is expected to be repurposed to transport hydrogen. Such repurposing of the natural gas infrastructure can contribute to a cost-effective energy transition, e.g. reducing stranded assets, and would cost up to 90% less than building new hydrogen pipelines (EC, 2020a). However, there is still some uncertainty about the future demand for hydrogen transport capacity, since the volumes and the geographical distribution of hydrogen demand and supply are still unclear. In this context, the revised TEN-E Regulation allows continuing until 31 December 2029 the financing of dedicated natural gas infrastructure converted to transport and store a pre-defined blend of hydrogen with natural gas or biomethane. However, the blending ratio is not mentioned.[121]

The recast Gas Directive in the Hydrogen and Decarbonised Gas Market Package came with the establishment of the ENNOH, which is mandated to develop, publish and regularly update a non-binding Union-wide TYNDP focussed on hydrogen. Furthermore, the recast promotes a more integrated approach to network planning between the electricity, gas and hydrogen sectors.[122] TYNDPs should be based on a joint scenario framework that is developed by the relevant infrastructure operators, including relevant electricity and gas distribution system

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120 See https://www.consilium.europa.eu/en/press/press-releases/2022/05/16/ten-e-council-gives-green-light-to-new-rules-for-cross-border-energy-infrastructure/ (last access 13 April 2022).

121 If you want to know more about the TEN-E Regulation and its compatibility with the Green Deal, read the Policy Brief “Making the TEN-E Regulation Compatible with the Green Deal: Eligibility, Selection, and Cost Allocation for PCIs”, available at https://fsr.eui.eu/publications/?handle=1814/67673.

122 Note that this integrated approach to network planning is also encouraged by other regulatory frameworks. For example, Action 2 of the EU Grid Action Plan tasks ENTSO-E to “further strengthen the synergies between different energy carriers in the TYNDP, ensuring engagement of the relevant stakeholders for distribution, storage, hydrogen, CO2, and gas sectors”. https://ec.europa.eu/commission/presscorner/detail/en/ip_23_6044

operators. The TYNDPs are to be in line with the integrated national energy and climate plans (NECPs) and their updates, and also with the integrated national energy climate reports under the European climate law (Regulation (EU) 2021/1119). This will allow more cost-effective development of energy infrastructure and allow transnational information exchange on the use of transmission systems. The TYNDP joint scenario report by ENTSOG and ENTSO-E (2020) is a good example of such practices.

3.3.2 CO2 networks and storage

CO_2 infrastructure aims to capture, transport and store CO_2 before it is released in the atmosphere. The revised TEN-E Regulation continues to support such infrastructure for the purpose of permanent CO_2 storage. CO_2 networks are particularly relevant in decarbonising energy intensive sectors in which CO_2 production is unavoidable despite electrification, renewable integration and energy efficiency measures. CO_2 storage is needed for achieving climate neutrality by 2050.

The revised TEN-E Regulation included CO_2 storage projects in transport projects. CO_2 could be transported for injection into storage through pipelines or other dedicated modes of transport such as ships, barges, trucks and trains. As CO_2 storage potential capacities are not equally distributed among countries in Europe (GEUS and CATF, 2021), cross-border cooperation will be essential to allow industrial emitters in the EU to be connected to permanent CO_2 geological storage.[123]

3.3.3 Offshore renewable energy and grid infrastructure

Offshore renewable energy can come from a multitude of sources via different technologies that are at different levels of readiness. For instance, in 2020, offshore bottom-fixed wind had 12 GW of installed capacity in EU waters, representing 42% of the global cumulative installed capacity. The EU is followed by the UK with 9.7 GW and China with 6.8 GW (EC, 2020b). Floating offshore wind is an emerging technology with multiple designs being developed. The EU installed capacity for this technology is 40 MW and there are currently large projects being announced in some Member States. Ocean energy technologies, mainly wave and tidal, are in the same situation with a current installed capacity of 13 MW in the EU. Other technologies, such as biofuels from algae, ocean thermal energy conversion, floating photovoltaic installations and thermal energy conversion, are in earlier development stages, i.e. demonstration stages (EC, 2020c).

The European Commission (2020b) offshore strategy proposes to increase Europe's offshore renewable energy capacity. It estimates that to reach the Green Deal decarbonisation objectives at least 60 GW of offshore wind and 1 GW of ocean energy will be needed by 2030, with a view to reaching 300 GW and 40 GW respectively of installed capacity by 2050. According to the EC, these targets are realistic and achievable and will also reduce the EU's dependence on imported fossil fuels and generate benefits for EU consumers. The REPowerEU Plan aims to accelerate independence from imported fossil fuels and renewable hydrogen production, and proposes an additional 80 GW of solar and on- and off-shore wind capacity by 2030, without specifying sub-targets for each technology type.

123 If you want to know more about the challenges of establishing an EU-level regulatory framework for CO2 infrastructure and the planning of CO2 networks, read the Policy Brief "The future regulatory framework applicable to Carbon Capture and Storage Infrastructure - issues for discussion" by Christopher Jones, available at https://fsr.eui.eu/publications/?handle=1814/76181.

Currently, most offshore wind farms are radially connected, meaning that the farms are individually connected to the shore. This means that there is no coordination between projects, and each one is developed independently. This way of developing and connecting offshore renewable energy is foreseen to continue, especially where the offshore deployment is in an early stage of development (EC, 2020b). Such projects could apply for PCI status under specific conditions such as transferring electricity from generation sites with capacities higher than 500 MW and being developed in areas with low offshore renewable energy penetration. The other alternative is hybrid projects connected via a meshed offshore grid that is similar to an onshore transmission grid in which electricity flows in different directions. This could be schematised as an interconnector between two countries, to which the offshore generation is connected. Offshore renewable generation projects could then be linked to an offshore meshed network in a cross-border setting, moving away from the traditionally national focus in offshore generation. Hybrid projects have important potential for cost savings in areas with increasing penetration of offshore renewable energy. They also require less space than radially connected projects and reduce impacts on the environment and other maritime activities (EC, 2020b).

To ensure the development of offshore systems, the revised TEN-E Regulation introduces the Offshore Network Development Plan (ONDP) as a new component of the TYNDP[124]. The Regulation also introduces simplified and accelerated permitting and authorisation procedures for promoters of offshore grids for renewable energy projects. Unique points of contact are to be established for cross-border offshore projects of common interest and projects of mutual interest that connect the EU with third countries and contribute to the EU's energy and climate objectives.

In addition to electricity grids, another option to connect offshore generation is offshore hydrogen production and transport through hydrogen pipelines to the shore. This alternative will also be considered in electricity and gas network planning (EC, 2020b). With further technology readiness and cost reduction, it could be cheaper to produce green hydrogen from northern Europe offshore wind farms and transport it to the shore.

To realise the planned offshore generation and grid investments, different EU funding instruments are relevant (EC, 2020c), namely:

- The InvestEU programme to support emerging technologies and provide guarantees;
- The CEF to promote grid infrastructure development and offshore cross-border RES projects;
- The Renewable Energy Financing Mechanism pursuant to Implementing Regulation (EU) 2020/1294, whereby Member States contributing to RES projects will receive statistical benefits in return;
- Horizon Europe to promote the development and testing of innovative technologies and solutions;
- The Innovation Fund under the EU Emission Trading System (EU ETS), which can further support the demonstration of innovative green technologies on a commercial scale, e.g. ocean energy, new floating offshore wind technologies and projects coupling offshore wind with battery storage or hydrogen production;
- The Modernisation Fund under the EU ETS to support the development of the power sectors and wider energy systems, including offshore renewable energy, in the ten

124 In January 2024, the first ONDP was published by ENTSO-E. Although this first edition was developed independently from the other TYNDPs, their integration is envisaged in the coming years.

lower-income eligible Member States (Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania and Slovakia).

3.3.4 Distribution network planning

In Europe 60% of the electricity network was composed of low voltage lines, 37% of medium voltage and 3% of high voltage lines in 2020 (Eurelectric, 2020).

The increasing decarbonisation of energy systems with more decentralised renewable generation and the increasing electrification of transport and heating requires a better and more transparent planning of distribution grids, taking into account new technologies such as distributed storage, electric vehicles (EVs) and demand response.[125] For this reason, the CEP Electricity Directive (EU) 2019/944 requires DSOs to develop bi-annual NDPs that set out their planned investments for the next 5-10 years, under supervision of their NRAs.[126] The directive also requires Member States to define regulatory frameworks that include incentives for DSOs to procure market-based flexibility services. These frameworks should allow DSOs to consider the use of demand response, energy storage facilities, energy efficiency and other resources as an alternative to grid expansions during network operation and planning. NRAs can opt for alternative approaches, i.e. flexible connection agreements[127], bilateral contracts or cost-based mechanisms for the provision of flexibility, if market-based processes are not economically efficient or when they would result in market distortions or higher congestion (CEER, 2020; Nouicer et al., 2020).

The Hydrogen and Decarbonised Gas Market Package will introduce new provisions regarding rules on firm capacity for renewable and low carbon gases. Gas DSOs are to ensure firm capacities for renewable and low carbon gas production facilities. The package extends membership of the DSO entity established by the CEP to gas DSOs. This aims to provide a way for DSOs, and now also gas DSOs, to contribute to the development of distribution-relevant rules in the EU, and to ensure close cooperation with gas TSOs and ENTSOG. In addition, vertical cooperation between DSOs and TSOs is key to facilitate coordinated access to distributed resources, especially with the emergence of bidirectional flows of electricity and gas (reverse flows). Moreover, similarly to the transmission level, more coordination between electricity and gas DSOs and hydrogen stakeholders is required to feed the joint electricity and gas TYNDP foreseen in the revised TEN-E Regulation. These plans should be taken into account in distribution network planning. Other stakeholders such as the DSO entity and relevant hydrogen sector stakeholders shall also be involved in the process.

3.3.5 The Grid Action Plan

Despite these steps in legislation outlined above, which are aimed at ensuring that transmission and distribution infrastructure can keep pace with the ambitions of the Green

125 To read more about the challenges that arise from the integration of these new technologies in European distribution grids, please refer to Beckstedde and Meeus (2023). From “Fit and Forget” to “Flex or Regret” in Distribution Grids: Dealing with Congestion in European Distribution Grids. IEEE Power and Energy Magazine, doi: 10.1109/MPE.2023.3269545.

126 It is interesting to note here that, in contrast with the TYNDPs for electricity and gas transmission, the EU DSO Entity, which has a similar role to ENTSO-E and ENTSOG for distribution, is more limitedly involved. One of the tasks of the EU DSO Entity is to develop best-practice reports with recommendation on how to improve distribution network planning, of which the first edition will be published in mid-2024.

127 Note that Article 6a of the amending EU Directive 2024/1711 of the latest Electricity Market Design reform now mandates Member States to develop a national framework that allows transmission and distribution system operators to offer flexible connection agreements to new grid users in congested grid areas. These agreements are envisaged to be temporary instruments that are in place while the grid is being reinforced and can only become permanent if they are proven the most cost-effective grid solution.”

Deal, the European Commission has recognised the enormity of the challenge not just of network expansion, but also of updating the existing infrastructure. To this end, the Commission published a dedicated Action Plan for Grids in November 2023. The Plan anticipates that an overall investment of 584 billion euros will be necessary before 2030 for grid expansion, maintenance, modernisation and digitalisation (EC, 2023). Of this amount, 375-425 billion euros will need to go towards distribution grids (*ibidem*).[128]

To tackle this challenge, rather than introducing more legislative or regulatory instruments, the Grid Action Plan principally seeks to improve how existing tools operate and enhance their coherence with each other and their overall alignment with the Green Deal priorities.

The Grid Action Plan puts forward a total of 14 actions, listed in table 3.2 below.

EU Action on Grids	
1	Commission, Member States and Transmission System Operators (TSOs) to strengthen support to PCI and PMI preparation, faster implementation and funding
2	ENTSO-E to enhance top-down planning towards 2050 by integrating the identification of offshore and onshore system needs and further considering hydrogen
3	EU DSO Entity to support DSO grid planning by mapping the existence and characteristics of distribution development plans
4	Commission to propose guiding principles identifying conditions under which anticipatory investments in grid projects should be granted
5	Commission to issue guidance on cross-border cost sharing for offshore projects
6	ENTSO-E and EU DSO Entity to agree on harmonised definitions for available grid hosting capacity for system operators and to establish a pan-EU overview
7	ENTSO-E and EU DSO Entity to promote uptake of smart grid, network efficiency and innovative technologies
8	ACER, in its next tariff report, to recommend best practices in relation to the promotion of smart grids and network efficiency technologies through tariff design, focusing on the consideration of OPEX in addition to CAPEX and benefit sharing
9	Commission to identify tailored financing models and strengthen dialogue to address obstacles to private financing
10	Commission to increase visibility on opportunities from EU funding programmes for smart grids and modernisation of distribution grids
11	Commission to support permitting acceleration providing guidance and technical support on how to implement existing legislative tools and Member States to implement acceleration measures
12	Commission to launch a Pact for Engagement for early, regular and meaningful stakeholder engagement and regulatory support

128 For the figures for distribution grid investment, the Commission relies on a 2021 study by Eurelectric. See https://www.eurelectric.org/connecting-the-dots.

13	ENTSO-E and EU DSO Entity to collaborate with technology providers to develop common technology specifications and improve visibility of grid project pipelines, to facilitate investments in manufacturing capacity and secure supply chains
14	Commission to promote common technical requirements for generation and demand connection

Table 3.2: Commission action on grids (source: EC,2023)

The Grid Action Plan urges Member States to prioritise projects of common and mutual interest, since they, by definition, add value to the entire energy system of the EU. The Action Plan further seeks to encourage more efficient long-term planning at the transmission and distribution level, for example through the Commission supporting ENTSO-E in the integration of TYNDPs with the plans for offshore networks and, eventually, hydrogen. The Action Plan recommends that ENTSO-E and the DSO Entity should coordinate in how they promote smart grid uptake and work with common definitions based on an updated Technopedia.[129] The Commission also encourages Member States to take advantage of expedited permitting procedures that were introduced as part of REPowerEU Plan. Finally, several measures also relate to the Commission identifying avenues for financing and investment in grid projects that are more cost-effective and rapid to implement.[130]

129 Technopedia, administered by ENTSO-E, provides factsheets on innovative grid technologies. For more information, see https://www.entsoe.eu/Technopedia/.

130 In Spring 2024, the FSR delivered a research report to ACER, exploring best practices in the promotion of efficient network investments in Europe and elsewhere. The report also proposed a concrete regulatory framework that European NRAs could apply at the national level. See Pototschnig and Rossetto (2024).

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3.4 Transport and (electro) mobility infrastructure

Daniele Stampatori and Max Münchmeyer

This section focuses on the future decarbonised EU transport sector, specifically on road transport. First, we describe some fundamental features of the EU transport sector. Second, we explain why the transport sector is important to achieve the Green Deal objectives. Third, we explain the vision for a decarbonised and digitalised EU transport sector. Finally, we explore the most relevant EU strategies and legislation.

3.4.1 Transport sector in the spotlight

Transport sector accounts for roughly 5% of EU Gross Domestic Product (GDP) and employs more than 10 million people (EC, 2020).[131] These estimates include road, water and air transport. In this section, however we will focus on road transport (which includes cars, light and heavy-duty vehicles,[132] buses, etc.) because of its relevance in terms of economic and environmental impacts.

Generally speaking, transport refers to moving goods and people, while mobility is the ability to freely move. In recent years, the term transport has been substituted with mobility. This shift in language seems coherent with the new perspective on mobility (in particular for people) based on access to a service rather than on ownership of a vehicle.[133]

3.4.2 Why is the transport sector important in achieving the Green Deal objectives?

Transport produces almost a quarter of the EU's greenhouse gas emissions (GHG) and is currently a main cause of air pollution in cities. In 2021, road transport was responsible for 76% of all EU transport GHGs (including domestic transport and international bunkers; EEA, 2023)[134]. After a decrease in transport-related GHG emissions by 13.6% between 2019 and 2020 because of a drastic reduction in transport activities during the Covid-19 pandemic, emissions increased by 8.6% in 2022, following a rebound of the economy.[135] However, the GHG emission share of road transport is expected to decrease as road transport decarbonises faster than other transport modes, such as aviation or international maritime transport.

Transport is relevant not only in terms of GHG emissions but also in terms of pollution, even though in recent years the situation has gradually improved with significant reductions in emissions of carbon monoxide, non-methane volatile organic compounds, sulphur oxides and nitrogen oxides. Since 2000, there has been a reduction in particulate matter emissions (44% for PM2.5 and 35% for PM10).[136]

The Covid-19 pandemic and the resulting economic standstill led to a drop in CO_2 equivalent emissions in the transport sector. According to IEA, the global emission reductions resulting from a drop in oil use in the transport sector accounted for more than 50% of the total global

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131 For an insight on transport workers in the EU, you can see https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20210923-2.

132 Light-duty vehicles includes passenger cars and vans, while heavy-duty vehicles encompass trucks, buses and coaches.

133 See the blogpost on the difference between transport and mobility by Forum for the Future in November 2019: https://www.forumforthefuture.org/blog/transport-or-mobility (accessed 4 March 2022).

134 In particular, in 2016, cars accounted for the main source of GHG road emissions: https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-greenhouse-gases/transport-emissions-of-greenhouse-gases-11.

135 Further information on historical and forecasted greenhouse gas emissions from transports in the EU is available here: https://www.eea.europa.eu/ims/greenhouse-gas-emissions-from-transport.

136 Since 1990 emissions of air pollutants have decreased for all modes of transport except shipping, for which nitrogen oxide emissions have increased, and aviation, for which emissions of all pollutants (except non-methane volatile organic compounds) have increased.

reduction in CO_2-equivalent emissions in 2020. In the EU, after a reduction of about 12% between 2019 and 2020, final energy consumption by road transport rose to 256 Mtoe in 2021 (Eurostat, 2024).

In terms of energy consumption, road transport is dominated by internal combustion engines, that run mostly on gasoline and diesel, as is shown in Figure 3.6 The road to decarbonised mobility is still long.

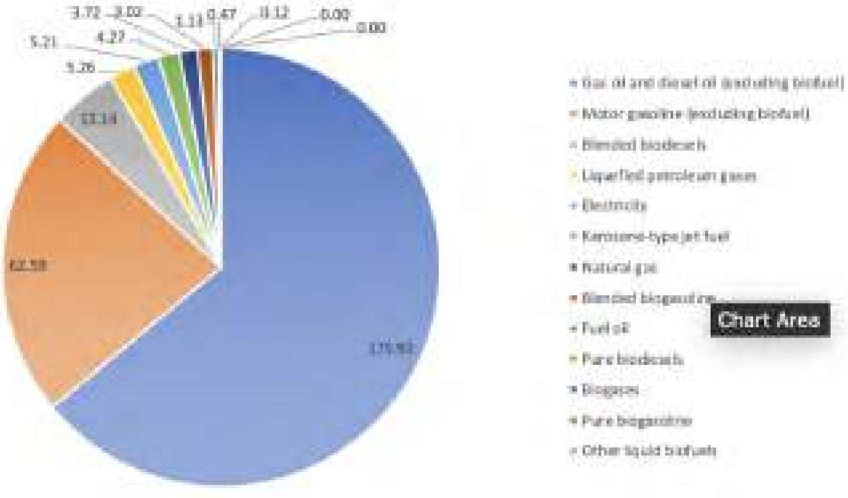

Figure 3.6: Shares of modes of road transport by fuel in the EU-27, 2021 in Mtoe (source: own illustration)

Even though the modal split[137] varies considerably among EU Member States, in 2020 road transport accounted for 77% of total inland freight transport in the EU in terms of tonnes per kilometre. Rail transport accounted for 17% of the EU total, while the share of inland waterways was 6% of total inland transport (EC, 2022). Interestingly, in terms of tonnage, maritime transport continues to be the most significant mode of long-distance goods transport to and from the EU (with almost two-thirds going to or from ports outside the EU; Eurostat, 2022a). Of the 10 top EU cargo ports in 2021, 5 were located in the Mediterranean, 4 on the North Sea coast of Europe and one on the Atlantic coast (EC, 2022).[138]

Passenger cars are by far the predominant mode of inland passenger transport in EU Member States: in 2020, they constituted 87% of all passenger transport in the EU (*ibidem*). However, there are relevant differences among Member States, as is shown in Figure 3.7.

In 2021, the total number of passengers travelling by air in the EU was 373 million, a substantial increase of 34.9% compared with 2020. Germany was the EU Member State carrying the highest number of passengers that year (Eurostat, 2022b). When it comes to maritime transport, the total number of passengers embarking and disembarking in EU ports in 2021 was estimated at around 268 million.[139]

137 The 'modal split' of transport refers to the relative shares of each mode of transport, for example road, rail and sea. It is based on passenger-kilometres (p-km) for passenger transport and tonne-kilometres (t-km) for freight and goods transport and it is usually defined for a specific geographical area and/or time period.

138 See https://www.consilium.europa.eu/en/press/press-releases/2022/06/02/fit-for-55-package-council-adopts-its-position-on-three-texts-relating-to-the-transport-sector/.

139 See https://ec.europa.eu/eurostat/databrowser/view/mar_mp_aa_cph/default/table?lang=en.

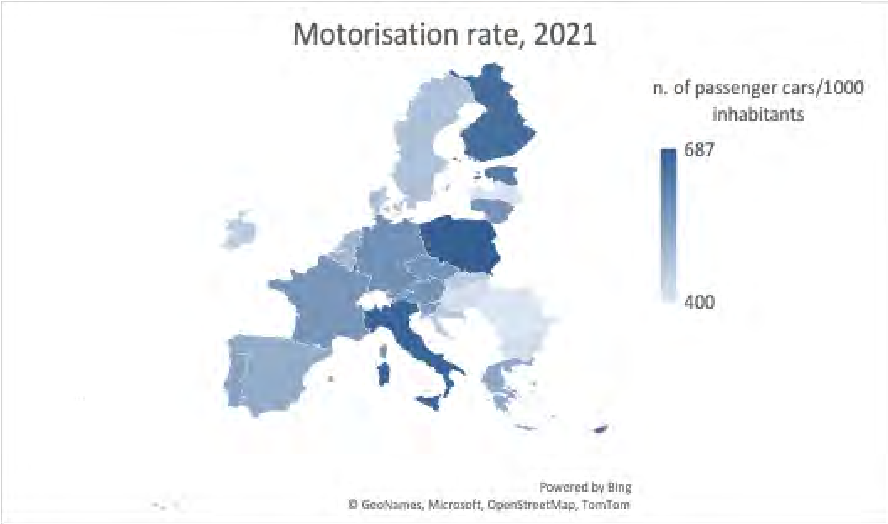

Figure 3.7: Passenger car ownership in the EU-27 in 2021 (Source: own illustration)

3.4.3 What is the vision for the green and digital transformation of the EU transport sector?

In order to reach carbon neutrality by 2050, the European Green Deal includes a target to reduce transport-related GHG emissions by 90% (compared to 1990 levels) by 2050, delivering a smart, competitive, safe, accessible and affordable transport system. To do this, all modes of transport need to be made more sustainable, sustainable alternatives need to be made widely available in a multimodal transport system, and the right incentives to drive the transition need to be put in place. In this regard, policy actions must strive to reduce the current dependence on fossil fuels, promote intermodal transport and internalise external environmental costs.

In December 2020, the Commission published its Sustainable and Smart Mobility Strategy (EC, 2020), which targets all modes of transport. It includes a roadmap that sets out how the EU transport system can achieve this transformation and sets concrete milestones to keep the transport system's journey towards a smart and sustainable future on track. The strategy pays close attention to three key objectives, namely making the EU transport sector sustainable, smart and resilient. The main milestones that the strategy sets are the following.

By 2030:

- at least 30 million zero-emission cars in operation on European roads;
- 100 climate-neutral European cities;
- carbon neutral scheduled collective travel for journeys under 500 km;
- large scale deployment of automated mobility;
- ready-for-market zero-emission vessels.

By 2035:

- ready-for-market zero-emission large aircraft.

By 2050:

- zero emissions from nearly all cars, vans, buses and new heavy-duty vehicles;
- a doubling of rail freight traffic and a tripling of high-speed rail traffic

- a fully operational multimodal trans-European transport network (TEN-T) for sustainable and smart transport with high-speed connectivity.

3.4.4 What are the most relevant EU strategies and legislation to decarbonise transport?

To achieve the targets, not only transport but also the related infrastructure is an important element to consider. Below we explore in more detail the components of the Fit for 55 Package concerning emission standards and the deployment of an alternative fuel infrastructure. We also look at the revision of the TEN-T Directive, which is part of the Mobility Package released by the European Commission (EC) in December 2021 (EC, 2021a).

3.4.4.1 *Emission targets*

Since 1 January 2020, CO_2 emission standards for new passenger cars and vans have been regulated by Regulation (EU) 2019/631 (EP and Council, 2019). This regulation included targets specifying that average CO_2 emissions of new passenger cars had to be 37.5% lower in 2030 than in 2021; in the case of new light commercial vehicles (i.e., vans) the reduction to achieve was 31% by 2030.

As part of the Fit for 55 Package, the EU adopted Regulation (EU) 2023/851, which amended Regulation (EU) 2019/631, setting more ambitious CO_2 emission targets for new cars and vans from 2030 onward. It contains significant goals:

- 55% reduction of emissions from cars by 2030;
- 50% reduction of emissions from vans by 2030;
- zero emissions from new cars and vans by 2035;
- from 2025 to 2029, a zero- and low-emission vehicles benchmark of 25% will apply to the sales of new cars, and a 17% benchmark to the sales of new vans;
- until 2028, manufacturers responsible for between 10,000 and 300,000 registrations of new cars per year may apply for a derogation from the specific emissions target;
- the maximum contribution of eco-innovation credits towards manufacturers' targets will be gradually reduced.

In addition to the revision of Regulation (EU) 2019/631, the EU created a separate Emission Trading System (ETS 2) for the road transport sector from 2027 (see Section 2.2.1). The aim is to put a price on GHG emissions from road transport, stimulating cleaner fuel use and re-investing the proceeds in clean technologies. The new EU ETS will apply to fuel suppliers and its revenue will be used not only for investment in technological developments but also to address social impacts arising from the new emission trading system. The mechanism should work in combination with a credit mechanism introduced in the revision of RED II. In order to promote electro-mobility, economic operators that supply renewable electricity to EVs via public charging stations will receive credits that they can sell to fuel suppliers, who can use them to satisfy their fuel supplier obligations.

In 2012, the EU ETS began covering flights within the European Economic Area (EEA). However, flights connecting the EEA with other parts of the world were not included in the EU ETS until December 2023. Even though flights within the EEA will continue to be under the EU ETS as before, changes have been made through the Amending Legislation to align with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). This means that flights to and from countries participating in CORSIA, from 2021 to 2026, will now fall under

EU law. Consequently, the exclusion of these flights from the EU ETS will be extended until the end of 2026. Thereafter, the Commission will assess the effectiveness and scope of CORSIA to determine whether it is comprehensive enough to avoid the need to incorporate CORSIA emissions into the EU ETS (EP and Council, 2023).

Regarding maritime transport, the FuelEU Maritime Regulation (EU) 2023/1805, aims to promote low-carbon fuels by introducing limits on the greenhouse gas intensity of ships; it also mandates the use of onshore power supply in EU ports by passenger ships and containers from 2030. Starting in 2025, the GHG intensity of energy used on board should start to decrease by 2% compared to a 2020 baseline. More stringent additional targets are set for 2030, 2035, 2040, 2045, and 2050, with mandatory reduction of 6%, 14.5%, 31%, 62% and 80% respectively.

Moreover, as of January 2024, the EU ETS encompasses emissions from maritime operations involving commercial ships carrying passengers or cargo with a gross tonnage above 5000. Subsequently, on January 1, 2027, offshore vessels exceeding 5000 gross tonnage will be integrated into the EU ETS framework. The system addresses 50% of emissions from voyages originating or concluding outside the EU and 100% of emissions during voyages between two EU ports and when ships are within EU ports.

3.4.4.2 *Alternative fuel infrastructure*

The need to deploy alternative fuel refuelling and recharging infrastructure in the Member States and guarantee long-term investment in alternative fuels and vehicles led to the adoption of the Alternative Fuel Infrastructure Directive (AFID) in 2014 (EP and Council, 2014). While not setting mandatory targets, AFID set the direction for the national policy framework (NPF) of each Member State. Its main objectives were to ensure the deployment of an adequate public recharging infrastructure for electric vehicles (EVs) and to instal shore-side electricity supply for inland waterway vessels and seagoing ships. Adequate infrastructure deployment had to be guaranteed for natural gas supply as well, while the possibility of including hydrogen refuelling infrastructure in their NPFs was left to the Member States.

The AFID has been reviewed as part of the Green Deal and replaced with Regulation (EU) 2023/1804 (AFIR). The new regulation sets mandatory national targets for the deployment of alternative fuel infrastructure. Together with provisions in the amended Renewable Energy Directive, it is intended to form the backbone of the turnaround in mobility on the road.

Recharging stations for electric vehicles

For electric vehicles, the AFIR sets out both national fleet-based targets for light-duty road vehicles and national distance-based targets for both light-duty and heavy-duty vehicles. For every EV, a total power output of at least 1.3 kW should be provided at publicly accessible recharging stations. Publicly accessible recharging pools dedicated to light-duty vehicles should be deployed in each direction of travel with a maximum distance of 60 km between them. For heavy-duty vehicles the same target is applied in the TEN-T core network, while in the TEN-T comprehensive network the limit is fixed at 100 km (for definitions of the TEN-T core and comprehensive networks, see Section 3.4.4.3. below). Other targets concern electricity supply for vessels in port and stationary aircraft.

Smart and bi-directional charging

Smart recharging can facilitate the integration of electric vehicles in the electricity system. In this regard, AFIR sets out that by 30 June 2024 at the latest (and periodically every three years thereafter) the regulatory authority of each Member State should assess the potential contribution of bi-directional charging to the penetration of renewable electricity in the electricity system on the basis of data made available by TSOs and DSOs.

Recharging operations should be facilitated by paying easily and conveniently at all publicly accessible recharging and refuelling points, which should accept payment instruments that are widely used in the Union, and in particular electronic payments.

Refuelling stations for hydrogen and LNG vehicles

For hydrogen, AFIR sets out that publicly accessible refuelling stations should be deployed with a maximum distance of 200 km between them in the TEN-T core network by the end of 2030 and with a minimum cumulative capacity of 1 t/day and equipped with at least a 700 bar dispenser. At least one publicly accessible hydrogen refuelling station should be deployed in each urban node. Lastly, MSs will have to provide a minimum coverage of publicly accessible liquefied methane refuelling stations for heavy-duty vehicles at least in the TEN-T core network and in maritime TEN-T ports.

3.4.4.3 *The trans-European transport network*

Adopted in June 2024, the recently-revised TEN-T Regulation (EU) 2024/1679 sets out guidelines for developing a trans-European transport network. The regulation lists compulsory targets to be reached, which are defined by key performance indicators. TEN-T has a triple-layer structure consisting of a core network, and extended core network, and a comprehensive network. The core and extended core networks consist of nine interconnected multimodal transport corridors going through several countries as well as two cross-cutting, horizontal priorities, while the comprehensive network aims to ensure accessibility and connectivity for all regions in the EU. Due to its economic relevance, the core network must be completed by 2030, and the extended core network by 2040 while the deadline for realisation of the comprehensive network is 2050.

Compared to its predecessor, Regulation 1315/2013, the current TEN-T Regulation introduces a series of novelties regarding infrastructure standards, synergies between infrastructure planning and the operation of transport services, requirements for deploying charging and refuelling infrastructure, use of innovative technologies like 5G, increased resilience of infrastructure to natural disasters and a requirement for 430 major cities in the TEN-T network to have sustainable urban mobility plans (SUMPs) by the end of 2027.

The revision of the TEN-T Regulation intertwined with the revision of other policy initiatives in the package of measures for efficient and green mobility, namely:

- A revision of the Intelligent Transport Systems Directive, adopted in November 2023 as Directive (EU) 2023/2661, which stimulates faster deployment of new intelligent services by proposing that certain crucial road, travel and traffic data are made available in digital format;
- An Action Plan on Rail (EC, 2021c) that aims to boost long-distance and cross-border passenger rail services;
- An EU Urban Mobility framework (EC, 2021d) that aims among other things to ensure neither capacity bottlenecks nor insufficient network connectivity in urban nodes can hamper multimodality in the trans-European transport network.

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3.5 EU Strategic Autonomy

Max Münchmeyer

In this section, we first provide a conceptual introduction to the EU's strategic autonomy. We then discuss the Green Deal Industrial Plan before moving on to examine two of its components in more detail: the Critical Raw Materials Act and the Net Zero Industry Act. Finally, we contextualise these legislative and policy developments in the global energy transition.

3.5.1 What is the EU's Strategic Autonomy?

The February 2022 Russian invasion of Ukraine has reignited the debate about the strategic autonomy of the European Union. While initially applied primarily in a security and defence context, strategic autonomy has now also entered discourse on the EU's energy import dependencies and, indeed, the Green Deal more broadly. A report by the European Parliament's research service refers to strategic autonomy as *'the capacity of the EU to act autonomously – that is, without being dependent on other countries – in strategically important policy areas'* (Damen, 2022, p. 1). However, how exactly strategic autonomy manifests within these policy areas, that is, defining a point where dependencies are reduced sufficiently to be able to consider the EU 'autonomous', is not easy to determine and is heavily context-dependent. In the area of energy, EU strategic autonomy has recently been defined as *'the Union's ability to pursue its own, viable path towards a decarbonized energy mix'* (Hancher and De Hauteclocque, 2024, p. 57).

Given the complex network of the EU's resource imports and the limited potential of the EU economy in some sectors, a completely autonomous (i.e. self-sufficient) EU is impossible, nor would it be desirable in many policy areas, including the import of resources necessary to realise the objectives of the European Green Deal. Here, strategic autonomy may be better thought of as the avoidance of strong import dependencies and leveraging EU diplomacy in a way that instead creates a stable network of trusted, interdependent partner countries.[140]

With the advent of REPowerEU, we have seen more significant efforts to bolster EU strategic autonomy in the energy sphere. For example, the AggregateEU programme for demand aggregation and joint purchasing of natural gas, coupled with EU diplomatic efforts to shift away from Russian gas, can be seen as a concerted effort to strengthen EU strategic autonomy through coordinated action (see Section 1.2.4.3.).

However, for what concerns the Green Deal, it is necessary to think about strategic autonomy as stretching well beyond fossil fuel supply security. The concept also applies to key resources, technologies, and capacities needed to realise the 2050 net-zero objective. While the transition to a net-zero economy should lead to a decrease in the EU's fossil fuel demand and thus imports, the rapid roll-out of many clean energy technologies required to reach carbon neutrality by 2050 will lead to significant increases in demand for other resources and technologies, not all of which can be produced within the European Union. The Critical Raw Materials Act and the Net Zero Industry Act, both part of the Green Deal Industrial Plan, are currently two fundamental elements of the attempt by the EU to pursue strategic autonomy in the future.

140 A 2023 expert panel discussion organised by the FSR also addressed questions of future EU strategic autonomy: https://www.youtube.com/live/NRm5tUX3BfI?feature=share

3.5.2 The Green Deal Industrial Plan

In February 2023, the European Commission published the blueprint for the industrial transformation necessary to support the objectives of the Green Deal, entitled *A Green Deal Industrial Plan for the Net-Zero Age* (EC, 2023a). The aim of the Green Deal Industrial Plan is to place the EU at the forefront of markets that will emerge or change as a result of global decarbonisation efforts. Maintaining the EU's strategic autonomy in this shifting geopolitical environment is at the core of the Plan, which provides that:

> *"The starting point for the Plan is the need to massively increase the technological development, manufacturing production and installation of net-zero products and energy supply in the next decade, and the value added of an EU-wide approach to meet this challenge together. This is made more difficult by the global competition for raw materials and skilled personnel. The Plan aims to address this dichotomy by focusing on the areas where Europe can make the biggest difference. It also seeks to avert the risk of replacing our reliance on Russian fossil fuels with other strategic dependencies that could impede our access to key technologies and inputs for the green transition, through a mix of diversification and own development and production" (EC, 2023a, p. 3).*

This plan was followed up by the Commission in March 2023 with three legislative initiatives aimed at securing these objectives:

- A proposal for the reform of the EU’s electricity market,
- A proposal for a Critical Raw Materials Act,
- A proposal for a Net-Zero Industry Act.

The EU's electricity market reform is discussed at several points in this textbook (see, in particular, Sections 3.2.2. and 4.1.7.). In this section, we focus on the latter two initiatives.

3.5.3 Critical Raw Materials

We first turn to the issue of critical raw materials. We define more closely what they are and how they factor into achieving the objectives of the European Green Deal. We then explain how the EU's Critical Raw Materials Act (CRMA) seeks to foster the development of secure supply chains for these materials.

3.5.3.1 *What are critical raw materials?*

Critical raw materials (CRMs), in US discourse also sometimes referred to as ‘critical minerals’, are those resources that are seen as essential for manufacturing technologies and equipment considered to be of strategic importance. What precisely is deemed ‘critical’ thus depends on the context, such as long-term strategic objectives or market trends, domestic and global demand developments, and technology penetration assumptions. The European Union, in this context, has focused on those raw materials that are essential to support its competitiveness and autonomy as it undergoes the ‘twin transition’ of digitalisation and decarbonisation, the latter referring to the pursuit of the objectives of the European Green Deal (EC, 2023b).

To determine whether or not to consider a material critical, the European Commission uses a combination of two factors: (1) economic importance and (2) supply risk.[141] Only those materials which cross both a supply risk (SR) threshold and an economic importance (EI)

141 For this assessment the JRC follows a complex criticality methodology developed in 2017 (JRC, 2017)

threshold are considered critical, with the exception of copper and nickel, which have a low supply risk but are nonetheless considered critical due to their many applications.

The perhaps best-known example of a critical raw material needed for decarbonisation is lithium, which is needed to manufacture batteries for electric vehicles, but there are many others. Examples include platinum, which is needed for manufacturing fuel cells and electrolysers, rare earth elements for permanent magnets needed in the generators of wind turbines, or silicon metal, which is crucial for solar PV panel technologies.

3.5.3.2 *Where are critical raw materials mined and processed?*

A principal factor contributing to the supply risks of CRMs is their uneven geographical distribution. Figure 3.8 illustrates this through the example of global cobalt and lithium reserves. Over half of global cobalt reserves are found in the Democratic Republic of Congo. For lithium, reserves are concentrated in Chile and Australia, with other countries, including Portugal, having relatively small reserves. Many other CRM reserves have a similarly uneven global distribution pattern, with sometimes even higher concentration in single countries than that shown in the maps below. South Africa, for example, is estimated to have over 90% of world platinum reserves (US Geological Survey, 2024, p. 137).

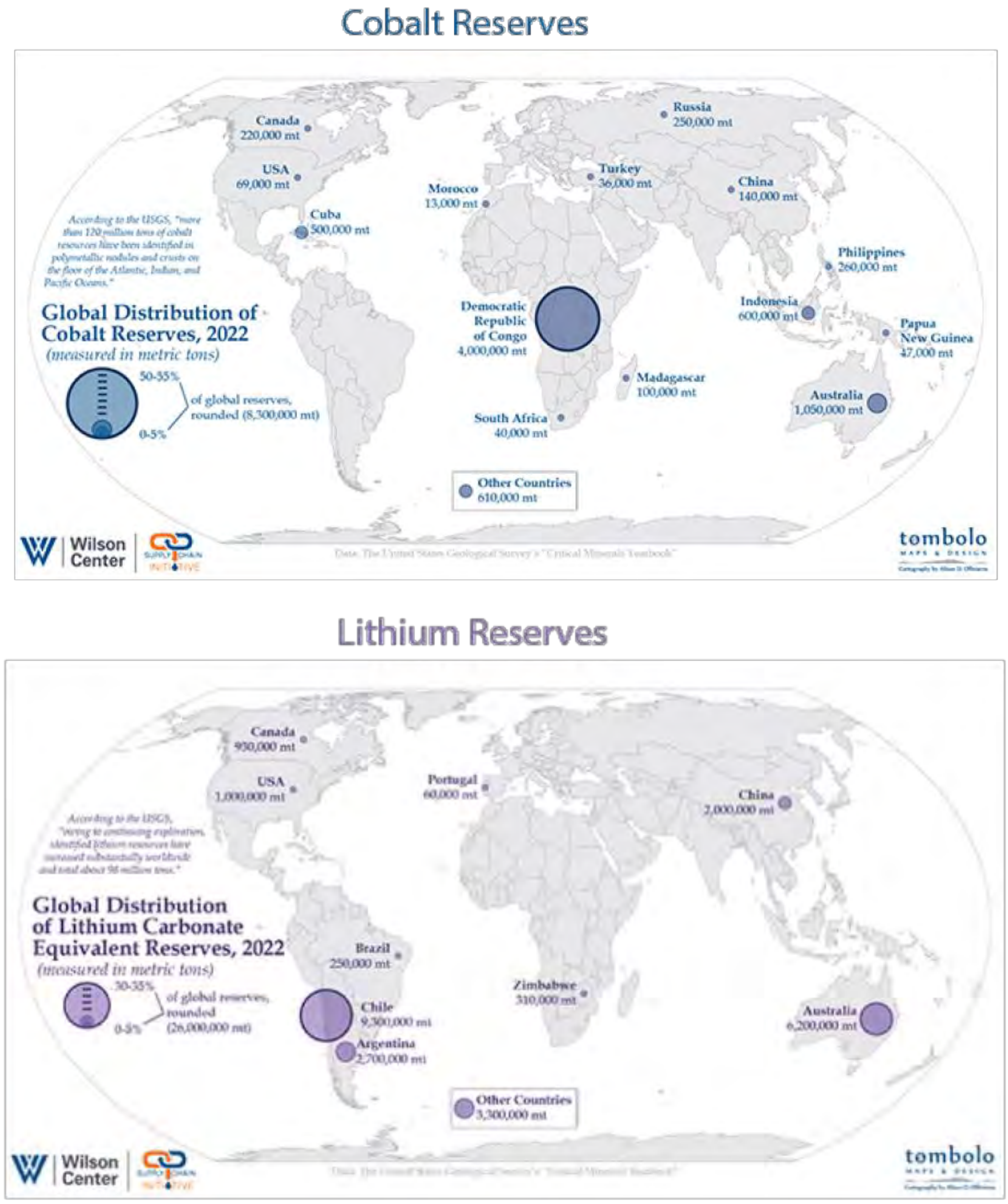
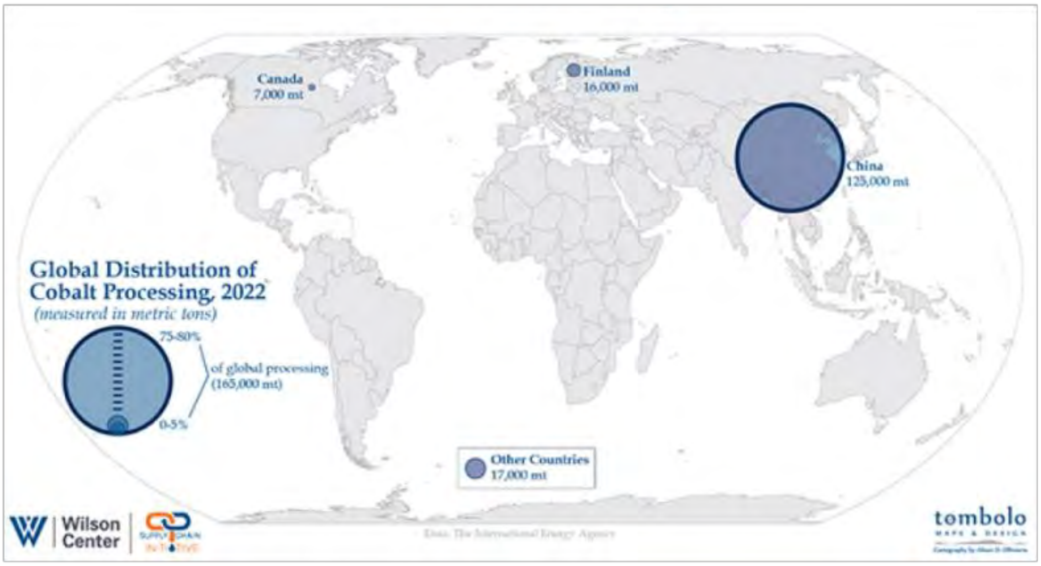


Figure 3.8: Map of cobalt and lithium reserves (source: Wilson Centre, 2024)

However, considerations about CRM supply security go beyond extraction and must include the entire CRM value chain, consisting of extraction, processing and recycling. Particularly in the area of CRMs processing, China has reached a dominant global position. Figure 3.9 below illustrates this, returning to the examples of cobalt and lithium.

Cobalt Processing



Lithium Processing

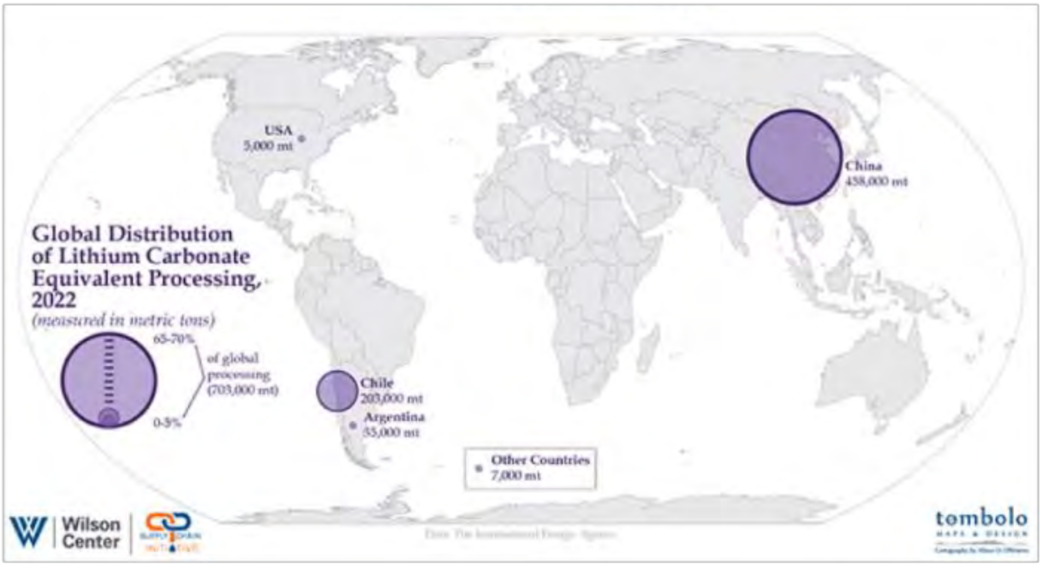


Figure 3.9: Map of cobalt and lithium processing (source: Wilson Centre, 2024)

Highly concentrated extraction and processing for CRMs leads to strategic dependencies due to the lack of alternatives for diversification of supplies. The negative implications of these dependencies are compounded by the expectation that demand for critical raw materials will rise exponentially over the coming decades. Research by the Joint Research Centre (JRC) suggests, for example, that a global 2050 carbon-neutrality scenario would see global lithium demand for clean tech increase from 12,300 tonnes per year in 2020 to 220,308 tonnes in

2030 and 1,090,014 tonnes in 2050 (Carrara et al., 2023, p. 9). This would mean that, by 2050, the EU would require approximately 175% of current lithium supply.

3.5.3.3 *Where is the EU currently standing on critical raw materials?*

The EU is heavily dependent on CRM imports at every step of the value chain. Figure 3.10 below shows the major suppliers for each CRM. It shows that the EU is strongly reliant on imports for many CRMs; moreover, EU's imports of many CRMs are highly concentrated, leading to strategic dependencies. For example, China currently provides 100% of EU's Heavy Rare Earth Elements (HREEs).

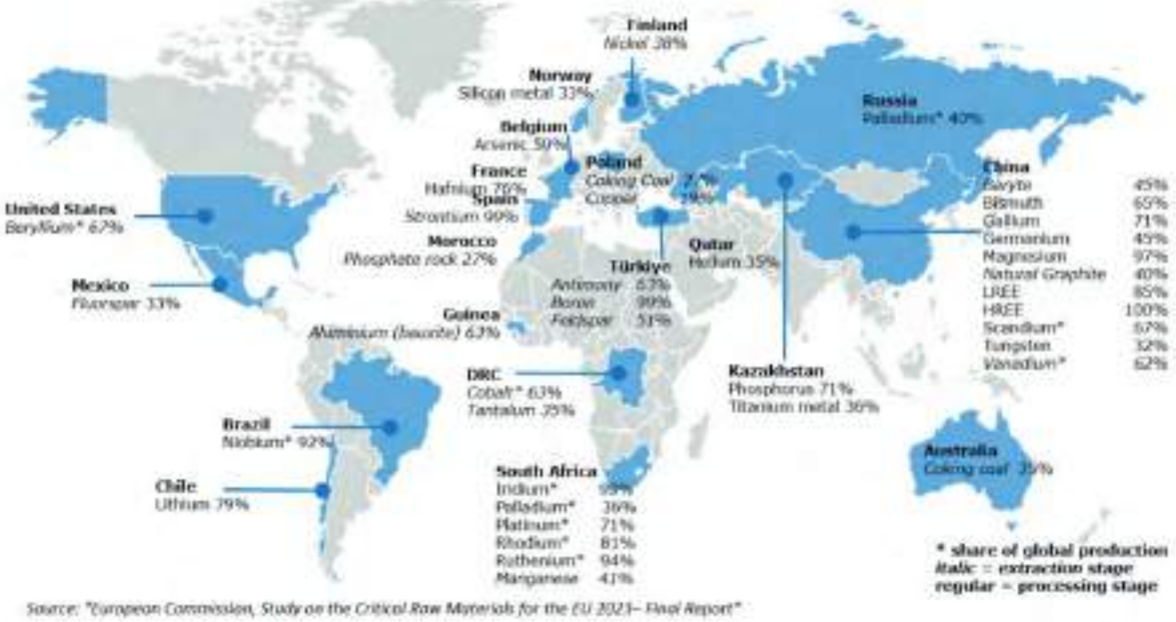


Figure 3.10: Major EU suppliers of CRMs (source: JRC, 2023)

The reason for this state of affairs is twofold. First, many raw materials needed for the realisation of the Green Deal objectives are simply not present in sufficient quantities in the EU. Secondly, it is often easier and cheaper, for an advanced and relatively affluent economy like the EU, to import materials mined or processed elsewhere.

While there is some CRM mining activity in the EU, it is clear that this domestic production capacity will not suffice to cover the EU's CRM needs. In addition, mining activities have often faced strong local opposition. Examples include the Barroso lithium mine in Portugal, which has faced strong resistance from residents (Bayley, 2023). A recent discovery of substantial CRM deposits in Sweden on land inhabited by communities of indigenous Sámi people also raises questions of whether it is possible to reconcile the respect for indigenous rights with the extraction of these minerals (Frost, 2023).

3.5.3.4 *What is the EU doing about critical raw materials?*

The issue of critical raw materials is not new in the European Union. The European Commission, based on analysis by the JRC, has published a list of critical raw materials every three years beginning in 2011, when the rapid industrialisation of economies like China, India and Brazil generated concerns about increasing scarcity of certain materials (EC, 2011).

However, the urgency which the EU and its Member States attribute to this issue has changed. As is evident in the Commission's Communication accompanying the 2023 list of CRMs, the

Russian invasion of Ukraine resulting in a gas supply crisis has contributed to the EU taking its strategic dependencies more seriously (EC, 2023b).

This is why, in 2023, the list of critical raw materials was for the first time accompanied by legislative action, as anticipated by the Commission President in her 2022 State of the European Union Address (EC, 2022). A *Critical Raw Materials Act* (CRMA) was thus proposed on 16 March 2023 as part of the Green Deal Industrial Plan (EC, 2023c). The European Parliament and the Council reached political agreement on the CRMA in November 2023, and the act was formally adopted on 18 March 2024 (Council, 2024).[142]

The CRMA specifies a list of 34 Critical Raw Materials, of which 17 are accorded the priority status of Strategic Raw Materials (SRMs) due to their particular importance for the EU's twin transition (Table 3.3). Both lists will be reviewed by the Commission every four years.

Strategic Raw Materials		
Aluminium	Germanium	Platinum group metals
Bismuth	Lithium – battery grade	Rare earth elements for magnets
Boron – metallurgy grade	Magnesium metal	Silicon metal
Cobalt	Manganese – battery grade	Titanium metal
Copper	Natural graphite – battery grade	Tungsten
Gallium	Nickel – battery grade	

Table 3.3: List of strategic raw materials as defined in the CRMA

The CRMA sets non-binding 2030 benchmarks for the EU along the entire value chain for SRMs. By 2030, the EU aims to achieve:

- 10% of extraction of EU annual demand of SRMs in the EU,
- 40% of processing of EU annual demand of SRMs in the EU,
- 25% of recycling of EU annual demand of SRMs in the EU.

To enhance its strategic autonomy, the CRMA further stipulates that the EU should not depend on a single supplier country for more than 65% of its annual demand for all SRMs at any step in the value chain.

Projects associated with SRMs can be designated ‘strategic projects’. These strategic projects will benefit from expedited permitting timeframes. The act specifies that the permit-granting process should be a maximum of 27 months for extraction projects and 15 months for processing and recycling projects. The act also stipulates that these projects should have priority access to financing.

In terms of governance, the CRMA institutes a Critical Raw Materials Board to coordinate EU efforts. The act also foresees the establishment of a mechanism for demand aggregation and joint purchasing of CRMs, operating in a way similar to the AggregateEU scheme instituted under REPowerEU for natural gas (see Section 3.1.4.2.).

142 Regulation (EU) 2024/1252.

However, even with these targets and incentives, given the EU's heavy reliance on imports and the supply concentration for many raw materials as illustrated above, accomplishing these objectives will be challenging (Carrara et al., 2023). In this context, it should also be noted that the act does not go hand-in-hand with dedicated EU funds, leaving the financing of raw materials projects up to Member States. This might lead to a risk of fragmentation and inefficiencies in raw materials procurement, as well as the implementation of the act's permitting and regulatory provisions at different speeds.

3.5.4 Where is the EU currently standing on clean tech?

Having sufficient manufacturing capacity and skilled workforce to use CRMs to produce the technologies needed to accomplish the Green Deal's objectives is another important part of maintaining the EU's strategic autonomy and competitiveness in the energy transition. Unlike with the critical raw materials, where the EU is highly import-dependent for all SRMs by definition, the picture in clean tech manufacturing is more variegated. Figure 3.11 below illustrates this.

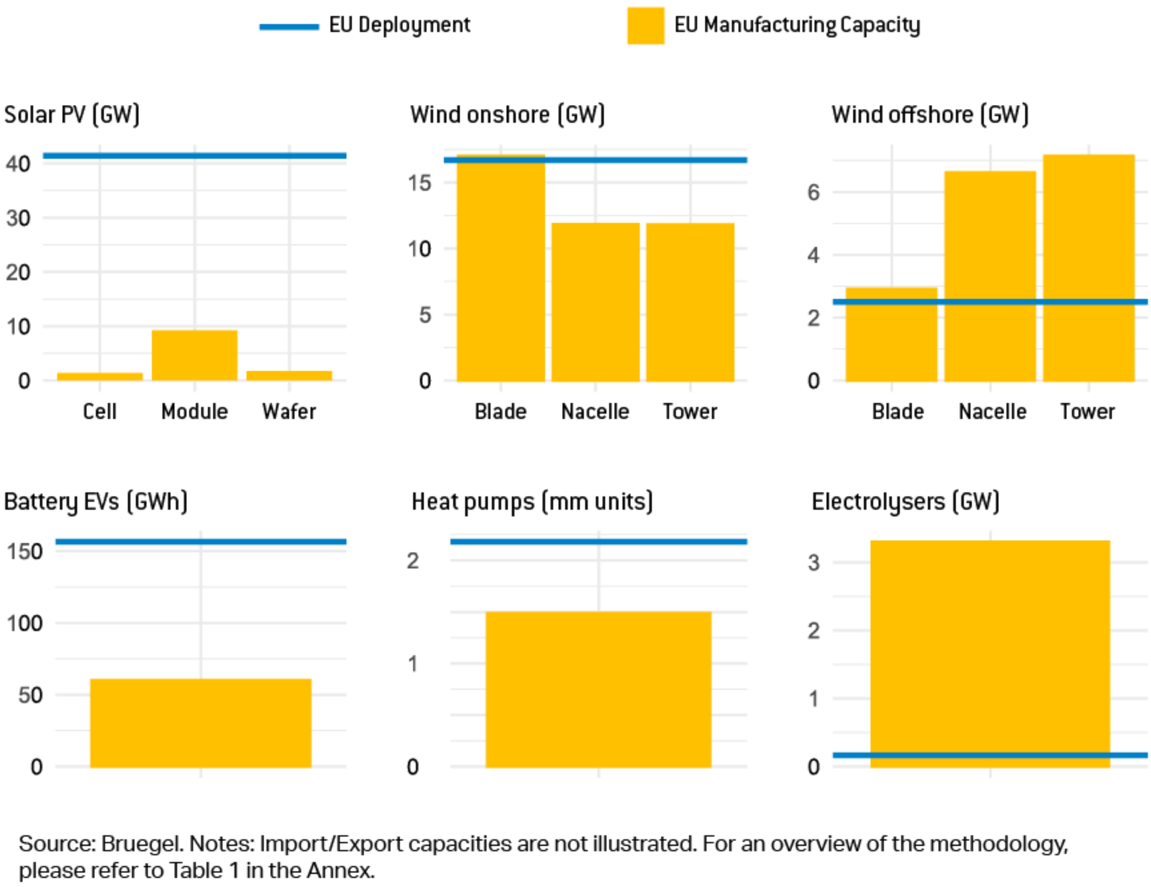


Figure 3.11: EU clean tech manufacturing capacities and domestic deployment levels in selected technologies, 2021-2022 (source: Sgaravatti, Tagliapietra, and Trasi, 2023)

While for some technologies, like onshore and offshore wind, the EU currently has the manufacturing capacity to meet most or even all of its deployment needs, the situation is different in other clean tech sectors, and markedly so in the field of solar PV, where the EU is highly import-dependent.

3.5.5 How is the Commission attempting to boost the EU's clean tech sector?

To support domestic manufacturing in the clean tech sector, the European Commission in March 2023 proposed the so-called *Net-Zero Industry Act* (NZIA) at the same time as the CRMA (EC, 2023d). Council and Parliament reached agreement on the NZIA on 6 February 2024 and it was formally adopted in June 2024 as Regulation (EU) 2024/1735.

Rather than focusing on raw materials, this piece of legislation aims to retain or claw back EU competitive advantages in the clean tech manufacturing sector. This is important for strategic autonomy, but also linked to the EU's global competitiveness as well as to the question of the just transition, discussed in Section 4.5. The EU seeks to maintain a competitive edge in clean tech sectors where it is comparatively strong (e.g. wind) and reclaim its competitiveness in sectors where it has lost its edge (e.g. solar PV).

The NZIA works in a similar way to the CRMA. It identifies a list of 19 Net-Zero Technologies whose manufacturing should be supported by the EU. It is important to note that, rather than fostering innovation, the NZIA is aimed at more mature, tried-and-tested technologies. In its proposal, the Commission thus only considered technologies that had reached a technology readiness level of 8 as defined by the International Energy Agency (IEA). This means that these technologies must at least have reached the level of a first commercial demonstration at full scale (IEA, 2023). Selected technologies should also have the potential to contribute to the decarbonisation and competitiveness of EU industry, while at the same time being subject to a certain supply risk (Net-Zero Industry Act 2024). While the Commission had initially envisaged a structure similar to the CRMA, which would have included a broader list of net-zero technologies and a smaller, privileged list of *strategic* net-zero technologies (analogous to the distinction between CRMs and SRMs), EU legislators in the Parliament disagreed with this approach. Additionally, in both Parliament and Council, heated political debates ensued concerning whether nuclear energy projects should be eligible for the same benefits as renewable energy technologies, such as privileged access to funding. In the end, co-legislators settled on a single list of net-zero technologies, shown in Table 3.4, which includes nuclear energy.

Net-Zero Technologies		
Solar technologies, including: solar photovoltaic, solar thermal electric and solar thermal technologies	Electricity grid technologies, including electric charging technologies for transportation and technologies to digitalise the grid	Biotech climate and energy solutions
Onshore wind and offshore renewable technologies	Nuclear fission energy technologies, including nuclear fuel cycle technologies	Transformative industrial technologies for decarbonisation not covered under previous categories
Battery and energy storage technologies	Sustainable alternative fuels technologies	CO_2 transport and utilization technologies
Heat pumps and geothermal energy technologies	Hydropower technologies	Wind propulsion and electric propulsion technologies for transportation
Hydrogen technologies, including electrolysers and fuel cells	Renewable energy technologies, not covered under previous categories	Nuclear technologies not covered under previous categories
Sustainable biogas and biomethane technologies	Energy system-related energy efficiency technologies, including heat grid technologies	
Carbon capture and storage technologies	Renewable fuels of non-biological origin technologies	

Table 3.4: List of net-zero technologies as defined in the NZIA

The NZIA sets a benchmark of reaching a supply capacity of 40% of the EU's annual deployment needs for these technologies necessary to achieve the EU's 2030 climate and energy targets. This target applies across all technologies rather than to each of them individually. Where the EU is dependent on a single third country for more than 50% of its demand of clean tech components, the NZIA specifies that any public tenders in relation to that component must take into account the resilience contribution of the bids.[143]

Rather than some technologies being considered inherently strategic, the version of the NZIA that was agreed stipulates that manufacturing projects for any of the net-zero technologies listed in Table 3.4. may ask the Member State in which they are located to be recognised as net-zero strategic projects, provided they:

1. Increase the manufacturing capacity of a component or a segment of the net-zero technology supply chain; or

143 The NZIA defines the contribution to resilience as "taking into account the proportion of the net-zero technologies or their main specific components that originates from a third country that accounts for more than 50% of the supply of that specific net-zero technology within the Union".

2. Provide European net-zero industries with access to the best available net-zero technology or to products produced in a first-of-a-kind manufacturing facility; or
3. Manufacture net-zero technologies through practices that implement improved environmental sustainability and performance or circularity features.

Similar to the case of Strategic Raw Materials, net-zero strategic projects benefit from expedited permitting procedures, defined in the NZIA as:

- 9 months for construction or expansion of net-zero strategic projects with a yearly manufacturing capacity of less than 1 GW;
- 12 months for the construction or expansion of projects with a yearly manufacturing capacity exceeding 1 GW;
- 18 months for the operation of a CO_2 storage site.

The NZIA also establishes a governance body, the so-called Net-Zero Europe Platform, mirroring the Critical Raw Materials Board set up under the CRMA. The platform represents a forum for Member States to coordinate their efforts and discuss financing of projects as they implement the act and will also collaborate with existing clean tech industrial alliances in the EU such as the European Battery Alliance, the European Solar Photovoltaic Industry Alliance, the European Clean Hydrogen Alliance, the Alliance for Zero-Emissions Aviation, the Industrial Alliance on processors and Semiconductor Technologies and the Renewable and Low-Carbon Fuels Value Chain Industrial Alliance.

While aimed at more mature technologies, the NZIA also seeks to foster innovation by encouraging Member States to establish net-zero regulatory sandboxes. The act also envisages the setting up of so-called Net-Zero Acceleration Valleys, which would concentrate projects associated with a certain technology to make them more attractive for investment. These valleys can also include dedicated innovation hubs. The EU's Strategic Energy Technology (SET) Plan (see Section 5.1.1.) was revised over the course of 2023 to align more closely with the NZIA.

The EU provides a financing instrument for technologies that it considers crucial through the Strategic Technologies for Europe (STEP) Platform. The STEP platform aims to efficiently channel investments from existing and new EU funding programmes towards the manufacture of strategic technologies.

Finally, the NZIA also recognises the fact that the EU needs to ensure that it has a workforce with the necessary skills to manufacture the needed technologies. To this end, the Act promotes the setting up of Net-Zero Industry Academies to upskill and reskill workers, with access to EU funds for their establishment.

3.5.6 Can the EU compete with other global players?

These efforts at enhancing the EU's strategic autonomy do not take place in a vacuum, but are set against the background of complex geopolitical developments. Other global players are also concerned about the rapid demand increase for critical raw materials and clean technologies and are seeking to position themselves so as to benefit from these developments.

In 2022, the US introduced the Inflation Reduction Act (IRA), a massive subsidy scheme heavily favouring US-manufactured energy transition technologies such as electric vehicles (Marconi, Münchmeyer, and Paviotti, 2024; Scheinert, 2023). As mentioned above, another global actor, China, currently dominates the supply chain for clean tech and many SRMs (García-Herrero, Grabbe, and Kaellenius, 2023). Supply chain concentration and protectionist measures by major global actors illustrate that free trade alone is unlikely to lead to outcomes able to preserve EU competitiveness and strategic autonomy. In this competitive geopolitical environment, the EU is endeavouring to align itself with countries producing or importing CRMs that share its values. A so-called Critical Raw Materials Club is supposed to enable these actors to coordinate in their efforts and ensure added value for all participants (Findeisen, 2023)

Therefore, the EU's strategy for more secure raw materials and clean tech supply chains also has to respond to these other global actors' efforts. On the one hand, the EU needs to diversify its imports by concluding partnerships with more trusted, third countries. On the other hand, future demand for clean tech and raw materials will make it difficult to break dependencies with countries that have already established significant economies of scale and will introduce an element of competition to concluding agreements with alternative import countries. Both the CRMA and the NZIA here emphasise the need for structured, strategic partnerships with third countries as a way to secure supply and thus enhance the EU's strategic autonomy. In the case of CRMs, African and South American countries with significant mineral wealth are seen by the EU as key partners for import diversification, and there has been a strong push to conclude formal Strategic Partnership Agreements with these countries, with an emphasis on enabling the partner country to develop the entire supply chain rather than just focusing on the extraction of minerals (Münchmeyer, 2023).

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4. EU energy markets

This chapter is divided into six parts. First, we provide a brief overview of the successive energy packages that have shaped the EU energy market. Second, we introduce electricity wholesale markets. Third, we present gas wholesale markets. Fourth, we provide an overview of the ongoing energy crisis and the measures that have been taken to tackle it. Fifth, we introduce retail markets and the new deal for consumers. Finally, we look at the concepts of a just energy transition and energy poverty.

4.1 An overview of EU energy packages

Athir Nouicer

The evolution of EU energy markets has been driven forward through successive legislative packages, some of which were already introduced in chapter 1. In this section, we provide an overview of the most important changes introduced by these packages. We close with a brief discussion of the changes introduced by REPowerEU and the electricity market design reform proposed by the Commission in March 2023 and adopted in May 2024. Though not part of a formal energy market package, these developments will have a lasting impact on the future of EU energy markets.

4.1.1 The First Energy Package

The First Energy Package contained two directives: the first Electricity Directive 96/92/EC adopted in 1996 and the first Gas Directive 98/30/EC adopted in 1998. The package laid down provisions on the liberalisation of the internal markets for electricity and gas. Management and accounting unbundling of national transmission system operators (TSOs) were required. Member States had to transpose the directives into national law by 1998 for electricity and 2000 for gas.

4.1.2 The Second Energy Package

The Second Energy Package was adopted in 2003 and contained two directives and one Regulation: the second Electricity Directive 2003/54/EC, the second Gas Directive 2003/55/EC and Regulation (EC) No 1228/2003 on conditions for accessing the network of cross border exchanges of electricity.[144] The package continued the liberalisation of the internal markets for electricity and gas, enabling, for instance, industrial and domestic consumers to freely choose their gas and electricity suppliers. Legal unbundling of TSOs was required. Importantly, the Second Energy Package also required Member States to create national regulatory authorities (NRAs) that are independent of the industry and government.

4.1.3 The Third Energy Package

The Third Energy Package was adopted in 2009 and contained two directives and three regulations. The two directives were Electricity Directive 2009/72/EC and Gas Directive 2009/73/EC. The regulations were Regulation (EC) No 713/2009 establishing an Agency for the Cooperation of Energy Regulators, Regulation (EC) No 714/2009 on conditions for access to the network of cross-border exchanges in electricity and Regulation (EC) No 715/2009 on

144 Regulation (EC) No 1775/2005 on conditions for access to the natural gas transmission networks is often considered part of the Second Energy Package too.

conditions for access to the natural gas transmission networks. The package had the aim of further liberalising and integrating the internal energy markets. For example, it included provisions requiring further unbundling of network operators and the establishment of ACER (see Section 1.4). The Third Energy Package also strengthened the independence of NRAs. Importantly, the European Networks for Transmission System Operators for electricity and gas (ENTSO-E and ENTSO-G) were created to enhance cross-border cooperation. The package set additional rules for opening and improving competition in retail markets. Finally, the package triggered the creation of electricity and gas network codes and the detailed rules governing these markets today (see Sections 4.2 and 4.3). The codes and guidelines were adopted as delegated legislation.

4.1.4 The Clean Energy Package

The Clean Energy for all Europeans Package, referred to in short as the Clean Energy Package (CEP), is a set of eight legislative acts on the energy performance of buildings, renewable energy, energy efficiency, governance and electricity market design. The European Commission published its initial proposal for the package in November 2016. This is why it was also nicknamed the Winter Package. The package was completed with the publication of its final texts in the Official Journal of the European Union in June 2019 after a trialogue between the European Commission, the Council and the Parliament.

The CEP is the fourth package of its kind. Unlike the previous energy packages, it did not include specific legislation on the gas sector, which instead fell under the scope of the Hydrogen and Gas Market Decarbonisation Package published in December 2021. The CEP further built on the energy policy framework set in the Third Energy Package and paved the way for a gradual transition away from fossil fuels towards a carbon-neutral economy. The CEP also updated the EU climate targets for 2030 (see Section 1.1).

4.1.5 The Fit for 55 Package and the Hydrogen and Decarbonised Gas Markets Package

The Green Deal climate neutrality objective for 2050 was written into law by means of the European Climate Law Regulation (EU) 2021/1119. To reach this target, the Climate Law, which entered into force on 29 July 2021, set the intermediate objective of reducing net GHG emissions by at least 55% compared to 1990 levels by 2030.

To put the 55% emission reduction objective on track and align EU policies with the updated targets in the Green Deal and the Climate Law, in July 2021 the Commission published the Fit for 55 Package, which contains a number of legislative proposals for measures to reach the 2030 targets, covering areas such as climate, energy, land use, transport and taxation. It was complemented in December 2021 with a second release of legislative proposals. Among them was the Hydrogen and Decarbonised Gas Markets Package, which aimed to review and revise the gas-related legislation in the Third Energy Package (see Section 4.3).

4.1.6 REPowerEU

In response to the hardships and global and European energy market disruptions caused by Russia's invasion of Ukraine, the European Commission presented the REPowerEU Plan in May 2022 (European Commission, 2022). The key objective is to rapidly reduce Europe's dependence on Russian fossil fuels and accelerate the green transition by means of three main streams of action: saving energy, producing clean energy, and diversifying Europe's energy supplies. REPowerEU aims to accelerate the roll-out of solar and wind power and heat pumps to reduce gas consumption. It includes plans to reskill and upskill the workforce, measures to simplify and shorten permitting for renewable energy projects, and stresses the importance of supporting infrastructure investments to enable the switch to electrification and hydrogen. The Commission will advance implementation of the Innovation Fund to support this switch. Although not a dedicated energy package, REPowerEU has put on the table a set of short-term and medium-term measures that are likely to be interacting with the areas of the Green Deal presented in this report.[145] Among the most important measures introduced by REPowerEU we find: a gas storage filling obligation, a gas demand reduction target, accelerated permitting rules, a higher share of energy from renewable sources by 2030 and an increased energy efficiency target.

4.1.7 The electricity market reform

Announced by Commission President von der Leyen during the State of the Union speech in September 2022, the proposal for a reform of the electricity market design was published in March 2023 by the European Commission. The reform is a more structural response, compared to the REPowerEU, to the energy crisis that started in 2021 and was further aggravated by the Russian invasion of Ukraine in February 2022, to face the issues of (energy) poverty and inflation, the insufficient hedging by consumers and retailers, the difficulties in accessing cheap renewables by consumers; and the investment uncertainty, which increased with the many emergency interventions during the crisis. It amends Regulation (EU) 2019/943 (Electricity Regulation), Regulation (EU) 2019/942 (ACER Regulation), Directive (EU) 2019/944 (Electricity Directive) and Directive (EU) 2018/2001 (Renewable Energy Directive) with the aim of improving the EU's electricity market design across 3 areas of action: (1) protecting consumers from volatile energy prices; (2) enhancing stability and predictability of the cost of energy, thereby contributing to the competitiveness of the EU economy; (3) boosting investments in renewable energy.

145 See the website of the European Commission on REPowerEU: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en.

4.2 Electricity wholesale markets

Tim Schittekatte, Leonardo Meeus, Ellen Beckstedde

This section is split into two parts. In the first part, we give an overview of how electricity markets are organised in Europe. In the second part, we provide more information on the European regulations that shape these markets: the EU Electricity Network Codes and Guidelines.

4.2.1 Part I – Overview of electricity market organisation in Europe

In this first part, we provide an overview of how electricity markets are organised in Europe by answering three questions. First, why do we have so many electricity markets? Second, which electricity markets are there and how do they work? And third, what does the future hold?

4.2.2 Why do we have so many electricity markets?

Electricity can be considered a commodity just as copper, oil and grain are. However, electricity markets differ substantially from other commodity markets. This is due to the physical characteristics of electricity:

- *Time*: large volumes of electricity cannot (yet) be stored economically. Therefore, electricity has different values over time.
- *Location*: electricity flows cannot be easily and efficiently controlled, and transmission infrastructure must be operated under safe flow limits. If not, there is a risk of cascading failures and blackouts. Therefore, electricity has different values over space.
- *Flexibility*: consumption and generation must match each other at all times. Otherwise, there is a risk of blackout. However, demand and the availability of renewable energy resources can strongly fluctuate over time, while some power stations can only change their outputs slowly and can take many hours to start up. In addition, power stations can suddenly fail. Therefore, the ability to change generation/consumption of electricity at short notice has a value.

These three unique physical characteristics explain why there is not just one electricity market. Bringing electricity towards consumers goes beyond the production of electricity in MWh. Transmission capacity and flexibility are scarce resources and should be priced accordingly. Therefore, electricity (energy, transmission capacity, flexibility) is exchanged in several markets until actual delivery in real time. Note that while in the EU electricity markets have been deregulated, other regulatory models can be in place in other parts of the world.[146]

4.2.3 Which electricity markets do we have in Europe and how do they work?

Figure 4.1 shows a schematic overview of the electricity markets that currently exist in the EU. We group the markets in four clusters and address them one by one in the following subsections.

146 For a comprehensive overview of regulatory models in the power sector, see https://fsr.eui.eu/regulatory-models-in-the-power-sector/.

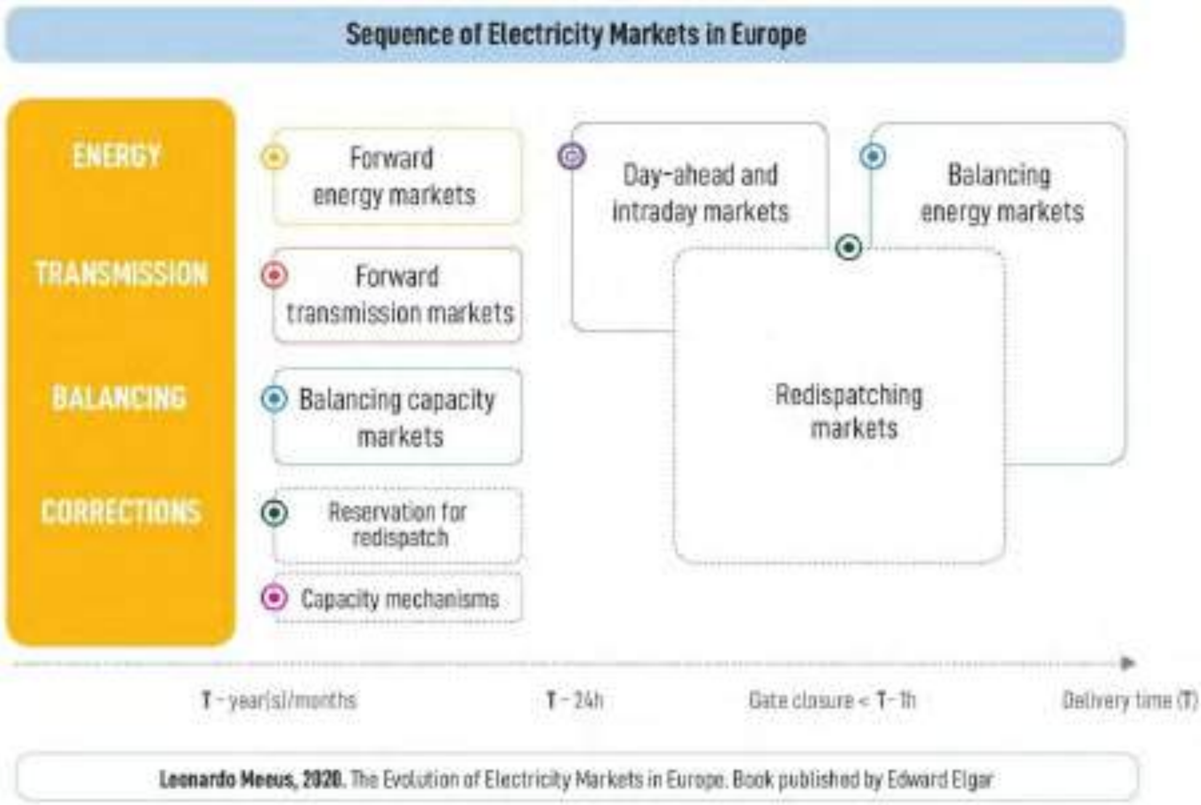

Figure 4.1: Schematic overview of the typical sequence of existing electricity markets in the EU. Markets in dotted lines are optional (source: Meeus, 2020)

4.2.3.1 Long-term markets (forward energy markets, forward transmission markets and capacity mechanisms)

Forward energy markets trade electricity more or less four years up to one month before delivery. A financial exchange organises multilateral trade using standardised products, but market parties can also make bilateral over-the-counter (OTC) deals, which indicate transactions taking place outside the marketplace. The energy prices negotiated are denominated by bidding zone,[147] which in most cases overlaps with national borders. The market does not consider potentially limiting network elements in a bidding zone, i.e. the bidding zone is seen as a copper plate. This is the essence of the so-called zonal electricity pricing system in place in the EU. Figure 4.2 shows the current bidding zone configuration in Europe. If a market party wants to hedge prices across bidding zones, long-term cross-zonal transmission rights need to be acquired separately on the Joint Allocation Office (JAO) platform. This platform is a joint transmission system operators (TSO) service company.

Besides forward energy and forward transmission markets, in the longer-term timeframe Member States can decide to set up a capacity mechanism if deemed necessary for adequacy reasons. Capacity mechanisms exist in many forms and are often organised by the TSO. Capacity procurement takes place one to about four years before delivery (see Section 3.2 for more on capacity mechanisms).

147 For a comprehensive explanation of the concept of bidding zones, see Schittekatte et al. (2020).

4.2.3.2 Wholesale or spot markets (day-ahead and intraday markets)

There is no obligation for market parties to buy and sell their energy on the spot market. Spot markets are often used to adjust long-term positions closer to delivery. Importantly, although volumes traded in the wholesale markets are in some cases only a fraction of the final volume of electricity generated, the wholesale prices serve as the price reference in long-term contracts (see also Pérez-Arriaga, 2013).

Figure 4.2: The bidding zone configuration in Europe in September 2023 (source: modified from Schittekatte et al., 2020)

The day-ahead market consists of one pan-European auction at noon for the 24 hours of the following day. All bids accepted are paid the marginal offer, which means the price of the last selected offer to meet demand. Trading is organised by one or several power exchanges (PXs) in each Member State. Single day-ahead coupling (SDAC) allows for efficient trade between all European bidding zones in the day-ahead timeframe. Electricity prices in neighbouring bidding zones diverge for a particular hour if all cross-zonal transmission capacity available for trade is utilised ('market congestion').[148] If not, prices converge between bidding zones. After the day-ahead market is cleared, the intraday market opens. Historically, continuous trading (as on a stock exchange) has been the mechanism in place for intraday trading. Under continuous intraday trading, cross-zonal trading is typically possible on a first-come-first-served basis until the available cross-zonal capacity is fully utilised. Only in some Member States such as Germany, Spain and Italy, intraday auctions were already organized in addition to continuous trading. In 2019, ACER decided that the future intraday European model will consist of a combination of continuous trading with three European-wide auctions at pre-defined times (ACER, 2019). In June 2024, the implementation of these three intraday auctions was completed (SIDC, 2024).

4.2.3.3 Balancing markets (balancing capacity and balancing energy markets)

After trading in the intraday market closes, a balancing mechanism is in place to ensure that supply equals demand in real time. Each TSO is responsible for the real-time balance in its

148 This is true under the simplest form of cross-zonal capacity allocation (net transfer capacity allocation) but is slightly more complicated in a setting with flow-based market coupling.

control area.[149] To do this, each TSO organises balancing markets where it procures the resources needed to balance the system. Balancing markets consist of balancing capacity markets and balancing energy markets. In balancing capacity markets, contracted balancing service providers (BSPs) are paid an availability payment. Contracting is done between one year ahead and one day ahead of delivery to make sure that there will always be enough balancing energy available in real time. The BSPs contracted in the balancing capacity market (and other BSPs without contracted balancing capacity) then offer their balancing energy in the balancing energy markets. The volume of energy activated depends on real-time imbalances.

While the TSO is responsible for the real-time balance in its control area, in principle all market parties have balance responsibility. This means that market parties are financially responsible for their imbalance position, which is difference between their contractual position (the electricity they bought/sold in other markets) and their physical position (the electricity they consumed/generated). Depending on the imbalance position and the imbalance price in the balancing markets, there will be different financial flows between the TSO and the balance responsible of each market party. More information on the rules and procedures for imbalance settlement can be found in Art. 55(1) of the Guideline on Electricity Balancing.

4.2.3.4 Transmission re-dispatch 'markets' (Reservation for re-dispatch and re-dispatching markets)

Redispatch is needed when the market outcome (in this case in the day-ahead or intraday market) results in generation and consumption schedules that would lead to potential violation of operational limits (e.g. thermal limits, voltage ranges, etc.) of a certain network element in a bidding zone (e.g. voltage sources, current sources). Such a situation occurs regularly, as typically transmission network elements within a bidding zone are not considered when trading in wholesale markets. Only the physical limits of network elements between bidding zones are considered.[150] Typically, re-dispatch involves increasing or decreasing the output of a generator at the end of a potentially congested line. The Clean Energy Package (CEP) prescribes organising re-dispatching by default in a market-based manner (Regulation (EU) 2019/943, Art. 13). Currently, in most EU Member States generators are still legally obliged to participate in re-dispatch and prices are regulated, i.e. the audited costs (in the case of upward activation) or foregone opportunity costs on the wholesale market (in the case of downward activation) are paid to the owner of the re-dispatched resources. Some Member States have merged the balancing energy and re-dispatching markets.

4.2.4 What does the future hold?

Europe started the process of harmonising and integrating national electricity markets with the first Electricity Directive in 1996 (see Section 1.2). Since then, we have seen much progress. For example, ACER and CEER's (2020) Market Monitoring report states that market coupling has so far benefitted European consumers approximately 1 billion euros a year. However, we are facing important challenges, of which we briefly describe in forward markets, one in wholesale markets and one in re-dispatch markets.

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149 A control area is defined as a coherent part of the interconnected system operated by a single system operator. More information can be found in Schittekatte et al. (2020).

150 In practice, some internal transmission network elements are considered in the market coupling algorithm but not priced. However, there are only a few of these and ACER (2016) strongly discourages inclusion of internal network elements in market coupling.

First, the EU energy crisis exposed the incompleteness of long-term power markets. In this context, the Electricity Market Design reform aims at completing the long-term markets to fulfil two main objectives: facilitating the entry of renewable energy sources at the lowest system cost and limiting the impact of sustained high prices on end users' bills.

Second, the current bidding zone configuration in wholesale markets is under pressure. Grid expansion cannot keep up with the impressive capacities of renewables installed, and consequently, among other problems, redispatch costs are high and still rising.[151] How bidding zones can be reconfigured is subject to heavy debate at the European level.[152] At low-voltage levels, distribution networks would need to be expanded in order to deal with the increasing number of PV panels installed by consumers, and electrification of transport (electric vehicles) and heating (heat pumps). Electrification is expected to accelerate even more driven by the ambitions set out in the European Green Deal. Flexibility markets can be used to limit costly grid expansions at low-voltage levels. How these new flexibility markets will be integrated in the existing sequence of markets remains an open issue (Schittekatte and Meeus, 2020).[153]

4.2.5 Part II – EU Electricity Network Codes

In this part of the section, we provide more information about EU electricity network codes. First, we explain what a network code is, describe the background to the EU electricity network codes, and list the first generation of network codes. We then explain how these network codes were developed and who they apply to. Finally, we explain the difference between network codes and guidelines and give an outlook on changes that the CEP brought to the network code landscape.

4.2.6 What is a network code?

A network code (NC) is a set of technical rules enabling the development of the internal energy market in Europe. The NCs address the major barriers impeding the cross-border flow of electricity and gas, transforming a mere patchwork of national energy markets into a single European energy market. The NCs guide the integrated operation of cross-border energy networks to allow increasing competitiveness, more cost-efficient integration of renewables and a secure supply of energy at prices that are affordable for European consumers.

Network codes address market, system operation and grid connection rules, the so-called 'software' of the EU internal energy market. The Trans-European Energy Networks (TEN-E) Regulation (EU) No 347/2013 addresses cross-border infrastructure investment, the 'hardware' of the internal energy market.[154]

4.2.7 Background to the electricity network codes and guidelines

The EU electricity network codes originated in the 2009 Third Energy Package (see Section 1.2). The Third Energy Package is a set of laws that are part of the process liberalising the

151 If you want to know more about distributed energy resources and electricity balancing, you can read the Research Project Report 'Distributed energy resources and electricity balancing: visions for future organisation', available at https://fsr.eui.eu/publications/?handle=1814/74246.

152 See, for example, the event highlights at the FSR policy workshop on bidding zones in June 2020, available at https://fsr.eui.eu/bidding-zones-configuration-liquidity-and-competition-in-the-electricity-market/.

153 A detailed overview of the evolution and organisation of electricity markets in Europe and a discussion of open issues is provided in the open access book by Meeus (2020) and the technical report by Schittekatte et al. (2020).

154 For a comprehensive overview of the TEN-E Regulation, see https://fsr.eui.eu/the-ten-e-regulation/.

electricity and gas markets initiated back in the mid-1990s. More specifically, Regulation (EC) No 714/2009 set out the areas in which electricity network codes can be developed and a process for developing them.

In 2017, after a four-year co-creation process carried out by the European Network of Transmission System Operators for Electricity (ENTSO-E), the European Union Agency for the Cooperation of Energy Regulators (ACER), the European Commission (EC) and many involved stakeholders from across the electricity sector, the first generation of network codes and guidelines were developed and entered into force. After the development of the network codes, the implementation phase started.

4.2.8 The first generation of electricity network codes and guidelines

The first generation of network codes consists of eight network codes and guidelines that have been published in the Official Journal of the European Union as Commission regulations. Commission regulations usually enter into force twenty days after publication unless explicitly stated otherwise. Figure 4.3 illustrates how these eight regulations can be subdivided in three groups.

In the following, we list the eight regulations and give some examples of topics covered in each of them.[155]

Figure 4.3: Electricity network codes and guidelines (source: own illustration)

- The *capacity allocation and congestion management guideline* (CACM GL). The CACM GL fosters efficient integration of the European power markets in the day-ahead and intraday timeframe. The guideline covers topics such as governance of power exchanges, criteria for bidding zone delineation and allocation of cross-zonal transmission capacity in the day-ahead and intraday timeframe.[156]
- The *forward capacity allocation guideline* (FCA GL). The FCA GL harmonises the allocation rules on long-term cross-zonal transmission rights. The guideline covers

155 An in-depth description of network codes and guidelines is provided in Schittekatte et al. (2020).

156 Note that there is an ongoing process to amend and improve the CACM GL. More information is provided by ACER at https://www.acer.europa.eu/news-and-events/news/acer-provides-recommendation-reasoned-amendments-capacity-allocation-and-congestion-management-regulation (accessed 17 March 2022).

topics such as setting up a pan-European platform for the allocation of long-term transmission rights, types of long-term transmission rights and rules on curtailment of long-term transmission rights.

- The *electricity balancing guideline* (EB GL). The EB GL aims to harmonise and integrate the European balancing energy markets. The guideline covers topics such as the European platforms for the exchange of balancing energy, imbalance settlement and allocation of cross-zonal transmission capacity in the balancing timeframe.
- The *electricity transmission system operation guideline* (SO GL). The SO GL sets minimum system security, operational planning and frequency management standards to ensure safe and coordinated system operation across Europe. Examples of topics that are covered are balancing capacity requirements and setting up regional security centres.
- The *network code on electricity emergency and restoration* (ER NC). The ER NC sets out rules for the management of the transmission system in the case of emergencies and blackouts, and other different system critical states that are defined in the SO GL. It also addresses suspension and restoration of market activities.
- The *network code on requirements for grid connection of generators* (RfG NC). The RfG NC covers requirements for generators (synchronously and asynchronously connected) to be connected. The RfG NC fosters robustness of the European electricity network and intends to establish a level playing field in terms of connection requirements for generators. Examples of topics covered are frequency bands to remain connected, voltage limits and reconnection and re-synchronisation capabilities.[157]
- The *demand connection network code* (DC NC). The DC NC covers requirements for demand facilities and distribution systems to be connected. The DC NC fosters robustness of the European electricity network and intends to establish a level playing field in terms of connection requirements for load. As under the RfG NC, examples are frequency bands to remain connected, voltage limits and reconnection and re-synchronisation capabilities.
- The *requirements for grid connection of high voltage direct current systems and direct current-connected power park modules network code* (HVDC NC). The HVDC NC covers requirements for long distance direct current (DC) connections. The HVDC NC fosters the robustness of the European electricity network and intends to establish a level playing field in terms of connection requirements for HVDC connections.

4.2.9 How were these network codes developed?

The key actors involved in the development of the first generation of network codes were the European Commission, the Agency for the Cooperation of Energy Regulators (ACER) and the European Network of Transmission System Operators for Electricity (ENTSO-E). They had unequal roles.

The development process for the network codes resulting from the Third Energy Package is detailed in Regulation (EC) No 714/2009. First, after having consulted ACER, ENTSO-E and

157 Note that there is an ongoing process to amend and improve the RfG NC and DC NC to reflect the latest developments in electromobility, storage, heat pumps, etc. More information is provided by ACER at https://www.acer.europa.eu/news-and-events/news/acer-proposes-amendments-electricity-grid-connection-network-codes (accessed 23 February 2024).

other relevant stakeholders, the European Commission drafted annual priority lists, which identified possible areas for network code development.

Following a request from the Commission, ACER prepared non-binding Framework Guidelines stipulating the key principles for development of the network codes. The European Commission requested ENTSO-E to draft the text of the network codes, which had to be in line with the relevant Framework Guideline developed by ACER. The drafts became a network code after their adoption was recommended to the European Commission by ACER and approved by a committee composed of national experts (Electricity Cross-Border Committee) using the comitology procedure.[158] At the end of the comitology procedure, the Commission adopted the network codes as implementing acts.[159]

4.2.10 Who do they apply to?

The network codes concern the operation of energy networks (for electricity and gas, across various market timeframes) connecting two or more EU Member States and countries which constitute part of the European Economic Area. However, over the past few years some non-EU countries have opted for voluntary adoption of NCs, e.g. the Energy Community Contracting Parties (see Section 1.2).

4.2.11 Similarities and differences between a network code and a guideline

We commonly refer to these eight regulations as ‘network codes.’ However, not all of them are legally defined as such. Just four of the eight are defined as network codes (ER NC, RfG NC, DC NC and HVDC NC). The other four are referred to as guidelines (CACM GL, FCA GL, EB GL and SO GL). Initially, all eight were planned to be developed as network codes, yet some became guidelines in the development process. In theory, network codes and guidelines can cover the same topics. In practice, however, it is observed that some topics lend themselves better to guidelines than to network codes and others vice versa.

Network codes and guidelines are similar in that they carry the same legal weight (both are Commission regulations and are legally binding), are directly applicable (they do not need to be transposed into national law) and are subject to the same formal adoption procedure (the ‘old’ comitology procedure). Network codes and guidelines differ regarding their legal basis, stakeholder involvement, amendment processes, topics, scope and the adoption of further rules during the implementation phase (see also Meeus, 2020).

The main practical difference is the work to do during the implementation phase. In general, network codes are more detailed than guidelines. This is because guidelines shift a larger share of further development to the implementation phase, which can allow more flexibility but can also slow down or complicate the overall process. Guidelines include processes in which TSOs or Nominated Electricity Market Operators (NEMOs) must develop so-called ‘Terms and Conditions or Methodologies (TCMs).’ TCMs are comprehensive (legal) texts that are often referred to as ‘methodologies.’ In most cases, methodologies have to be jointly developed by all TSOs or all NEMOs at the pan-European level or by the relevant TSOs/NEMOs at the regional[160] or national levels. Depending on the scope of methodologies, the Third Package foresaw them being approved either by all National Regulatory Authorities (NRAs) (pan-

158 Information on comitology is provided by the European Commission at https://commission.europa.eu/law/law-making-process/adopting-eu-law/implementing-and-delegated-acts/comitology_en.

159 A comprehensive overview of the legal perspective on network codes and guidelines is provided in Hancher et al. (2021).

160 Please note that, in this context, regional refers to a group of countries rather than a region at sub-national level.

European methodologies) or the relevant subset of NRAs (regional and national methodologies). In certain cases, a decision is to be referred to ACER if no consensus between all or the relevant subset of NRAs is reached. The implementation of TCMs foreseen in the first generation of network codes and guidelines is still ongoing.[161]

4.2.12 Clean Energy Package: additional network codes and guideline areas

In the Clean Energy Package, the European Commission proposed a recast of Regulation (EC) 714/2009. The adoption of the CEP brought significant changes for both existing and future generations of EU network codes and guidelines.[162]

First, the recast of Regulation (EC) 714/2009 includes provisions that modify the operation of a number of the network codes and guidelines. Moreover, additional areas for a 'second generation of network codes and guidelines' were identified. Examples are rules on demand response, including aggregation, energy storage and demand curtailment, and rules for cybersecurity aspects of cross-border electricity flows.[163] In these two areas, new network codes or guidelines are currently being developed. They are at different stages of the development process. Regarding the former area, the framework guideline on demand response was submitted by ACER to the European Commission in December 2022 (ACER, 2022). In 2023, the Commission requested the EU DSO Entity and ENTSO-E to draft a Network Code proposal, which has gone through a public consultation in the end of that year (ENTSO-E, 2023). The EU DSO Entity and ENTSO-E were expected to submit the proposal of the NC on demand response to ACER by the 8th of May 2024 (ENTSO-E and EU DSO Entity, 2023). Currently, ACER is reviewing the draft network code and will submit it to the Commission by March 2025, who then has six months to review and finalise the NC. Regarding the latter area, ENTSO-E and the EU DSO entity cooperated in drafting the Cyber Security Network Code and submitted a draft proposal for revision to ACER in January 2022. In July 2022, the Commission received the revised draft network code from ACER, leading to the adoption of the NC CS in March 2024 and becoming legally binding across the EU.

Second, the development process saw a shift in roles and responsibilities. The strong role of ENTSO-E in drafting the network codes was reduced. The CEP also mandated the establishment of an EU DSO entity to involve distribution system operators (DSOs) in the network code and guideline drafting process. The role of ACER in the development phase is expected to increase. Another change concerns the time interval in which the European Commission is required to compile a priority list for new network codes.

Third, changes were introduced in the adoption process for both TCMs and new network codes and guidelines. Regarding TCMs, ACER now directly decides on methodologies at a pan-European scale (the former 'all NRA' decisions). Regarding network codes and guidelines, the Clean Energy Package distinguishes between the adoption of network codes and guidelines as implementing or delegated acts. Depending on the type of act, European institutions and stakeholders have different rights and possibilities to intervene in the adoption process.

161 More details on network codes versus guidelines are provided in a FSR blog post available at https://fsr.eui.eu/network-codes-versus-guidelines/ and at https://fsr.eui.eu/implementation-challenges-i-terms-conditions-and-methodologies/ .

162 In the provision agreement of the EMD reform, no structural changes have been made to the CEP provisions regarding the procedures and responsibilities of network codes and guidelines. Nevertheless, an extension of the applicable areas of network codes is foreseen in Article 59(1a), including "different governance options, features of the tools to allocate and trade financial long-term transmission rights, and methodologies for compensating offshore renewable electricity plant operators."

163 More information on the second generation of network codes and guidelines is provided in Reif et al. (2021).

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4.3 Gas wholesale markets

Ilaria Conti and James Kneebone

In this section we break down the wholesale markets for natural gas and the associated supply chains. This includes the composition of 'natural gas' and its applications, the supply chain that brings it from production to consumption, the way the markets function and the future of natural gas markets in the EU. We also provide an overview of the existing EU Gas Network Codes.

4.3.1 What is 'natural gas'?

Natural gas is an odourless and colourless mixture of four gases, predominantly methane with smaller quantities of ethane, butane, and propane. It serves a range of important functions, including for heating, electricity generation, and industrial applications. Natural gas currently constitutes roughly 22% of overall energy consumption in the EU (Eurostat, 2023).

The term 'natural gas' has historically referred to 'fossil methane', a product of heat and pressure applied to organic matter in geological formations. The natural gas network as described in this section predominantly serves the extraction, transportation and use of this product. Nevertheless, to a much smaller (but growing) extent the same network now also serves 'biomethane', another methane-based gas that can be used interchangeably and in combination with fossil methane. Like fossil methane, biomethane is also produced from decomposition of organic matter but it is not considered a fossil fuel. This is because biomethane is recovered from anaerobic digestion of organic matter (such as food and animal waste, or dedicated crops) above ground rather than extracted from fossil sources in geological formations underground. In this sense, there is a technical distinction between methane of fossil origin and methane of biogenic origin. Nevertheless, due to the similarities in their chemical composition the market functioning is broadly unaffected by this distinction, likewise the emissions intensity of the two gases upon combustion. In this section the term 'natural gas' will be used to describe the combination of fossil gas and biomethane that is used in the modern European gas network.

4.3.2 The natural gas value chain

4.3.2.1 *What is the natural gas value chain?*

The term 'value chain' or 'supply chain' in this context refers to the process, actors and infrastructure that bring natural gas from the point of production/generation to the end-user at the point of consumption. It is a complex series of interactions between actors and infrastructure that link together EU market actors across borders and connect the EU to the wider global natural gas value chain (Figure 4.4). Europe has around 200,000km of transmission pipes, and more than 2,000,000km of smaller diameter distribution pipes.

Figure 4.4: The EU natural gas infrastructure network, including entry points (source: ENTSOG, 2021)

4.3.2.2 Which are the actors in the value chain and what are their roles?

Actors in the natural gas value chain can be broadly categorised in three different segments:

- production/generation (upstream);
- transmission (midstream);
- distribution (downstream).

Generation or production includes exploration, drilling, collection, and processing of gas. Fossil gas extracted from the earth comes with impurities such as water, oil, and trace gases. The upstream segment must therefore process these contaminants out of the product before it can be injected into the gas network. Similarly, biogas produced in anaerobic digesters must be further refined into biomethane before injection. These upstream operations are carried out by privately-owned or state-owned corporations that typically own the upstream assets.

Transmission is the process of transporting natural gas from the point of production to the distribution network, perhaps storing it along the way. The EU gas Transmission System Operators (TSOs) coordinate the flows of gas in the transmission network to keep it in balance (Figure 4.5).

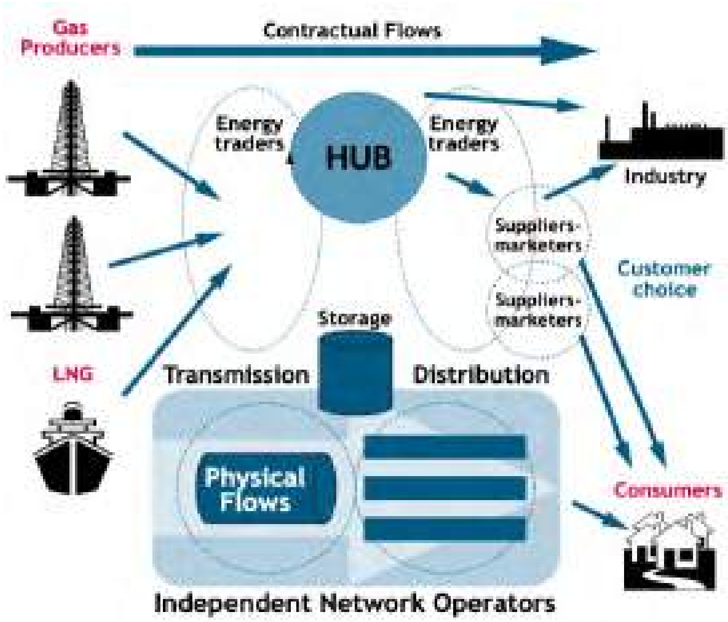

Figure 4.5: Overview of natural gas value chain actors (source: EFET, 2005)

The gas is brokered by energy traders and transported by shippers.[164] Natural gas is either transported under pressure through pipelines or cooled to -163°C where it becomes liquid and can then be transported as liquid natural gas (LNG) on ships or by rail/road. Where the gas is not immediately required for use in the distribution network or where traders would rather store it for resale later, it is injected into a storage facility along the transmission network. Unlike electricity, natural gas can be stored cost-effectively for long periods of time, typically in underground reservoirs, such as salt caverns. The stability and cost-effectiveness of storing natural gas makes it a flexible energy vector,[165] useful in balancing the electricity grid through combustion in gas fired power plants. Moreover, natural gas storage helps to account for seasonal variations in overall supply and demand and protects against security of supply concerns and price fluctuations (see Section 3.1 for more details). Natural gas storage is managed at the operational level by Storage System Operators (SSOs).

Distribution is the final step in delivering natural gas to consumers. While some large industrial customers such as steel and chemical companies receive their natural gas directly from the transmission network, most users such as households and small businesses receive natural gas from a distribution company. These companies use local distribution networks of small pipelines to take natural gas from the transmission network and deliver it to the point of consumption. Before the natural gas reaches consumers it typically undergoes some further refining and the addition of an ‘odour’ to make it easier to identify leaks. The distribution network is coordinated by Distribution System Operators (DSOs).

4.3.2.3 How are the different components in the value chain organised and regulated?

Pipeline operation is considered a natural monopoly due to the scope and economies of scale associated with the infrastructure; for example it is far more efficient to have one large gas transportation pipeline than five small ones. The transmission segment used to be considered

164 An ’energy trader’ is a broker between buyers and sellers of energy commodities, in this case gas, on an exchange, for example the Dutch TTF. ’Energy shippers’ physically transport energy commodities for a fee, in this case pipeline operators or shipping companies.

165 An energy vector allows to transfer, in space and time, a quantity of energy.

an operational branch of the incumbent company, however, liberalisation of the European gas market has brought many changes to the organisational characteristics of the network to increase competition and avoid market failures at the transmission and distribution levels. In its modern configuration, the different components of the supply chain must be owned and operated by separate companies to ensure owners of monopoly infrastructure such as pipelines do not distort the market. Producers, shippers, and distribution companies must have contracts with the TSOs and DSOs to transport gas through the network. This process of disaggregating the supply chain is called 'unbundling'. It is a core pillar in EU energy policy as it promotes competition in the wholesale and retail energy markets with the ultimate scope of keeping prices for consumers low.[166]

Another important actor in the value chain is the energy regulator, who defines the rules applying to each segment of the supply chain. Rules cover everything from extraction techniques to consumer protection and ensures fairness and transparency for all the actors involved. In the EU, there is one national energy regulator for each member state.[167] These regulators are represented at the European level through Agency for the Cooperation of Energy Regulators (ACER). There can be more than one gas TSO and DSO in a member state, and all the gas TSOs in Europe are represented by ENTSOG while there is currently no homologous association at the EU level for gas DSOs (see Section 1.4 on EU agencies￼ on EU agencies).

4.3.3 How does the natural gas market work?

4.3.3.1 Natural gas as a commodity

Natural gas is a commodity like electricity, oil, or grain. Commodity markets have an inherent degree of volatility, and natural gas is one of the most volatile commodities currently traded. The natural gas market has unique characteristics that differ from other commodity markets, this is primarily due to the physical characteristics of natural gas and the natural gas network. For example, the natural gas network is relatively centralised with a limited number of injection and offtake points. This creates a high level of dependence on certain pieces of infrastructure for the operation of the network. Certain natural gas infrastructure components require specific conditions to operate, for example pipelines operate at a given pressure which is directly related to the volume of gas flowing through them. The high variability of natural gas supply and demand can therefore put the proper functioning of the grid at risk. As a result, effective balancing in the network is crucial to avoid network failures.

4.3.3.2 Natural gas markets

There are two markets for natural gas, the spot market and the futures market. The spot market is the daily market in which natural gas is bought and sold with immediate effect, this is the most 'accurate' natural gas price at any given point.[168] The futures market is used to purchase and sell natural gas with a contract between 1 and 36 months in advance. For example, in a simplified futures contract one could enter into an agreement today for physical delivery of gas in two months' time. Natural gas futures are traded on specific exchange platforms, for example the European Energy Exchange (EEX) and the New York Mercantile Exchange (NYMEX).

166 A comprehensive description of unbundling in the European gas and electricity sectors is provided in an FSR blog post available at https://fsr.eui.eu/unbundling-in-the-european-electricity-and-gas-sectors/.

167 See the European Commission list available at https://energy.ec.europa.eu/topics/markets-and-consumers/energy-consumer-rights/protecting-and-empowering-energy-consumers/national-regulatory-authorities_en.

168 I.e. most closely reflecting the conditions in the global market.

Futures contracts are one of an increasing number of derivative contracts used in commodity markets and they can be quite complex and difficult to understand.[169]

Natural gas is priced and traded at different points around the world called 'market hubs'. These are either physical points located at the intersections of major pipeline systems or 'virtual hubs'[170] in the pipeline stocks of national transmission systems. The US hub ('Henry Hub') is located in Louisiana and futures contracts that are traded on the NYMEX are Henry Hub contracts, meaning they reflect the price of natural gas for physical delivery at this hub. An example of a virtual hub is the Italian Punto di Scambio Virtuale (Virtual Trading Point – PSV). The price at which natural gas trades differs among the major hubs (such as TTF, NBP, Henry Hub, Asean) depending on the supply and demand for natural gas at those particular points, e.g. Dutch Title Transfer Facility (TTF) versus Italian PSV. The difference between the price at one hub and another hub is called the 'location differential'. As is indicated in Figure 4.6, the traded price of natural gas often makes up the largest single component of its cost to consumers.

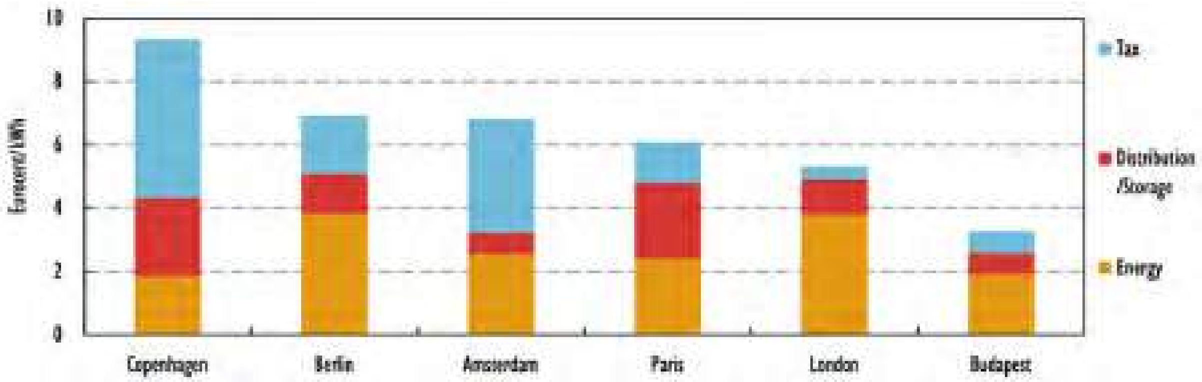

Figure 4.6: Composition of household retail natural gas prices in selected European cities (Eurocent/kWh) (source: Liu et al, 2016)

There are two primary types of natural gas trading: physical trading and financial trading. Physical natural gas trading involves buying and selling the physical commodity. This is the most common form of transaction. Financial trading involves derivatives and sophisticated financial instruments, with the buyer and seller never taking physical delivery of the natural gas. Physical long-term contracts have historically been the most common means of purchasing natural gas, particularly for pipeline deliveries.

4.3.4 What are the rules that govern the operation of the natural gas market in the EU?

A number of key rules covering the functioning of the natural gas market are contained in the Third Energy Package, a series of five legislative acts introduced in 2009 aimed at further liberalising and integrating the EU energy market. It contained two directives, the Electricity Directive 2009/72/EC and the Gas Directive 2009/73/EC and three Regulations: (EC) 713/2009, (EC) 714/2009 and (EC) 715/2009.

The Third Energy Package included provisions requiring further unbundling of network operators, the establishment of ACER and strengthening the independence of National Regulatory Authorities (NRAs). ENTSO-E and ENTSOG were also established in the Third

169 For more information on the different forms of contracts see https://www.reuters.com/business/energy/how-natural-gas-is-traded-europe-2022-12-20/.

170 A virtual hub is a non-physical point in a natural gas market which represents all the entry and exit points in the given area.

Energy Package as a means to enhance cross-border cooperation, in addition to rules for opening and improving competition in retail markets. Finally, the Third Energy Package also triggered the creation of electricity and gas 'network codes' (NCs).

The NCs are a set of technical rules for the functioning of Europe's internal energy market. They address the major barriers impeding the cross-border flow of electricity and gas, thus transforming a patchwork of national energy markets into a single European energy market. The NCs guide the integrated operation of cross-border energy networks to allow increased competitiveness, more cost-efficient integration of renewables and a secure supply of energy at affordable prices. Network codes address the market, system operation and grid connection rules. They represent the 'software' of the EU internal energy market.

So far, four gas NCs and a set of guidelines have been adopted:

- The interoperability and data exchange rule NC deals with technical, operational and communication-related barriers to cross-border gas flow.
- The gas balancing NC harmonises the rules in the gas balancing markets and distinguishes the responsibilities of TSOs and Network Users in this context.
- The capacity allocation mechanism NC introduces harmonised auctions and standardised capacity products to be traded according to the same rules and at the same time.
- The harmonised transmission tariff structure NC aims to harmonise the approaches to tariff setting for gas transmission services in the EU Member States.
- The congestion management procedure guidelines introduce two basic principles: (i) network users are required to use the contracted capacity, otherwise they risk losing it; and (ii) any unused capacity should be offered back on the market.

4.3.5 What is the future of the natural gas market?

Demand for natural gas in the EU is likely to remain stable in the short to medium term, with a requirement for flexible electricity production to balance growing variable renewable sources and coal users utilising gas-fired power plants in their transition to renewable energy. However, the origin and form of delivery of that gas is likely to change since the Russian invasion of Ukraine in February 2022. Prior to this, Russia was Europe's main gas import partner, constituting as much as 45% of deliveries, the vast majority via pipeline. However, the EU has committed to eliminating Russian fossil fuel imports as soon as possible. By the end of 2022 the EU had already reduced the share of Russian gas in imports to just over 10% (European Council, 2022). Furthermore, gas pipelines have increasingly become strategically important tools for geopolitical leverage, encouraging a transition to LNG deliveries which are inherently much more flexible. EU Member States are working towards receiving larger shares of gas deliveries in this form and are building the infrastructure to make it possible.

By 2050 natural gas is envisaged to have a considerably smaller role in the energy mix as it is increasingly replaced with a mix of direct electrification and clean molecules, such as renewable hydrogen, biomethane and synthetic methane (EC, 2016). As discussed earlier, biomethane is already present in the existing natural gas network and is widely considered to be among the most commercially and technically viable alternatives to replace part of the current natural gas consumption. Hydrogen is also likely to play a role in the EU energy mix by 2050, with the EU aiming to install 80 GW of electrolyser capacity in the EU and neighbouring region by 2030 (EC, 2020). The viability of satisfying meaningful portions of natural gas demand with renewable hydrogen requires a number of key developments, including significant sustained demand for renewable hydrogen, an increase in the availability of renewable energy, a further drop in the cost of renewable electricity and a drop in the cost of electrolyser manufacturing and the supply chain. Much of the existing natural gas network will likely have an important role in the future energy market, as stakeholders look to repurpose existing infrastructure such as pipelines and underground storage for hydrogen and other clean molecules (Council, 2023).

In May 2024 the EU adopted a new legislative package on the functioning of the hydrogen and gas markets that will go a long way to shaping the future of the sector (Council, 2023; Kneebone, 2024). This legislation aims to establish the conditions to facilitate the rapid and sustained uptake of renewable and low-carbon gases, improve consumer engagement, better account for contemporary security of supply concerns, address price and supply concerns at the level of the Union, and recalibrate the structure of regulatory bodies.[171]

171 For more information on the details of the Package, see our dedicated article here: https://fsr.eui.eu/the-eu-hydrogen-and-decarbonised-gas-market-package/.

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4.4 The EU energy crisis and the functioning of electricity markets

Tim Schittekatte and Emma Menegatti

In this section, we provide an overview of the current EU energy crisis and the measures that have been applied so far to reduce its impact. We answer seven key questions related to the functioning of the electricity markets during the energy crisis.[172] Furthermore, we describe the electricity market reform published by the European Commission in March 2023 and adopted in May 2024.

4.4.1 What has happened?

Starting from the end of the summer 2021, Europe's energy prices reached sustained, unprecedented, and largely unexpected high levels, raising a vivid debate across the EU. The energy crisis was first and foremost a natural gas crisis. However, as reference day-ahead electricity markets reflect the system marginal (opportunity) cost of generation, often set by gas-fired plants, also electricity prices attained sustained high levels. Figure 4.7 shows monthly averaged day-ahead electricity prices from the start of 2021 until the beginning of 2024 for a selection of European countries. The price dynamics have not been homogeneous across countries, due to the diverse levels of gas dependency, cross-border interconnections, and national interventions in the spot market (most notoriously in Spain and Portugal since 15 June of 2022, see e.g., Euronews, 2022).

172 Several answers are based on Schittekatte and Batlle (2023).

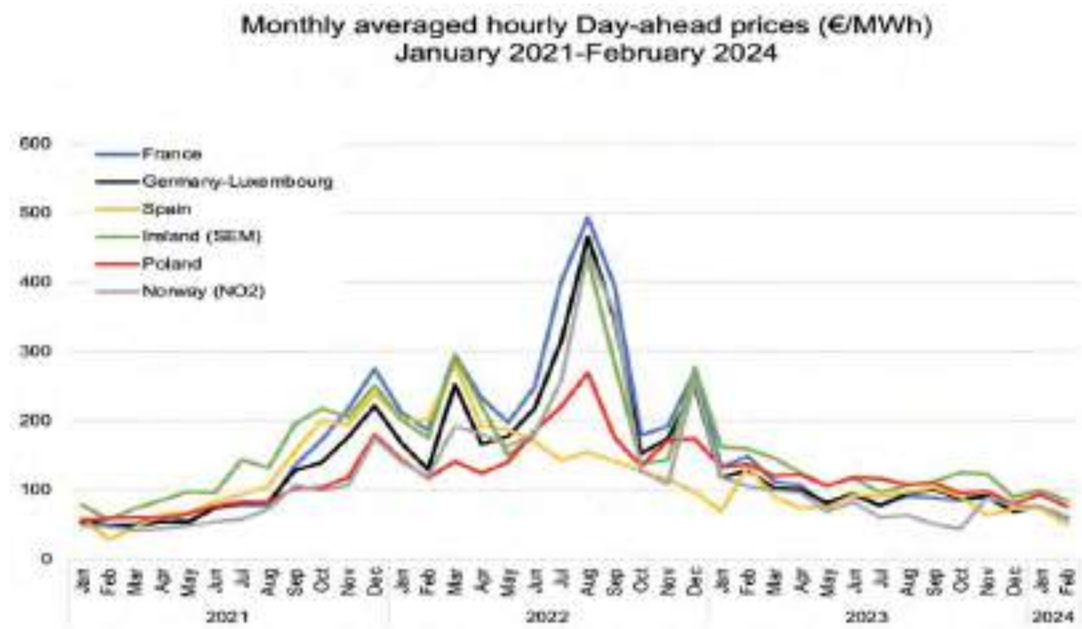


Figure 4.7: Monthly averaged day-ahead prices for six bidding zones 2021-2024 (source: ENTSO-E TP Data)

4.4.2 Were the high prices in spot electricity markets (day-ahead) a consequence of a failed electricity spot market design?

No, this is not the case. The electricity spot markets functioned as anticipated. The high spot prices reflected the market conditions. More precisely, these spot prices have indicated the burning of very expensive gas to satisfy our electricity demand. High gas prices were the main issue. These high electricity spot prices indicated that the EU needed to become more independent from (Russian) natural gas for electricity production.

4.4.3 'Pay-as-cleared' is the pricing rule applied in the day-ahead EU electricity markets. Under this pricing rule the most expensive dispatched generator needed to satisfy the electricity demand determines the hourly price received by all generators. Is that a good idea?

The main idea behind *'pay-as-cleared'* is that when satisfying the demand for electricity, a watt-hour produced by one generation technology is indifferentiable from another watt-hour generated by another technology. Hence, the price for each watt-hour delivered at a particular location shall be priced the same in real time, independent of how the watt-hour is produced. The price that every seller of electricity receives, and every buyer of electricity pays is called *'the clearing price'* (e.g., the unique price for electricity in a particular hour in a certain bidding zone if we consider the day-ahead market). Under the assumption that market power is absent and disregarding any non-convexities[173], the *'clearing price'* will be equal to the marginal cost of the producer with the highest marginal cost to satisfy instant demand. With marginal cost is

173 Non-convexities imply the existence of costs of electricity production that do not scale linearly with electricity production or technical constraints that are not linear. Examples are start-up costs for a generator or minimum up time, i.e., a generator when being started up needs to stay online for at least a certain number of hours.

meant the cost incurred by a producer to increase its production with one unit. For example, when simplifying, an increase of production of 1 MWh implies for a gas-fired unit to burn about 2 MWh of natural gas. Hence, the marginal cost for producing electricity by that gas-fired unit with be equal to the value of 2 MWh on the gas spot market.[174] Often the marginal cost is approximated by the variable production cost.[175]

Under the same assumptions that market power is absent and disregarding any non-convexities, in the day-ahead market auction each seller will offer to sell its generation at the marginal cost of that generation. If the offer were lower than the true marginal cost of the generator, it could be that the generator is *'cleared'* but loses money. This would be the case if the clearing price lies between the true marginal cost of the generator (upper bound) and the offer (lower bound). If the offer were higher than the true marginal cost of the generator, it could be that the generator would have been making money, but it is not committed and, as such, money is left on the table. This would be the case if the clearing price is between the offer (upper bound) and the true marginal cost of the generator (lower bound). Finally, the *'clearing price'* is set by the marginal cost of the generator with the highest marginal cost needed to satisfy instant demand. Hence, *'pay-as-cleared'* is often referred to *'marginal pricing''* or *'uniform pricing'*.

Any deviation from this principle (*'the rule of one clearing price'*) will lead to uneconomical decisions on the supply side, demand side, and the usage of cross-border interconnectors.[176] Even though trading volumes in spot markets are often not very high, highly traded longer-term contracts reflect expectations of the spot market prices. As such, inefficient spot prices 'propagate' along the sequence of markets and lead to significant additional costs. In the longer run, the evolution of marginal prices should also indicate which technologies are most valuable to add to the existing resource mix. In that regard, high spot prices give an important incentive to massively invest in additional production capacity (e.g., renewables) on the supply side and energy efficiency on the demand side. Another example is the many days in summer 2023 with negatively priced hours around noon and higher prices during the early evening. Such prices give a strong signal to shift consumption within the day. On the longer run, such price volatility signals the value of flexible assets such as storage, which could *'buy low and sell high'*. More storage would lead to less volatility until a new equilibrium is reached.

Marginal pricing is not unique to the power sector, but the standard approach in all commodity markets such as gas, oil, coal, copper or grain. A complexity that is specific to the electricity sector is that, today, electricity is not (yet) / hardly storable in many jurisdictions. This implies that short-term trade directly determines production. This is less the case for other commodities such gas, coal and oil which can more easily be stored and transported. Considering this reality, one could argue that efficient pricing is (even) more crucial for electricity than for these other commodities. Marginal pricing is in place in the spot markets everywhere in the world

174 It could also be that the gas-fired unit has a long-term gas contract with each MWh of gas having a predetermined price. However, what matters is the opportunity cost of the gas, i.e., for the holder of the long-term contract reselling that gas on the gas spot market is an alternative to burning gas through a turbine to generate electricity.

175 In case the marginal cost is not dependent on the instantaneous level of production, the marginal cost equals the variable production cost (possibly including variable maintenance costs). However, this approximation is not always correct. For example, it can be that the marginal cost for producing is higher when a production unit is generating at its minimum generation capacity (i.e., lower efficiency) and lower when a production unit is generating near its maximum generation capacity (i.e., higher efficiency). In other words, the marginal cost can be a function of the production level while the variable production cost equals the total spending on fuel divided by the production level.

176 Professor Ross Baldick (2009) of the University of Texas at Austin also wrote a brilliant explanation of the very basics of the rule of one clearing price.

where the power sector is liberalized: Europe, the United States, the majority of Latin-America, and Oceania (see e.g., Glachant et al., 2021).

Even though often disputed (for flawed reasons), in a future with a higher penetration of near zero-marginal cost renewables, marginal pricing becomes even more important than what has already been today, to coordinate increasingly volatile supply, increasingly controllable demand, storage, and the grid flows. Marginal pricing, based on open bidding, is the only suitable way to reveal marginal operating costs or opportunity costs in the case of demand response and storage (for an elaboration, see e.g., Hogan, 2022).

Obviously, European electricity spot market design can and should be gradually improved (for a complete overview see Meeus, 2020). Examples are more locational prices, bidding formats, the removal of portfolio-based balance responsible parties (BRPs), and scarcity pricing (see, respectively, Eicke and Schittekatte, 2022, Herrero et al., 2020, Neuhoff et al., 2016, Papavasiliou, 2020). However, none of these gradual improvements has a direct link with the current high prices.

4.4.4 But weren't several electricity producers who did not need to burn gas to generate electricity (e.g., renewables, hydro, nuclear, …) earning very high profits that were finally paid by all end-consumers?

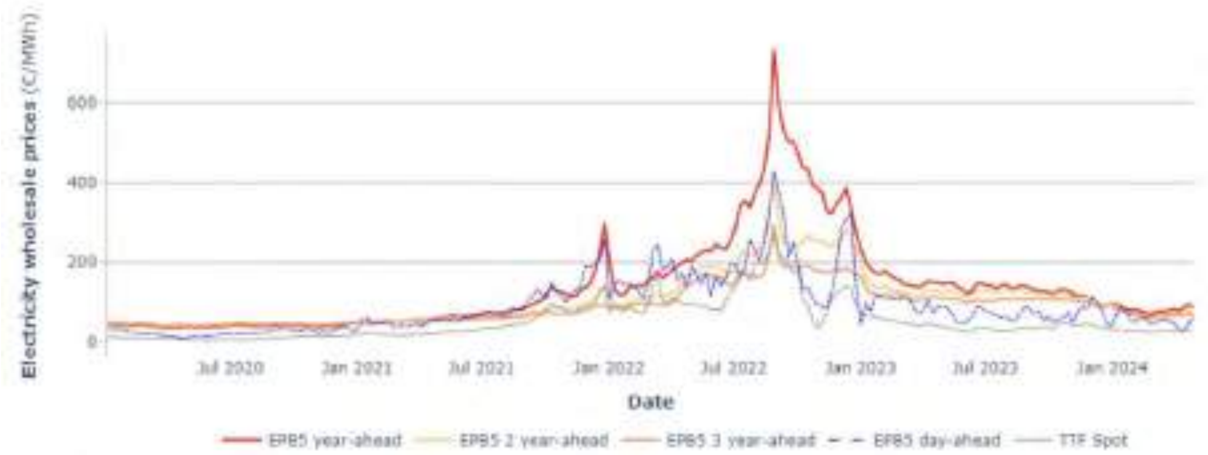
It is true that starting in the summer of 2021 the electricity spot price was significantly higher than the average production cost of electricity (including the consideration of investment costs per MWh produced and a reasonable rate of return). Conversely, between March 2020 and May 2021, due to a low electricity demand during the COVID-crisis, spot prices were lower than average costs (ACER and CEER, 2021). In general, electricity spot prices have been fairly low in the 10 years preceding the crisis. In that context, most emphasis was laid on the spot prices not giving enough incentives to invest in new generation capacity.

Investors in electricity generation rely on periods of high prices to recuperate their investment costs. A crucial concept in this regard is the 'inframarginal rent', the difference between the marginal cost of an electricity producer and the clearing price.[177] The inframarginal rent is needed to recuperate the investment cost of generators which often have a lifetime of several decades. Some generation technologies have relatively high marginal costs, but low investment costs (e.g., gas- and coal plants), and vice versa (e.g., renewables, hydro, and nuclear power plants).

Whether producers earned excessively high margins that went beyond the inframarginal rents that were anticipated to recuperate their investment costs depends to a large extent on their contractual arrangements or hedging strategies. For example, large volumes of renewables are subject to long-term contracts with the Government at predetermined prices and the revenues for these developers are often independent from spot price movements. For other technologies, typically, a large share of the production is hedged via long-term contracts. For example, Vattenfall indicates that 56% of its production for 2023 in the Nordics (Sweden, Denmark and Finland) is under long-term contracts with an average price of 30 €/MWh (Vattenfall, 2023). Typical long-term contracts have a duration of 1-3 years. This also implies that many consumers (directly or indirectly via retailers) have been shielded from the high prices via long-term contracts. Thus, on the short run (the first year in the crisis) the profits made by these producers were not necessarily excessive.

177 The unexpected large profits for gas-fired generators holding medium- to long-term gas supply contracts at pre-crisis conditions have been less under the radar of the political action.

However, each long-term contract has a termination date. Many long-term contracts were renewed. The link between spot prices (applying marginal pricing, organized 24 hours before delivery up to real-time) and long-term contracts (traded bilaterally or in an organized way months to years ahead of delivery) is that quoted prices in long-term contracts are based on expectations of prices in spot markets (averaged over a longer duration plus a risk premium). As such, long-term contracts concluded during the crisis could lead to excessive profits (and overly expensive hedges at the demand-side) as spot prices were expected to remain high for a longer period of time. Sustained high prices can result from a continuation of the stressed situation in the gas market and a lack of new entry in the electricity market. Figure 4.8 shows how the gas price levels (TTF) drive the electricity spot prices, which in their turn impact prices for future baseload contracts on different time horizons. Baseload contracts cover each hour of a particular year. Prices of these annual baseload contracts can change from one minute to another, in figure 4.8 weekly averages are shown. For instance, a price level of 200€/MWh for EP5 3-years ahead in week 35 of 2022 means that during that week, on average, traders were willing to close a contract that hedged all hours of 2025 at 200€/MWh. Disregarding risk premia and other imperfections in trade, one could say that in week 35 of 2022 the expected average day-ahead for 2025 price was equal to 200€/MWh (or at least that was the bet traders were willing to make).



Source: S&P Global Platts.

Figure 4.8: Weekly futures baseload prices (source: EC, 2024)[178]

The reverse link between both markets is that positions obtained via long-term contracts can be adjusted again in spot markets at will. In short, while spot markets are crucial for the optimization of production, consumption and cross-border trade schedules, long-term markets are crucial for financing investments and guaranteeing a predictable cost for electricity for end users. Spot markets for electricity function relatively well in the EU, while long-term markets need to be improved. This was also the recommendation of ACER's assessment of the EU electricity market design during the crisis published in April 2022 (ACER, 2022).

178 EP5 stands for a consumption-weighted baseload benchmark of the prices in France, Germany, the Netherlands, Spain, and Nord Pool. Prices are weighted according to the consumption levels in individual markets. TTF stands for Title Transfer Facility, which is a virtual trading point for natural gas in the Netherlands. Often the TTF is used as a reference spot price for Natural Gas in Europe

4.4.5 Is replacing marginal pricing with pay-as-bid (i.e., market participants receive their bid price instead of a uniform price when they clear the market) a good idea?

No, this is not a good idea. First, changing from pay-as-clear to pay-as-bid could only be done at EU-level, no Member State could initiate such change by itself without completely decoupling from the EU internal electricity market. Second, in theory, under perfect conditions, the outcome of an auction based on pay-as-cleared and pay-as-bid would give the same results. The common fallacy about pay-as-bid is that the bidding strategy of producers would remain the same as their bidding strategy under marginal pricing. On the contrary, under pay-as-bid, each producer will bid its opportunity cost, being the highest bid that is expected to be accepted to satisfy the electricity demand. If the producer were to bid its marginal cost under pay-as-bid, the producer would never have the chance to recuperate any investment cost (i.e., it would be paid its bid, not the bid of the producer with the highest marginal cost to satisfy demand). As such, both pay-as-cleared and pay-as-bid lead to every producing generator receiving the highest marginal cost needed to satisfy instant demand. In practice, the consensus is that pay-as-cleared pricing is a superior pricing rule over pay-as-bid.

Let us consider the following example. Imagine there is a demand for two units of a product and there is no difference in terms of quality or any other characteristic of the product, i.e., it is a commodity, just like electricity is. Imagine there are two producers, producer A can manufacture one unit of the product at a low cost and producer B can manufacture many units but at a higher cost per unit. To maximize its profits, under pay-as-bid, the price per unit asked by producer A will not be its marginal costs, it will be a price that is slightly lower than the price that is estimated to be set by producer B. As there is uncertainty about the price asked by producer B, producer A can miss out profits by setting the wrong price. These imperfections in pricing are costly and will lead to a higher total cost of producing the good, especially in the case of electricity for which real-time trade determines production. Pay-as-bid rules advantages bigger players as they might have more means to produce better predictions (i.e., bidding under the *'pay-as-cleared'* rule is simpler as the rational action is just to bid your marginal cost). Pay-as-bid does also not resolve market power issues. For a more elaborate discussion see e.g. Pototschnig et al. (2022a).

How did policymakers react to mitigate the impact of high electricity prices on end users? During the crisis, governments have spent billions of euros, often representing several percentage points of their national GDP, to shield consumers and industry from high prices.[179] Figure 4.9 provides an overview. Even when considering such substantial public support, many end users faced affordability issues.

179 If you want to know more about the role of consumers in mitigating the impacts of high energy prices, you can read the FSR Topic of the month 'Citizens taking the lead: what can consumers do to protect themselves from high energy prices?', available at https://fsr.eui.eu/citizens-taking-the-lead-what-can-consumers-do-to-protect-themselves-from-high-energy-prices/. To understand the possible role of energy communities during the energy crisis, you can watch the recording of the FSR Talk 'Can Energy Communities Contribute to the Transition and Solving the Energy Crisis?', available at https://fsr.eui.eu/event/can-energy-communities-contribute-to-the-energy-transition-and-to-solving-the-energy-crisis/.

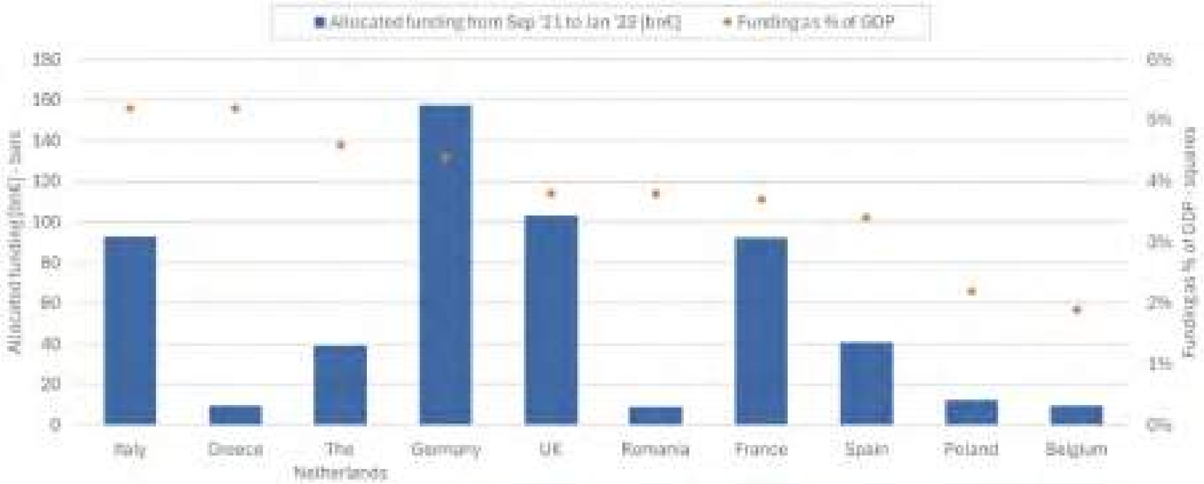


Figure 4.9: Governments earmarked and allocated funding to shield households and firms from the energy crisis for the 10 most populated countries in EU+UK (Sep 2021 - Jan 2023), % GDP. Last update: 26 June 2023 (source: own illustration based on Bruegel, 2023)

An important lesson of the energy crisis is that although it was a gas crisis, the regulatory power market compound has proven to be fragile for political interference. The European Commission (EC) initially defended the functioning of the power market (EC, 2021). At the start of the energy crisis, the most important measure to mitigate electricity bill impacts in many Member States was the reduction or removal of levies and taxes from the electricity bill. In many Member States end user prices for electricity have been made artificially expensive during the last decade due to the inclusion of high levies in the electricity bill. These levies disincentivize electrification and their removal could be a silver lining of this crisis, see e.g. (Rosenow et al., 2023).

After the invasion of Ukraine by Russia in February 2022, the EC has gradually allowed Member States to intervene in their national electricity markets (EC, 2022). Batlle et al. (2022a, 2022b) discuss these policy responses and interventions. An important milestone occurred on 6 October 2022, when the Council of the EU (2022a) finally adopted the Regulation on an emergency intervention to address high energy prices. A centerpiece of that regulation was the introduction of a cap for the market revenues set at a maximum of €180/MWh for inframarginal electricity generators, such as renewables, nuclear and coal. The mandatory cap on revenues covered all market timeframes and would was applied across the EU from 1 December 2022 to 30 June 2023.

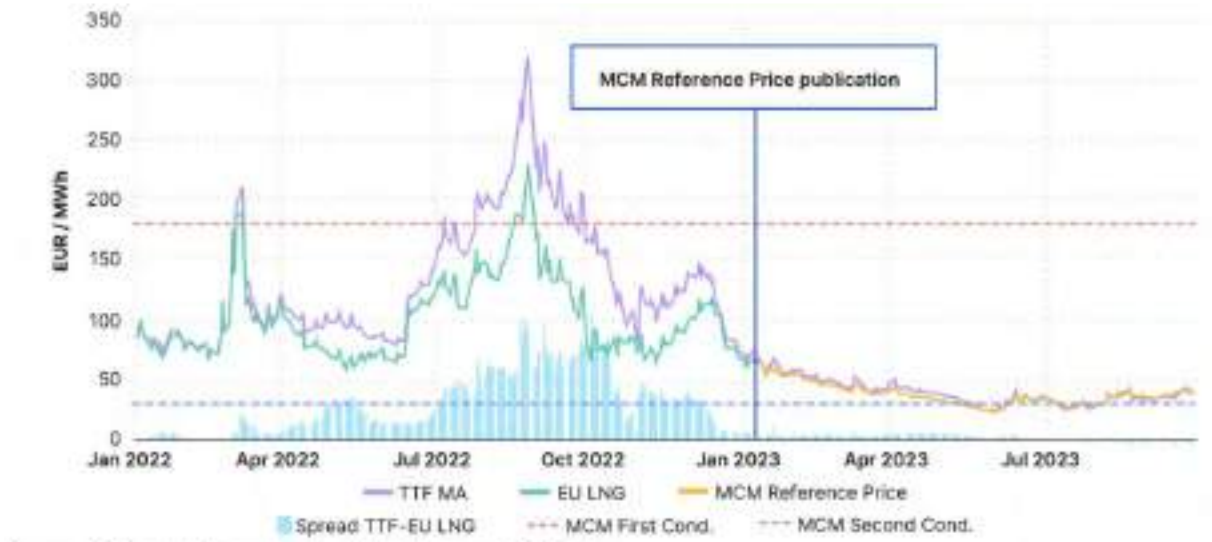
The idea behind this revenue cap is that the captured income can be used to finance (to some extent) measures that protect the purchasing power of household consumers and, potentially, the solvency of strategic industry. Note that using the income from interventions to reduce the average price (in euro per kWh consumed) is a very bad idea as this reduces incentives to save energy. A better idea is to use the income to write lump-sum cheques (see e.g., Pototschnig et al., 2022b) or subsidize a minimum level of consumption, while keeping the exposure to spot prices for consumption levels beyond that threshold. The latter are called inclined block rates in the academic literature and have been recently introduced in e.g., Austria, the Netherlands and Germany (see e.g., Euractiv, 2022).

Any direct intervention in the electricity market itself, e.g., the introduction of a cap in electricity wholesale markets or a subsidy for fossil-based generators (as has been approved in Spain and Portugal), is not a good idea for many reasons. Cross-border trade is distorted, just as incentives for generators and incentives for consumption. In case price intervention was implemented in the electricity market and gas prices were at high levels, perverse signals would be sent to end users of both energy vectors. For example, in winter, consumers would start heating houses with mobile electrical resistance heaters instead of a gas-boiler, while there would be more gas burned in gas-fired power generators than in the respective boilers for the same final heating load. Such a situation is especially an issue when gas is scarce. Importantly, any intervention in the power market, including the revenue cap, has to some extent also long-term consequences; reduced regulatory credibility will lead to increased financing costs of the much-needed capital-intensive future investments in (mostly renewable) generation. Considering the massive investment needs in low-carbon generation, a couple of percentage points increase in financing costs implies billions of additional costs that will finally be passed through to consumers.

Finally, as the origin of the issue was the gas market, a solution might also be found in that market. At the time of the highest witnessed gas prices (the end of August 2022), several proposals have been discussed: a conditional price cap on all gas in case of a disruption, a direct introduction of a price cap for Russian gas, or an import tariff for Russian gas. Finally, a gas price cap was agreed upon that would be activated in case the month-ahead price on the Title Transfer Facility (TTF) exceeds 180€/MWh for three working days and the month-ahead TTF price is 35€ higher than a reference price for liquified natural gas (LNG) on global markets for the same three working days (Council of the EU, 2022b). Figure 4.10 gives an indication of when the Market Correction Mechanism (MCM) conditions would have been reached if implemented.

Discussing the effectiveness of such gas market price cap goes beyond this piece. However, one can note that the cap is set at a relatively high level, which implies that it does not necessarily protect against affordability issues for both gas and power. There is a trade-off. Setting the cap lower would also have negative consequences such as increasing the likelihood of supply interruptions (and consequently possibly also electricity disruptions).[180]

180 If you want to know more about capping the EU price for gas, you can read the FSR Topic of the month ‘A price cap on EU gas markets?’, available at https://fsr.eui.eu/a-price-cap-on-eu-gas-markets/.



Source: ACER calculations based on Platts, Argus and ICE Endex.

Figure 4.10: Front-month TTF, EU LNG spot and MCM Reference Price evolution (EUR/MWh) – January 2022 – September 2023 (source: ACER and CEER, 2023)

4.4.6 Why did the crisis trigger a 'power market reform'?

Maybe even more important than any temporary intervention in the short-term electricity market (even though few temporary measures are truly temporary) is that in the meantime, the EC started working on its own assessment of the existing power market design. The outcome of this assessment may prove to be even more important than any temporary intervention in the spot market (even though few temporary measures are truly temporary). On 23rd of January 2023, the Commission launched a public consultation on the reform of the EU's electricity market design (EC, 2023a). All components of electricity market reform, discussed in more detail in Section 4.4.7. below, were adopted by the European Institutions by May 2024.

It is worth pointing at the actual reason behind the urgence to change the regulatory compound: (marginal) energy prices had reached sustained and unexpected high levels, and there were reasons to think that it was not necessarily going to be an exceptional situation. In this new reality, the variable costs of an important share of the existing and upcoming capital-intensive fleet, e.g., nuclear, hydro and renewables, were significantly lower than the marginal spot clearing price. On the one hand, looking backwards, several policymakers and academics blame the already existing investments of 'unfairly' making too large profits. It is argued that the relevant investors could have never dreamt of the current price levels when they risked their capital at the time of initially financing the projects (or later by acquiring the shares that gave them the right to collect any future returns). On the other hand, looking forward, the investment costs for (intermittent) renewable energy sources (RES) have been significantly reduced much earlier than expected and investment in RES appears now as the by far cheaper alternative.

In economic terms, there is an increasingly widespread perception that long-term marginal generation costs, signalled now by renewable technologies, are and very likely will be for quite some time well below short-term marginal prices often set by gas-fired generators.[181] In an extremely theoretical market context with strictly zero entry barriers, the current crisis would be nothing less than a great opportunity. Strictly zero entry barriers imply full connection access, manageable investment risks and, related to this, the willingness to competitively engage in long-term contracts from both the supply and demand side. Under these conditions, from today to tomorrow, thousands of renewable megawatts would connect to the electricity grid. Since there would be a severe risk for new entrants of what now has been called cannibalization, they would necessarily have to rely on some sort of long-term commitments with end users. The massively entering renewables would quickly bring overall price levels down by selling their currently below-market-price energy, considering not only their operating costs but also capital expenditures and a reasonable rate of return. It is in this context that the open (and like any other marginal) market framework, which has been in force for the last two decades, is severely questioned. But the market framework is a compound of many interrelated mechanisms, and the fact that the current market outcomes might deviate from what politicians would desire does not mean that all its building blocks are malfunctioning.

Spot markets have been working well, as discussed when answering to the second and third question. The issue that has led to the current financial hardship is an incomplete long-term power market leading to a lack of customer protection.[182] In that regard, several measures can be taken and those are at the core of the 'market reform'. Important in this regard is that proposals that aim at completing the long-term market fulfill two main objectives: facilitating the entry of RES at the lowest system cost and limiting the impact of sustained high prices on end users' bills. These two different objectives are less related than often thought, since they concern different groups of stakeholders with radically different risk profiles, i.e., newly connecting RES units and existing generators.

Regarding the entry of RES, there are good arguments to keep auctions for government-backed long-term contracts in place (see e.g., Neuhoff et al., 2022), even if currently RES costs decrease near or below grid parity. These contracts are typically designed as contracts-for-differences (CfDs). Contract design is important, and the contract details should be reviewed to remove distortion while limiting increases in investment risk. Besides organized auctions for long-term contracts, there is also an important role for bilateral power purchase agreements (PPAs) that have been successfully facilitating new entry in some Member States but have been less utilized in other Member States.

Regarding the existing generators, the most groundbreaking aspiration of (at least some) Member States' governments was to regulate/limit their income more permanently and to discretionally subsidize end-user prices. Alternatively, market mechanisms can be introduced to somehow engage in hedges with large portfolios of existing generators to better protect end users that might require such protection. Finally, the liquidity in organized forward markets can be further stimulated by for example a market maker obligation and capacity remuneration mechanisms (CRMs) can be refined.

181 It is not the first time that this is a factor behind a significant regulatory reform in the energy sector. Back in the early nineties, the fact that the long-run marginal cost of the by then new technology (combined-cycle gas plants) was perceived to be lower than the existing generation technologies at that time was undoubtedly one of the factors that pushed policy makers to introduce the major restructuring that led to the market framework that is in force today.

182 For an overview of proposals see also Meeus et al. (2022).

4.4.7 The electricity market reform

The reform is a more structural response, compared to the REPowerEU, to the energy crisis started in 2021 and further aggravated by the Russian invasion of Ukraine in February 2022. It aims to address the issues of (energy) poverty and inflation; the insufficient hedging by consumers and retailers; the difficulties in accessing cheap renewables by consumers; and the investment uncertainty, which increased with the many emergency interventions during the crisis.

A proposal for a market reform was presented in March 2023 by the European Commission.[183] After interinstitutional negotiations, the legislative components of the reform were adopted in May 2024 and published in the EU's Official Journal in June 2024 as Directive 2024/1711 and Regulation 2024/1747.[184] In the following, we give an overview of the main novelties introduced in the reform.

4.4.7.1 Safeguarding the retail market to better protect consumers during crises

An increase in short-term price energy price levels does not necessarily translate into a proportional increase in consumers' or suppliers’ energy procurement costs. Through various long-term contracts and markets, they can hedge their business against upwards price risk. The crisis has shed light on the over exposure of some suppliers to short term-energy prices.

When insufficiently hedged, they passed on their consequent cost increases to consumers, or had to exit the retail market (a number of suppliers filed for bankruptcy over 2021-2022 (ACER, 2023)). To address this issue, the reform foresees the introduction of new rules to assess and **monitor suppliers’ hedging strategies**. To ensure consumers’ supply in case of supplier failure, Member States now have to implement a *‘supplier-of-last-resort’* regime.

The crisis also has placed attention on the unavailability of fixed-price contracts and the lack of transparency in the retail market. The reform mandates that all consumers should have **access to affordable fixed-price and fixed-term contracts**. To ensure the transparency required for sane decision-making, consumers should be provided with better and clearer contract information from their retailers before signing. Moreover, the reform prevents retailers from unilaterally modifying the terms and conditions of the contracts.

On the other hand, consumers have the possibility to engage more with the electricity system and markets. Dynamic pricing is essential to unlock consumer flexibility and thereby a reduction of energy costs. Consumers therefore keep the possibility to choose dynamic price contracts. In addition, the reform allows consumers to enter into multiple or combined contracts (e.g. dedicated to their electric vehicle of heat pump). Active consumers will be able to **share renewable energy** (e.g. from rooftop solar energy produced locally) more easily, i.e. without the need to create energy communities.

The reform also introduced guidelines on emergency measures to be applied during an electricity price crisis. Member States are temporarily allowed to set regulated prices below

183 To understand the flavour of the debate surrounding the market reform, you can read the highlights of the FSR Talk ´EU electricity market design reform: check-in before boarding´ and the FSR Debate ´The Energy Market Design Proposal: risking re-regulating the Internal Market?´, available at https://fsr.eui.eu/an-electricity-market-design-reform-to-support-a-well-functioning-interconnected-electricity-system/.
You can also read the FSR Policy Brief ‘Electricity market reform: what is (not) in the European Commission proposal’, available at https://cadmus.eui.eu/bitstream/handle/1814/75580/RSC%20PB%202023%2007.pdf?sequence=1&isAllowed=y.
To know more about the elements covered by the initial proposal, you can read the FSR News ‘A summary of the proposal for a reform of the EU electricity market, available at https://fsr.eui.eu/a-summary-of-the-proposal-for-a-reform-of-the-eu-electricity-market/.

184 Regulation 2024/1747 amending Regulation 2019/942 (ACER Regulation) and Regulation 2019/943 (Electricity Regulation). Directive 2024/1711 amending Directive 2018/2001 (Renewable Energy Directive) , and Directive 2019/944 (Electricity Directive).

costs. As discussed in previous sections, it is crucial to keep a minimal amount of price exposure to avoid counterproductive incentives which would increase consumption. To prevent such perverse effects, the reform mandates that price regulation should be limited to 80% of median household consumption and 70% of the previous years' consumption for SMEs.

4.4.7.2 Reinforcing long-term markets to enhance stability and predictability of revenues for producers, and of energy costs for consumers

One major aspect of the reform focuses on reinforcing the long-term components of the electricity markets. This should notably help providing more hedging opportunities for all types of market participants.

First, the reform foresees various measures to improve the functioning of the **forward market** (which concerns trades from several years to 2 days ahead). This market is essential for cost stability, as it allows participants to protect their businesses against the risks of price changes on long-term timeframes. However, it has suffered from '*insufficient liquidity, accessibility, competition and transparency*' (ACER, 2023). One underlying issue is the current allocation process of Long-term Transmission Rights (LTTRs), which fails to ensure sufficient hedging opportunities. To address this gap, the reform expands the role of the single allocation platform (SAP) issuing LTTRs and foresees potential changes in the maturity and frequency of allocation of LTTRs. The Commission is moreover tasked to assess solutions to strengthen the forward secondary market, and the possibility to introduce regional virtual hubs. The latter would consist in providing a reference price reflecting the aggregated price of multiple bidding zones, which could be used to offer forward hedging products and pool liquidity. For more information on this matter, you can refer to ACER's Policy Paper on the further development of the EU electricity forward market (ACER, 2023).

Second, the reform aims to boost the development **Power Purchase Agreements** (PPAs). PPAs are long-term (typically with a 10 to 14 years duration) private contracts between a renewable or low-carbon energy generator and a consumer. These contracts provide simultaneously stable revenues for sellers (e.g. RES developers), and long-term price stability for buyers. While the EU PPA market is growing, their availability has remained limited to a few Member States, and to very large offtakers. The reform aims at fostering the uptake of RES PPAs in the EU by removing existing barriers. First, barriers should be removed on the buyers' side. Member States can for example set up a public guarantee scheme to reduce the buyers' default risk, or facilitate the aggregation of demand for PPAs. Second, liquidity in the PPA market should be increased by removing barriers on the sellers' side. To do so, Member States can allow RES projects participating in public tenders to reserve a share of their generation for sale through a PPA. Finally, the reform foresees potential additional measures which could help improve the liquidity, accessibility, and transparency of the EU PPA markets. Such measures include the development of standard contracts for PPAs, and the establishment of one or several EU market platform(s) for PPAs. They are to be assessed respectively by ACER and the European Commission.

4.4.7.3 Boosting investments in low carbon generation and flexible resources through public support schemes

The measures discussed above should enhance the functioning of the *'private'* side of the electricity market design. Member States can in addition provide public support to foster investments in resources that contribute to reaching their adequacy or decarbonization objectives.

Public support schemes are today the main driver of RES development in most EU Member States (IEA, 2023). The novelty of the reform is that it mandates the use of **two-way Contracts**

for Difference (CfDs) in public support schemes for new, non-fossil and low carbon electricity generation (or equivalent schemes with the same effect). A CfD provides the asset with revenue guarantee by ensuring a minimum buying price. *'Two-way'* means that the CfD includes, in addition, a payback mechanism, such that any revenue made from selling energy above a certain strike price is paid back to the public entity. Two-way CfDs were recognized as good practice during the energy crisis as they were able to provide substantial revenues for the public entities concerned, much needed to partly compensate for the costs of emergency protection measures. Two-way CfDs can act as a form of partial and long-term hedge (against upwards price risk) bought by the public authority on behalf of consumers. To ensure this protection, the reform mandates that CfDs' revenues should be passed on to final consumers. To prevent counterproductive effects, this redistribution should be done in a way that preserves incentives for consumers to reduce or shift their demand during periods of high prices. Aside from the advantage of generating revenues during high-price crises, two-way CfDs are not perfect instruments per se. They can distort short-term operational signals (namely by providing *'produce-and-forget'* incentives) as well as investment signals[185]. To reduce potential distortions, the reform includes additional guidelines and examples of good practices that Member States can use, such as injection based CfDs with one or several strike price, a floor price, capability based CfDs, or yardstick CfDs.[186]

Another major novelty of the reform is the possibility for Member States to introduce ***'flexibility support schemes'***. The latter aim to boost investments in non-fossil flexibility, in particular storage and demand response, in case private markets are insufficient for Member States to reach their flexibility objectives. Moreover, the role of support schemes for resource adequacy (the so-called *'capacity mechanisms'*) is also reinforced. These two measures are discussed in more details in Section 3.2.

Finally, the reform foresees the possibility to organise measures at the Union's level, complementing national measures, to facilitate the achievement of the new Union's objective for 2030 (45% of renewable energy sources in the Union's gross final energy consumption). The Commission should assess the interest of such measures and in particular, the possibility to organise **EU-level renewable energy auctions**.

4.4.7.4 *Tackling grid-related obstacles to investments in generation assets*

The electricity grid can become a major bottleneck to investments in renewable generation and electrification. A critical level of congestion is already observed in some EU Member States, with lengthy and growing waiting lines for new connections. To address this issue, the reform promotes the use of **anticipatory investments** in electricity grids, in particular in the new designated renewables acceleration areas when relevant. The Commission will also assess the suitability of the current Union's legal and financing framework on distribution grids to deliver the Union's objectives.

To maximize the use of the existing grid and reduce grid connection delays, investors should have access to precise information on the available grid capacity when deciding on projects'

185 For more information on this issue see for example (Schlecht et al., 2024)

186 For more information on the future of CfDs, see for example the dedicated FSR Cover the Basics https://fsr.eui.eu/contracts-for-difference/ , the FSR debate 'The role and design of contracts for difference in a future-proof electricity market design' https://fsr.eui.eu/event/the-role-and-design-of-contracts-for-difference-for-a-future-proof-electricity-market-design/ , and (Morawiecka et Scott, 2023). Examples of innovative CfD designs in the most recent litterature include for example (Newbery, 2023) on "Yardstick" CfDs, and (Schlecht et al. , 2024) on "financial" CfDs.

location. The reform introduces a new **requirement for system operators to publish and update information on the capacity available** for new connections in their areas of operation (at least monthly for the transmission level, and quarterly for the distribution level). This information should have high spatial granularity, include the capacity under connection requests, and show the possibility of flexible connection in congested areas. Moreover, information regarding the status of connection requests should be provided within 3 months and updated at least quarterly.

Uncertainty regarding grid development, both in terms of topology and timeline, is also a main obstacle to investments in offshore projects. This concerns in particular hybrid offshore projects, located in offshore bidding zones and connected to more than one market though a hybrid interconnector. The reform mandates that **TSOs should compensate hybrid offshore projects**, where they have not made available the capacity agreed in the connection agreement. This measure should help reduce the risk that face offshore project developers. The details of implementation of this compensation mechanism will be developed in an implementing act.

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4.5 Retail markets and the new deal

Athir Nouicer, Valerie Reif and Leonardo Meeus

This section consists of three parts. First, we present the current status of the EU retail energy markets and the existing barriers. Second, we introduce relevant provisions of the Clean Energy for all Europeans Package (CEP) on retail electricity markets and the Hydrogen and Decarbonised Gas Package (Gas Package) on retail gas markets. Both packages aim to enhance consumer empowerment and protection. Third, we give an overview of the changes to retail markets introduced in the context of the REPowerEU plan and the electricity market reform.

4.5.1 EU retail markets

Energy retailing, or supply, is the final step in the traditional energy supply chain, following generation, transmission and distribution. Retailers or suppliers are the entities in charge of buying energy in wholesale markets and selling it to their contracted consumers. Retailers are often part of a company that also generates electricity, which provides them with a hedge against wholesale prices.

The first concrete EU-wide steps in the liberalisation of retail markets started with the Second Energy Package. The Electricity Directive 2003/54/EC and Gas Directive 2003/55/EC enabled industrial and domestic customers to freely choose their gas and electricity suppliers by July 2007. Six years later, the Electricity Directive 2009/72/EC and Gas Directive 2009/73/EC in the Third Energy Package established that the supplier switching process was to be effective within three weeks. Price regulation was only permitted under strict conditions. In addition, the Third Energy Package introduced rules to increase retail market transparency and reinforce consumer protection.[187]

Several indexes are used to assess the functioning of retail markets. The 'ACER Retail Competition Index' (ARCI) uses a structure-conduct-performance framework. Market structure can be assessed with CR3[188] and HHI[189] indicators. Market conduct can be measured through the entry and exit activity of suppliers in the market, customer switching and the number of alternative offers per supplier. Market performance can be approximated with price dispersion and average mark-up (ACER and CEER, 2015). The use of ARCI was discontinued in the ACER and CEER Market Monitoring Reports (MMRs) in 2016, but some of the indicators continue to be reported.

The Felsmann and Vékony (2021) report to the European Commission developed a Barriers Index, which builds on the ARCI. The five top barriers identified are:

- Advantage of vertically integrated market players;
- Low customer awareness or interest;
- Uncertainty around the regulatory future or digitalisation;
- Uncertainty around the current regulatory environment or its development;
- Strategic behaviour of incumbent or other market players.

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187 If you want to know more about how the EU electricity retail market is doing 15 years after liberalisation, you can read the highlights from the FSR debate 'Electricity retail market liberalisation: 15 years on', available at https://fsr.eui.eu/how-is-eu-electricity-retail-market-doing-15-years-after-liberalisation/.

188 CR3 refers to the concentration ratio or total market shares of the three largest suppliers in one market.

189 The HHI refers to the Herfindahl-Hirschmann Index used to measure the degree of market concentration. It is calculated by summing the squares of the markets share of each firm in the market. An HHI greater than 2,000 indicates that the market is highly concentrated.

Figure 4.10 shows the results of the Barriers Index for the electricity and gas markets in 2020. For electricity, the index indicates that new entrants in retail markets faced the lowest barriers in Norway, followed by Slovenia, Sweden, the Netherlands and Finland. These markets stood out for having no regulated end-user prices, and no licencing obligation for new suppliers (except for the Netherlands). The countries where the report indicates the highest barriers were Cyprus, Bulgaria and Poland, all of which had the specificities of extensive price regulation.

For gas markets, the Netherlands had the lowest barriers index, followed by Belgium, the UK, Austria and Germany, which were considered new entrant-friendly markets. On the other hand, in Poland, Romania and Bulgaria, gas suppliers were facing significant barriers.

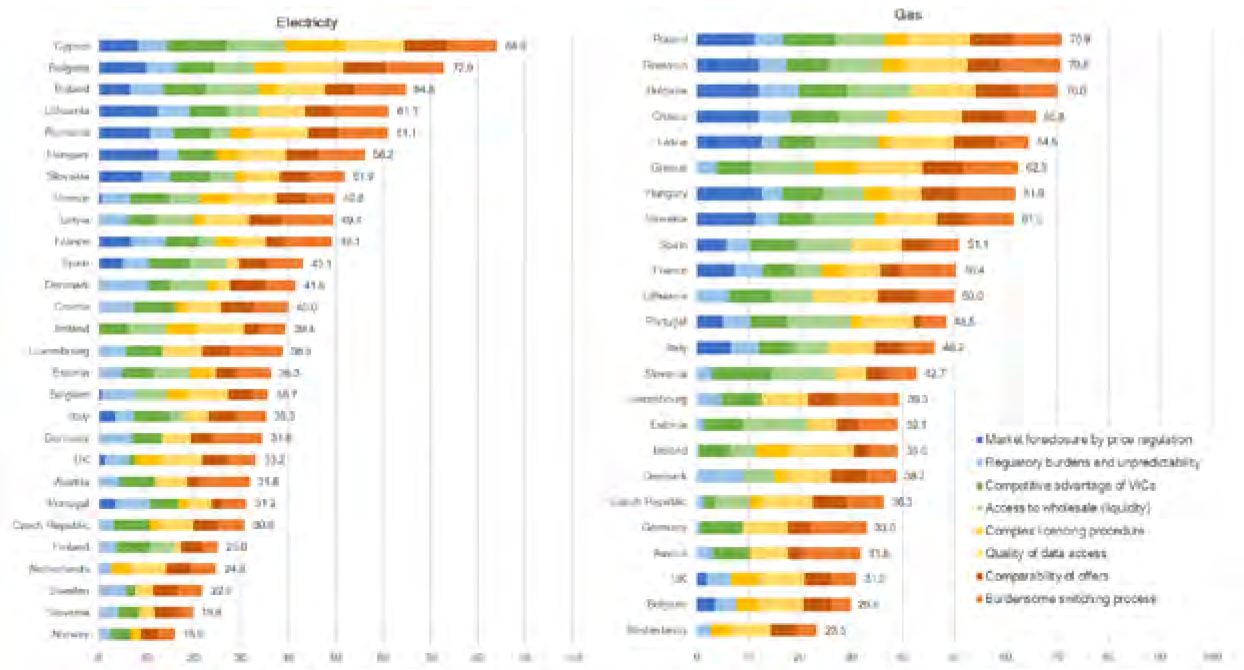

Figure 4.11: Barriers index for electricity and gas (source: Felsmann and Vékony, 2021)

4.5.2 Empowering energy consumers

In 2015, the European Commission published the communication 'Delivering a new deal for energy consumers', building on Third Energy Package provisions. For the electricity sector, consumer empowerment and protection provisions were enhanced by the CEP in 2019. In this regard, the Hydrogen and Decarbonised Gas Market Package mirrors the provisions in the Electricity Directive (EU) 2019/944 and aim to reduce the lag in gas consumer empowerment compared to electricity consumers. In what follows, we present the relevant provisions on: (i) self-consumption, (ii) smart metering systems, (iii) dynamic pricing, (iv) data access and management, (v) aggregators and (vi) energy communities.

4.5.2.1 Self-consumption

Directive (EU) 2019/944 provides a definition of self-consumers, or prosumers, which are referred to as active customers in the directive. The definition is quite broad and encompasses individual and jointly acting final customers that can consume, store and sell their self-generated electricity. Jointly acting renewable self-consumers are defined in RED II. They are referred to as a group of two or more renewable self-consumers that are located in the same building or multi-apartment block.[190]

The recast Gas Directive (EU) 2024/1788 provides a similar definition of active customers of natural gas. As in the case of electricity, the definition also encompasses jointly acting final customers. An active customer can consume or store renewable gas that is located within a limited perimeter, or when permitted by the national authority in other premises. It can also sell self-produced renewable gas using the natural gas system and participate in energy efficiency schemes as long as these activities do not constitute the active customer's primary commercial or professional activity.

Active customers endowed with energy, including renewable gas, storage facilities have the right to a grid connection within a reasonable time after requesting it, subject to fulfilling necessary conditions, e.g. balancing responsibility and adequate metering. They are not to be subject to any double charges, including network charges, for the renewable gas or electricity stored or when they provide flexibility services.

By 2026, consumers should be able to switch electricity and gas suppliers within 24 hours on a working day, and household customers and small enterprises should not be subject to any switching-related fees unless under specific conditions. At least one free-of-charge comparison tool for suppliers' offers is to be provided to households and microenterprises with an expected yearly consumption below 100,000 kWh for electricity microenterprises.

The Electricity and Gas Directives promote consumer-friendly billing, aiming to increase the readability and understandability of bills. Member States shall ensure that billing information is clear, accurate and easy to understand, facilitating comparison by consumers. Both directives include minimum requirements (Annex I) for billing and billing information that have to be met, such as the price and a breakdown of it where possible, information on the benefits of switching, and a link to offer comparison tools.

Finally, electricity network tariff schemes that do not account separately for the electricity fed into and consumed from the grid, e.g. net metering, will not be granted new rights after 31 December 2023.

4.5.2.2 *Smart metering systems*

Electricity Directive (EU) 2019/944 and Gas Directive (EU) 2024/1788 highlight the role of electricity and gas smart meters as a prerequisite for consumers to benefit from innovative services (e.g. facilitate demand side response and storage optimisation) and for DSOs to have better visibility of their networks. Member States are to conduct a cost-benefit analysis (CBA) for the roll-out of smart meters. If the CBA is positive, Member States are to ensure that 80% of final customers are equipped with these systems within seven years, or by 2024 for electricity smart meters. If the CBA is negative, Member States are to revise this assessment at least every four years and notify the Commission of the outcome. Member States with a negative CBA are to ensure that every final customer that wants to pay for a smart meter is entitled, on request, to have one installed or upgraded. This is to be carried out within a reasonable time and no later than four months following the request. The electricity smart meters that were installed before 4 July 2019 and the gas smart meters installed before 4 August 2024 may remain in operation if they meet the minimum requirements in Article 20 and Annex II of Directive (EU) 2019/944 and Article 19 and Annex II of the recast Gas Directive.

190 In RED II, the possibility for Member States to allow production to take place at a location other than the consumer's premises was also introduced.

Otherwise, they shall be phased out by 5 July 2031 for electricity, and by 5 August 2036 for gas.

For hydrogen, Article 18 of the recast Gas Directive provides that Member States shall ensure deployment of smart metering systems and ensure their security and that of data communication and privacy. Interoperability requirements for hydrogen smart meters will be adopted by the Commission by means of implementing acts.

4.5.2.3 *Dynamic pricing*

Directive (EU) 2019/944 defines a dynamic electricity price contract as an *'electricity supply contract between a supplier and a final customer that reflects the price variation in the spot markets, including in the day-ahead and intraday markets, at intervals at least equal to the market settlement frequency'*.

All customers with a smart meter installed are to have the right to conclude a dynamic electricity price contract with at least one supplier in their market and with every supplier that has more than 200,000 final customers. Customers shall be fully informed of the opportunities and risks involved in dynamic price contracts. In addition, suppliers need to get their consumers' consent before switching them into dynamic electricity price contracts. The electricity market reform confirmed the right of consumers to have fixed price contacts as well as dynamic price contracts and multiple contracts in amendments to Article 11 of the Electricity Directive 2019/944.

Note that there are no provisions on dynamic gas pricing in the Gas Package due to the nature of natural gas (wholesale) pricing, which is typically less dynamic within a day.

4.5.2.4 *Data access and management*

Regarding data management models, Directive (EU) 2019/944 and the Gas Directive (EU) 2024/1788 do not specify a particular model for consumer energy data which include metering and consumption data and data needed for customer switching and other services. Member States or the competent authorities are to authorise and certify parties that are responsible for data management to ensure their compliance with the electricity and gas directives.

Eligible parties are to have non-discriminatory and simultaneous access to customers' final data. When consumers want to access their data on electricity or gas supplied or demand response, there should be no additional cost. The European Commission worked on data interoperability rules and adopted them by means of an implementing act (see Section 5.3) in June 2023. The act aims at improving access to metering and consumption data; this secondary legislation introduced requirements and procedures to ensure that data on metering and consumption in EU countries use one common reference model (EC, 2023). The 'reference model' proposed in the act is characterised by a minimum set of requirements to ensure that a given procedure (e.g., access to validated historical metering and consumption data by an eligible party or the final customer) can run correctly, while allowing for national customisation.

4.5.2.5 *Aggregators*

Directive (EU) 2019/944 defines aggregation as *'a function performed by a natural or legal person who combines multiple customer loads or generated electricity for sale, purchase or auction in any electricity market'*. Member States are to develop regulatory frameworks for independent aggregators, which creates a level-playing field for the demand side with all consumers being entitled to conclude a contract with an aggregator without needing the consent of their electricity supplier. In addition, if a customer contracts with an aggregator, they are not to be treated in a discriminatory way by the electricity supplier. The rules on fees for terminating contracts with independent aggregators are similar to those on contracts with electricity suppliers. Aggregators must fully inform customers of the terms and conditions of aggregation contracts. On request, they must also communicate the relevant electricity and demand response data to their customers free of charge at least once in every billing period.

Regarding the aggregation implementation model, Directive (EU) 2019/944 leaves this open for Member States to decide as long as they respect the principles and rules in the directive such as including perimeter correction and compensation for suppliers. Indeed, aggregators will be financially responsible for any system imbalances that they cause. They can be balance responsible or delegate the responsibility to a third party. Regarding compensation, e.g. of suppliers, Member States may require aggregators to pay financial compensation to other market participants or to their balance responsible parties (BRPs). The compensation is to be limited to covering costs incurred by customers' suppliers or their BRPs during activation of demand response (Schittekatte et al., 2021). To facilitate the activities of aggregators, the recent amendments of the Renewable Energy Directive foresee that, if technically available, distribution system operators shall make available anonymised and aggregated data on the demand response potential and the renewable electricity generated and injected to the grid by self-consumers and renewable energy communities (EP and the Council, 2023).

Note also that there are no provisions on aggregators in the Hydrogen and Gas Market Decarbonisation Package. The European Commission's public consultation on the package, which was held in 2021, included *'consumer participation in demand response through aggregation contracts'* among the options for strengthening the rights of consumers and information available to them. However, this was not included among the provisions in the final package.

4.5.2.6 *Energy Communities*

Another new intermediary for customers introduced in the CEP is energy communities. Two types of energy communities are introduced. An enabling framework for Citizen Energy Communities (CECs) is defined in Directive (EU) 2019/944, while provisions on Renewable Energy Communities (RECs) were introduced in RED II.[191]

4.5.2.6.1 Citizen Energy Communities (CECs)

Directive (EU) 2019/944 defines a CEC as a legal entity controlled by its members or shareholders, participation in which is open and voluntary. The members or shareholders can be natural persons, local authorities, including municipalities, or small enterprises. The primary purpose of a CEC is to provide its members or the areas in which the community is active with environmental, economic or social benefits. A CEC may engage in almost all energy system activities where applicable, e.g. generation, distribution, supply, consumption, aggregation, storage, energy efficiency services and charging services for electric vehicles for the electricity system.

Member States are required to adopt a legal framework for the establishment of CECs. The electricity directive provides a broad guide with a catalogue of applicable rights and obligations. This includes rules regarding membership of CECs and their access to all electricity markets. CECs must not be subject to any discriminatory or disproportionate treatment in relation to their activities, rights and obligations. In turn, they should have balance responsibility for any imbalances they cause or delegate this responsibility. Nevertheless, Member States are free

191 For an overview of the energy communities in the context of the CEP, see Verde and Rossetto (2020).

to decide on rules relating to cross-border participation by CECs, their ownership and the establishment, purchase and lease of distribution networks in their area.

4.5.2.6.2 Renewable Energy Communities (RECs)

RED II defines a REC as a legal entity based on open and voluntary participation. The definition includes proximity requirements for owned and developed renewable energy projects for the shareholders and members controlling the REC. They can be natural persons, small or medium-sized enterprises or local authorities, including municipalities. The primary purpose of a REC is to provide its shareholders, members or the local area where it operates with environmental, economic or social community benefits. REC generation activities cover only renewable energy but are not limited to electricity. REC members can produce, consume, store and sell renewable energy, including through renewable power purchase agreements (PPAs). They can share the renewable energy produced within the community. RECs are also entitled to access all suitable energy markets either directly or through aggregation.

RED II requires the Member States to assess existing barriers to REC development and the potential for RECs in their territories. They have to provide an enabling framework that removes unjustified regulatory and administrative barriers. In addition, the relevant DSOs must facilitate energy transfers among RECs. The communities are to be subject to fair, transparent and proportionate procedures, including for registration and licensing, and cost-reflective network charges. The amendment of RED II confirmed this point, providing that simplified registration processes and reduced registration fees shall be introduced for renewable energy communities.

Furthermore, renewable energy communities should be able to participate in available support schemes on an equal footing with other participants. Indeed, their specificities are to be taken into account when designing support schemes without prejudice to Articles 107 and 108 TFEU (Almeida et al., 2021).

4.5.3 Recent developments: REPowerEU and the electricity market reform

European energy consumers have been affected, since 2021, by high wholesale prices in different ways (see Section 4.3). While some consumers were temporarily protected by fixed-price contracts, others were directly exposed to wholesale prices. Eventually, however, most consumers faced unprecedented energy bills as retail prices often follow wholesale prices with a certain delay and price exposure could not be withheld indefinitely. What has made the situation particularly difficult is that a cohort of consumers that had never previously needed financial support found themselves in need of assistance in managing their energy bills. Price increases have also affected energy suppliers, some of which have faced significant hedging and liquidity challenges, limiting, among others, their ability to offer fixed price products to energy consumers (ACER and CEER, 2022). Note in this context that some retailers also clearly misbehaved and that the number of consumers who have contacted consumer organisations across Europe due to questionable or even illegal commercial practices have grown significantly since the beginning of the crisis (BEUC, 2022).

The European Commission has responded with several sets of measures to tackle the crisis and mitigate high energy prices, including the toolbox of October 2021 (EC, 2021) and the REPowerEU Plan of May 2022 (EC, 2022). The other institutions have also been involved, for example the Council in passing the Regulation on an emergency intervention to address high energy prices (Council, 2022).[192] Member States have introduced an abundance of measures to protect consumers and the economy (ACER, 2023). Since the start of the energy crisis in September 2021, €758 billion has been allocated and earmarked across European countries to shield consumers from the rising energy costs (Bruegel, 2023). The majority of Member States intervened in the wholesale or retail market (or both), with some exceptions (ACER, 2023). Bruegel (2023) reports that all Member States except Finland and Ireland have implemented or at least publicly announced retail price regulation.

It is too early to judge to what extent the effects of all these measures will overhaul previous efforts of offering a new deal to consumers and putting the citizen at the centre of the energy transition. What seems certain is an increasing degree of fragmentation in European (retail) electricity markets due to (emergency) measures as compared to before the crisis. At the FSR, we have contributed with several publications to this ongoing debate, which the interested reader my consult to read further, for example, Meeus et al. (2022a, 2022b), Pototschnig (2022), or Pototschnig et al. (2022a, 2022b).

In May 2024, the European Parliament and the Council adopted the reform of the European electricity market design published by the European Commission in March 2023. The reform aims to improve the access of consumers and suppliers to renewable and non-fossil energy technologies. Consumers will be given the option to choose between fixed-term contracts and dynamic pricing contracts. Other measures foresee the obligation for Member States to establish suppliers of last resort, the obligation for suppliers to (partially) hedge their price risk (to back up the fixed-price contracts they offer to their customers to avoid going bankrupt), and the option for Member States to provide certain types of regulated retail prices to households and SMEs in case of a crisis. Moreover, rules for sharing renewable energy are strengthened; a right to participate in energy sharing is now applicable to SMEs and households.

192 See here an overview of the EU actions to tackle the energy crisis: https://energy.ec.europa.eu/topics/markets-and-consumers/actions-and-measures-energy-prices_en.

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4.6 Energy poverty and the financial instruments for a just energy transition
Daniele Stampatori

This section introduces the topic of energy poverty and the financial instruments that the EU is employing to alleviate the negative effects of the energy transition. First, we explain what energy poverty is. Second, we give an overview of the EU legislative framework to tackle energy poverty. Third, we describe the financial instruments through which the European Green Deal seeks to address energy poverty. Finally, we provide an overview of the measures that were adopted to shield consumers from the 2021/2022 price hikes.

4.6.1 What is energy poverty and what is the status quo in Europe?

Even though energy poverty has been a widespread problem across the EU for a long time, an official EU definition did not exist before the recast of the Energy Efficiency Directive (EED, see Section 2.5). The EED defines energy poverty as

> *"a household's lack of access to essential energy services, where such services provide basic levels and decent standards of living and health, including adequate heating, hot water, cooling, lighting, and energy to power appliances, in the relevant national context, existing national social policy and other relevant national policies, caused by a combination of factors, including at least non-affordability, insufficient disposable income, high energy expenditure and poor energy efficiency of homes*" (art. 2(52)).

According to the Covenant of Mayors (see Section 5.2), energy poverty can be defined as '*a situation where a household or an individual is unable to afford basic energy services (heating, cooling, lighting, mobility and power) to guarantee a decent standard of living due to a combination of low income, high energy expenditure and low energy efficiency of their homes'.*

In practice, consumers face energy poverty situations when energy bills represent a high percentage of their income and limit their capacity to afford other expenditure.[193] In the worst cases, households even need to reduce their energy consumption for economic reasons.

Due to its multi-dimensional nature, energy poverty is a hard phenomenon to detect. Various indicators have been developed in order to make it measurable and quantifiable. These fall in four groups (EC, 2020a):

- indicators comparing energy expenditure and income;
- indicators based on self-assessments;
- indicators based on direct measurements, for example of physical variables (e.g. temperature);
- indirect indicators, such as arrears on utility bills, numbers of disconnections and housing quality.

The European Commission (EC) estimates that in 2021 about 6.9% of the EU population, equivalent to 30.8 million people, were unable to keep their homes adequately warm, with significant differences among Member States, as is shown in Figure 4.11.[194] The Member State with the largest share of people saying that they were unable to keep their home adequately

193 A 10% income threshold is widely used in the literature to identify energy poverty.

194 See https://energy.ec.europa.eu/topics/markets-and-consumers/energy-consumer-rights/energy-poverty-eu_en (accessed 2 March 2023).

warm in 2022 was Bulgaria (22.5%), followed by Cyprus (19.2%), Greece (18.7%) and Portugal and Lithuania (both with 17.5%).[195]

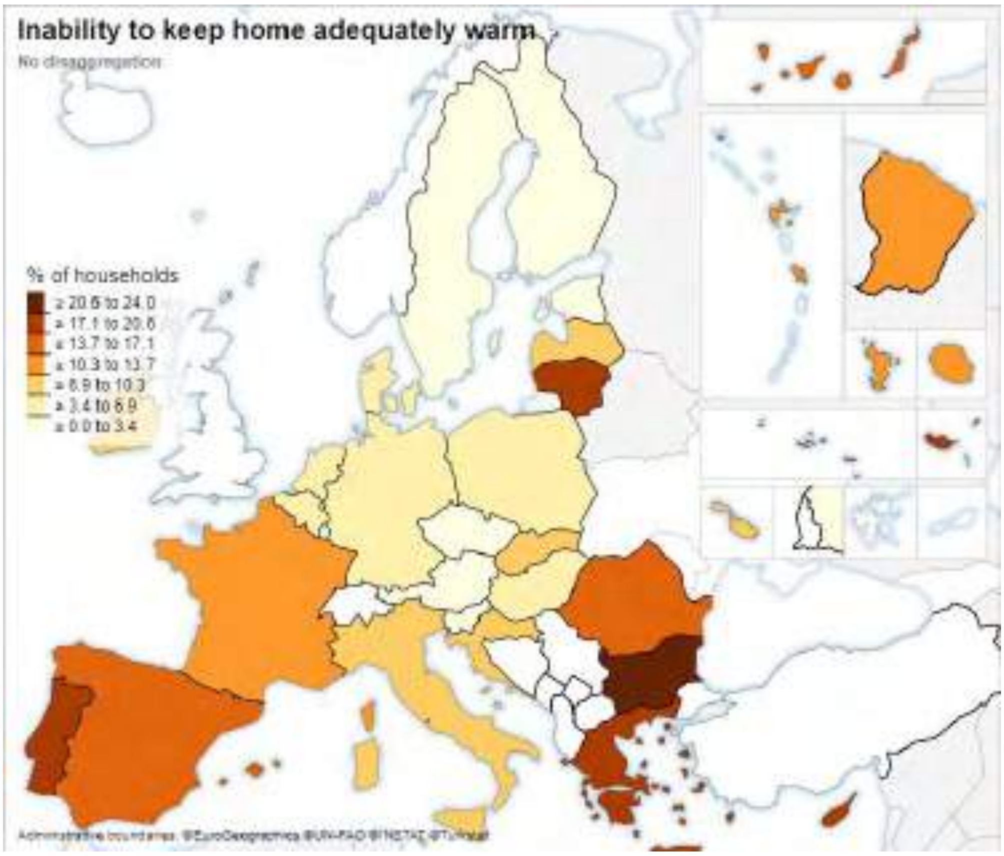

Figure 4.12: Inability to keep the home adequately warm (% of populations) in 2022 (source: EU Energy Policy Advisory Hub, 2022)

4.6.2 What is the EU legislative framework to tackle energy poverty?

The first references (at the Community level) to energy poverty are present in the Electricity Directive 2003/54/EC and Gas Directive 2003/55/EC of the Second Energy Package, which pointed out that actions needed to be taken to protect citizens against electricity disconnection and inability to pay bills (Pye et al., 2017). In addition to the provisions of the directives of the Third Energy Package, several initiatives have been put in place to specifically tackle the

195 Data synthesised by the EU Energy Povery Advisory Hub (EPAH), discussed below in this section, https://energy-poverty.ec.europa.eu/observing-energy-poverty/national-indicators_en

problem such as the Vulnerable Consumers Working Group[196] and the Energy Poverty Observatory.[197]

Energy poverty was also a primary concern of the Clean Energy Package, which included measures to tackle it, for example in:

- The Electricity Directive (EU) 2019/944, which requires Member States to adopt appropriate measures to address energy poverty. A significant new element in the directive is that it requires the number of households in energy poverty to be quantified and specific strategies to be included in the National Energy and Climate Plans (NECPs) of the countries in which the number of households in energy poverty is significant;
- The Energy Efficiency Directive, which requires Member States to take into account the need to reduce energy poverty in the context of their energy efficiency obligations;
- The Energy Performance of Buildings Directive, according to which Member States must outline relevant national measures to help alleviate energy poverty as part of their long-term renovation strategies.

Another EU-wide initiative is the Energy Poverty Advisory Hub (EPAH), which aims at eradicating energy poverty and accelerating the just energy transition of European local governments. Building on the EU Energy Poverty Observatory's legacy, the EPAH adopts an action-based approach by creating a space for collaboration and exchange for local and regional authorities planning a variety of measures to tackle energy poverty in the pursuit of a just and fair transition.[198]

4.6.3 A just transition: how does the Green Deal ensure it?

While the benefits of the energy transition will be more evident in the medium and long term, its costs will have to be addressed in the coming years. The switch towards more sustainable sources and uses of energy will come with a loss of jobs in fossil-based sectors and an increase in energy prices.[199] Moreover, energy transition policies will have a mix of progressive and regressive effects. Significant social and distributional impacts may disproportionally affect vulnerable households, micro-enterprises and transport users, who spend a large part of their incomes on energy and transport solutions and who, in certain regions, do not have access to other affordable mobility and transport alternatives.

In order to signal these implications of the energy transition and the need to take them into account when drafting policies, the concept of a just transition has been introduced. According to Eurofound, a just transition can be defined as a

196 In 2011 in the 4th Citizens' Energy Forum, the European Commission launched a working group on vulnerable consumers with the aim of establishing qualitative and quantitative mapping of various aspects of vulnerability and measures which can contribute to addressing the issue, providing recommendations on defining vulnerable consumers in the energy sector based on the current state of play in the Member States, and highlighting good (national) practices and appropriate non-policy solutions with a long-term potential to better target vulnerability.

197 The EU Energy Poverty Observatory (EPOV) was a 40-month project that commenced in December 2016. It was established with the aim of fostering transformational change in knowledge about the extent of energy poverty in Europe and innovative policies and practices to combat it. At the end of 2020 with the end of the EPOV approaching, the European Commission launched the Energy Poverty Advisory Hub, a 4-year initiative with the objective of assisting municipalities in the fight against energy poverty.

198 https://www.housingeurope.eu/section-110/energy-poverty-advisory-hub. Additional information about EPAH can be found on the portal on energy poverty of the European Commission (https://energy-poverty.ec.europa.eu/index_en).

199 For a consumer perspective, see the recording of the FSR online event ‘Focus on energy consumers’, available at https://fsr.eui.eu/event/focus-on-energy-consumers-how-to-make-them-part-of-the-transition/ (accessed 12 April 2022).

> "*transition to a climate-neutral economy while securing the future and livelihoods of workers and their communities. A Just Transition to a climate-neutral economy provides and guarantees better and decent jobs, social protection, more training opportunities and greater job security for all workers affected by global warming and climate change policies.*"[200]

In order to ensure a just transition, the EC planned to allocate a large amount of financial resources to sustain the most vulnerable citizens, as stated in its Communication 'A strong social Europe for just transitions' (EC, 2020b).

4.6.3.1 *The Just Transition Fund*

In January 2020 the EC published a legislative proposal for a Just Transition Fund (JTF), which aims to help regions relying on fossil fuels and carbon-intensive industries to succeed in their energy transition. The act was adopted in June 2021 as Regulation (EU) 2021/1056. In the latest amendment, the JTF budget was increased from €7.5 to €17.5 billion[201] (CR 2021a/b; EC 2020d). The JTF, together with the InvestEU 'Just Transition' scheme[202] and the Public Sector Loan Facility[203] (Council and Parliament 2021a/b) constitutes the Just Transition Mechanism (EC 2020e), which is expected to mobilise around €55 billion in investments over the period 2021-2027 (see also Section 1.1).

The funding provided by the JTF will be complemented by national co-funding according to the category of the regions in which the areas identified are located (more developed regions, transition regions and less developed regions). The budget for the JTF may be further supplemented with resources from the European Regional Development Fund (ERDF) and the European Social Fund Plus (ESF+). Such transfers from other cohesion policy funds are made on a voluntary basis and may not exceed three times the JTF allocation in the Multiannual Financial Framework (MFF). The JTF includes a green reward mechanism linked to reductions of greenhouse gas (GHG) emissions in regions benefiting from JTF support and makes access to 50% of JTF resources conditional on the adoption of the EU target of climate neutrality by 2050.

The allocation method used by the Commission is based on five socio-economic criteria, each of which has a different weighting factor: half the allocation is based on economic criteria (GHG emissions, production of peat, oil shale and oil sands) and the other half is based on social criteria (employment data).

After calculating the allocation based on these weightings, a May 2020 Commission proposal (EC, 2020c) applied further capping and adjustment: an upper limit for each Member State was applied to prevent a Member State receiving an excessive share of the overall Just Transition Fund resources (which in practice only applies to Poland) and an adjustment according to gross national income per capita was factored in to ensure that resources are concentrated on assisting less developed Member States.

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200 See https://www.eurofound.europa.eu/topic/just-transition, https://www.forumforthefuture.org/blog/transport-or-mobility.

201 €7.5 billion in the MFF and €10 billion in NGEU, in 2018 prices.

202 The InvestEU 'Just Transition' scheme will provide a budgetary guarantee under the InvestEU programme. It will provide a scheme to generate some €10 to €15 billion of (mainly private) investments.

203 The Public Sector Loan Facility is a new public sector loan facility, consisting of a grant component worth €1.5 billion from the EU budget and a loan component of up to €10 billion from the European Investment Bank's resources. It is expected to mobilise around €18.5 billion of public investments.

The final result of this allocation method across the Member States is depicted in Figure 4.12. Poland and Germany are the largest beneficiaries of the fund, accounting for almost a third of total resources.

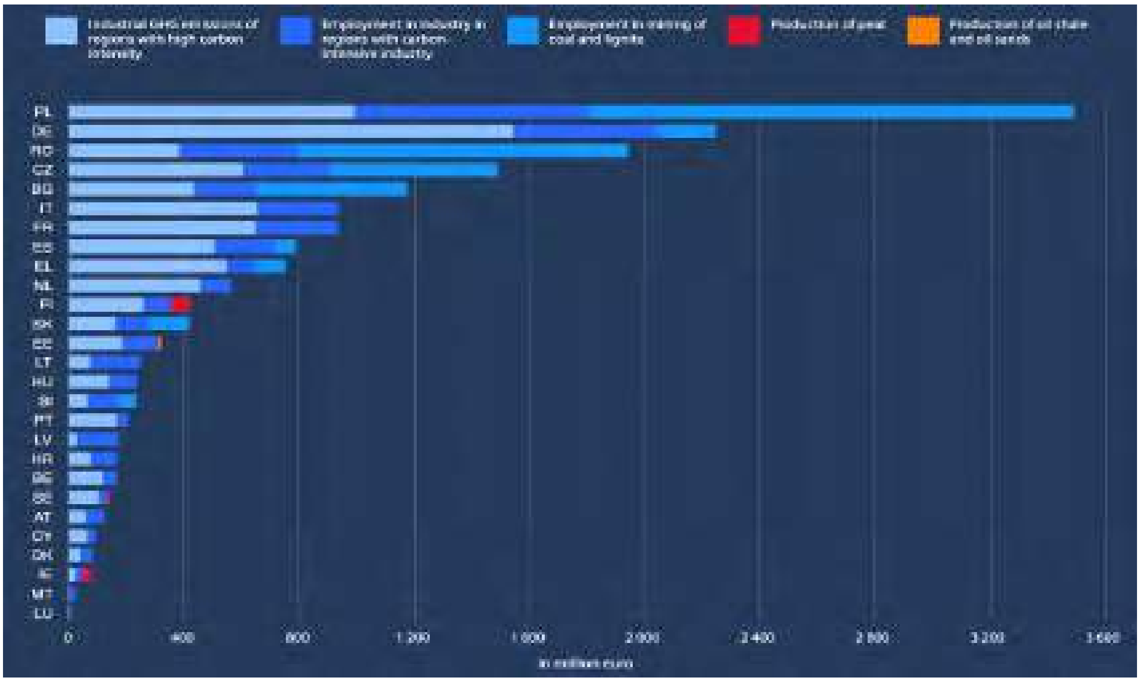

Figure 4.13: Allocations of the JTF budget across Member States after capping and adjustments (source: European Parliament, 2021)

The regulation establishing the Just Transition Fund (Regulation (EU) 2021/1056) envisages that each Member State shall establish a performance framework and provides indicators for monitoring the output of the JTM, with milestones set for the end of 2024 and 2029. A midterm evaluation of the JTF is scheduled for 2025.[204]

4.6.3.2 The Social Climate Fund

The main purpose of the Social Climate Fund (SCF) is to compensate vulnerable households, micro-businesses and transport users for the future costs of the EU's green energy transition in the buildings and road transport sectors, to which the EU plans to extend the emissions trading system (EC, 2021a; EP, 2023, see also Section 2.2.1.). The SCF will principally be funded from the revenues from this ETS 2.

According to the SCF Regulation (EU) 2023/955 (article 10), the SCF should receive €65 billion of EU funding in the period of its operation (2026-2032).

The SCF Regulation (article 4) requires the Member States to submit social climate plans (SCPs) to the Commission by June 2025. The Fund should provide Member States with funding to support measures and investments in improved energy efficiency of buildings, decarbonisation of building heating and cooling – including integration of energy from

204 The European Commission offers a dashboard to monitor the overall budget performance of the JTM, as well as the Just Transition Platform, which visualises the regions the mechanism supports and links to their regional JTF informational websites. See: https://commission.europa.eu/strategy-and-policy/eu-budget/performance-and-reporting/programme-performance-statements/just-transition-mechanism-performance_en ; https://ec.europa.eu/regional_policy/funding/just-transition-fund/just-transition-platform_en

renewable sources – and granting improved access to zero- and low-emission mobility and transport. Additionally, Member States will contribute 25% of the cost of the Social Climate Plans to the fund, which is expected to raise the total endowment of the fund to above €80 billion (Widuto, 2023)

4.6.4 What are the most recent developments?

In 2021-2022 the EU faced a sharp increase in energy prices. This upward trend was initially driven by increased global energy demand due to the post-pandemic recovery, but it was exacerbated by the Russian invasion of Ukraine (see Section 4.4).

In response to the hikes in energy prices, in October 2021 the EC (2021c) published a 'toolbox' of measures to be implemented by Member States to safeguard vulnerable consumers. Immediate measures include caps on energy prices and tax breaks and reductions for vulnerable consumers. In addition, Member States can plan specific social payments such as lump-sum payments and time-limited compensation measures and direct support for energy-poor end users to cover part of their energy bills. At the same time, Member States can put in place (or maintain) safeguard mechanisms to avoid disconnections from the energy grid.

Bruegel (2022) offers a broad overview of such measures that have been implemented by 23 EU countries, Norway and the UK since September 2021 to protect vulnerable consumers as well as businesses. Six main strategies are identified, of which 'transfers to vulnerable groups' and 'reduced energy tax/VAT' are the most widespread among the Member States. Moreover, some countries have directly intervened in the market imposing caps on energy prices at the retail or wholesale level. Other measures concern support schemes for business activities and introducing special taxes on windfall profits of energy companies due to price hikes.

In March 2022, the EC (2022a) published the REPowerEU strategy, which boosts and moves up some of the Fit For 55 objectives with the primary aim of phasing out the EU's dependence on fossil fuels from Russia by 2030 (see Section 1.1.2.6.). The strategy consists of two main 'pillars':

- Diversifying gas supplies through higher LNG imports and pipeline imports from non-Russian suppliers, and higher levels of biomethane and hydrogen;
- Reducing dependence on fossil fuels at the level of homes, buildings and industry, and at the level of the power system by boosting energy efficiency gains, increasing the share of renewables and addressing infrastructure bottlenecks.

In the strategy, the EC confirms that price regulation can be used to mitigate the effect of high energy prices on consumers' bills but reducing the energy prices consumers face could distort the market in a negative way. In fact, this type of measure weakens the incentives to save energy and therefore runs counter to the more general energy policy objectives of sustainability and security of supply. In this regard, Pototschnig et al. (2022) suggest that lump-sum rebate payments can safeguard vulnerable consumers from unaffordable energy bills without weakening incentives to save energy.

In a further communication (2022), the EC emphasizes again the benefits of social payments, of support for energy efficiency improvements and of reductions on taxes and levies to face the current crisis. Reductions in environmental taxes are considered as well: in case these reductions respect the minimum levels of taxation and the rules set out in the Energy Taxation Directive (see Section 1.5), they can be implemented without notifying the Commission.

Additional information on national measures implemented to tackle high energy prices can be found in Section 4.4

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5. EU energy innovation

In this chapter, we focus on energy innovation in five sections. First, we present the Strategic Energy Technology Plan. Second, we describe the EU initiatives that are relevant for smart cities. Third, we explain how digitalisation is impacting the energy sector and explore some of the challenges that come with it. Fourth and fifth, we provide insights on how clean molecules, and in particular hydrogen, will impact the energy sector and discuss the potential for their large-scale roll-out.

5.1 The European energy research and innovation strategy

Athir Nouicer, Daniele Stampatori and Ronnie Belmans

Research, innovation and competitiveness are one of the five dimensions of the Energy Union strategy (EC, 2015). In this regard, as part of the 2016 'Clean Energy for all Europeans Package' proposal, the European Commission (EC) adopted a Communication outlining a strategy to accelerate clean energy innovation (EC, 2016). The research and innovation actions of this strategy are supported by two specific initiatives: the Strategic Energy Technology (SET) Plan and the Strategic Transport Research and Innovation Agenda (STRIA). In this section, we describe first the SET Plan and the STRIA. We then illustrate the synergies between these programs and the EU energy policies. Finally, we answer two key questions: how to support R&I and how to implement R&I at the EU level.

5.1.1 Strategic Energy Technology Plan

The EC proposed the creation of the SET Plan following two communications in 2007: 'An Energy Policy for Europe' (see Section 1.1) and 'Towards a European Strategic Energy Technology Plan'. The SET Plan that was agreed on by the Council in 2008 had two major timelines: 2020, as it provided a framework for the implementation of low-carbon technologies to contribute to the 2020 targets; and 2050, as it aims to mitigate climate change by maintaining the global temperature rise below 2°C. Later, the European Commission's Roadmap for the Energy Union, which is an Annex to the Energy Union Strategy Communication, established the Integrated SET Plan that defined the new European Research and Innovation (R&I) energy-related agenda that covers the EU energy system as a whole (EC, 2015b).

The SET Plan consists of four elements:

- the SET Plan Steering Group,
- the European Energy Research Alliance (EERA),
- the European Technology and Innovation Platforms (ETIPs), and
- the SET Plan Information System (SETIS).

The SET Plan Steering Group is composed of high-level representatives from EU Member States and Iceland, Norway, Switzerland and Turkey. It had its first meeting in 2008. The group aims to ensure alignment between the SET Plan priorities and different R&I programmes at the EU and national levels, and commitments by the member countries (EC, 2017).

The European Energy Research Alliance (EERA) was established in 2008 in parallel with the launch of the SET Plan. It constitutes its public research pillar. EERA brings together more than 250 organisations from 30 countries (EERA, 2021). The alliance seeks to accelerate the deployment of new energy technologies by aligning the R&D activities of research organisations with the SET Plan priorities. To date, EERA has 18 distinct Joint Programmes.

The European Technology and Innovation Platforms (ETIPs), which constitute the SET Plan's industrial pillar, were established in 2014. There are eleven distinct ETIPs and they aim to bring together EU Member States, industry and researchers in key action areas. In particular, ETIPs promote the uptake of the following key energy technologies: wind, PV, ocean energy, bioenergy, geothermal energy, renewable heating and cooling, smart networks, carbon capture and storage (CCS), and sustainable nuclear energy technology. These platforms seek to pool funding, skills and research facilities for the different areas (EC, 2017).

The SET Plan Information System (SETIS) provides information related to the implementation of the Plan. SETIS, which the EC set up through its Joint Research Centre (JRC), gathers SET Plan-related documents in a dedicated platform. It includes, for instance, information on the different implementation plans. There are 14 implementation plans clustered by sector or technology that identify the required R&I activities and demonstration projects to achieve the SET Plan strategic targets (see Figure 5.1). The implementation plans are executed by 14 different Implementation Working Groups, reporting to the Steering Group. Examples of targets included in the implementation plans are cost reduction for a certain technology in a defined horizon and the development of cost-competitive integrated wind energy systems that can be used in deep waters. Achievement of targets is measured by dedicated Key Performance Indicators (KPIs).

In line with the 2015 Energy Union strategy R&I dimension (see Section 1.1), the integrated SET Plan identifies ten actions, linked to the 14 Implementation Plans mentioned above (see Figure 5.1). The countries involved in the SET Plan and relevant stakeholders have also formed Implementation Working Groups (IWG).

Figure 5.1: SET Plan Key Actions and Implementation Plans (source: adapted from EC, 2021)

The Communication on the revision of the Strategic Energy Technology Plan, adopted on 20 October 2023, will help harmonising the original SET Plan strategic targets with the European Green Deal, the REPowerEU and the Net Zero Industry Act.

5.1.2 Strategic Transport Research and Innovation Agenda

In May 2017, the EC adopted the Strategic Transport Research and Innovation Agenda (STRIA) as part of the 'Europe on the Move' Package. STRIA aims to set out common priorities to support and speed-up the research, innovation and deployment process leading to radical technology changes in transport. STRIA is also the interface between other relevant sectors such as energy and information and communication technology.

Figure 5.2: STRIA Roadmaps (source: EC, 2023)

STRIA builds on and integrates seven thematic transport research areas (Figure 5.2):

- The Connected and Automated Transport roadmap focuses on actions that will develop technologies and support their swift deployment while ensuring the competitiveness of the European industry and enable potentially disruptive innovation that may lead to new transport services. This will provide a framework that contributes to the decarbonisation of the European transport sector, allowing EU energy and climate targets to be met.
- The Transport Electrification roadmap aims to bring forward the developments carried out in the framework of the European Green Vehicles Initiative and encourage multi-sectorial and multi-disciplinary research and innovation activities on new materials, advanced propulsion systems and information and communication technology.
- The Low-emission Alternative Energy roadmap focuses on renewable fuels production, alternative fuel infrastructures as well as the impact on transport systems and services of these technologies for road, rail, waterborne transport and aviation. The roadmap embeds methane-based fuels, propane and butane-based fuels, synthetic paraffinic and aromatic fuels and hydrogen.
- The Smart Mobility and Services roadmap aims to identify transport research and innovation (e.g. multi-modal, electric and autonomous vehicles, drone technology and on-demand mobility services) that can contribute to the successful implementation of EU decarbonisation goals.
- The Transport Infrastructure roadmap identifies several key challenges for EU transport infrastructure, such as governance, pricing, taxation and finance; the syncromodality, intermodality, interoperability and integration of transport systems; life-cycle optimisation, construction, operation, safety and security. Although the development of the first STRIA roadmap on transport infrastructure in 2016-2017 was mainly focused on the goal of decarbonisation, the updated version adopts a wider approach. The roadmap aims also to map plans for R&I in these key areas, test new methodologies, and pave the way for future transport infrastructure policies.
- The Network and Traffic Management System roadmap aims to develop an advanced multimodal transport system by effectively optimising the entire transport network across new areas.
- The Vehicle Design and Manufacturing (VDM) roadmap aims to develop successful marketable transport vehicles with shorter development times. The roadmap faces five main challenges: growing competition from emerging economies, growing complexity and cost pressure, increasing number of environmental and safety regulations, more companies competing, and behavioural change in users and industry. The VDM also establishes three main cross-modal objectives: advancements on design tools and

processes; advancements on new vehicle concepts and architectures; and circular economy, modular vehicle architecture and remanufacturing, greening industry.

The establishment and implementation of STRIA and its seven roadmaps are supported by the Transport Research and Innovation Monitoring and Information System (TRIMIS) analytical tool.

5.1.3 Aligning R&I and EU energy policies

The SET Plan and the STRIA objectives aim to boost the development and deployment of new energy-related technologies across Europe, without which it is difficult to imagine the EU reaching the updated climate and energy targets, *inter alia*, with the Fit for 55 Package and the REPowerEU. In this context, the SET Plan and the STRIA can provide substantial support for the transition to net-zero by 2050.

At the national level more efforts are required to align R&I with European and national energy policies. Indeed, in its EU-wide assessment on the draft updated National Energy and Climate Plans the EC pointed out that most plans report on regional cooperation in research and innovation under Horizon Europe and the Strategic Energy Technology Plan but do not set out measurable objectives to be achieved through joint projects (EC, 2023a).

Four strategies, introduced in the context of the Green Deal and for which cooperation between the Member States' R&I efforts is needed, are particularly relevant to the SET Plan: hydrogen, offshore renewables, energy system integration, and the renovation wave. These strategies overlap with some of the SET Plan implementation plans and key actions, in which some targets are being updated. For instance, the Hydrogen Strategy foresees steering the development of key pilot projects supporting hydrogen value chains in coordination with the SET Plan from 2020 onwards (EC, 2020). The 2023 European Wind Power Action Plan states that, by the end of 2023, the EC will strengthen wind-related activities under the revised SET Plan, along with increased support for research and innovation in the wind manufacturing sector (EC, 2023b). Lastly, the EC Communication 'Delivering on the EU offshore renewable energy ambitions' foresees in 2024 that the EC reassesses and possibly revises the R&I targets of the SET Plan Implementation Working Group on wind energy and supports the ETIP on ocean energy to revise their Strategic Research and Innovation Agenda and publish it in Spring 2024 (EC, 2023c).

In the reporting period 2022-2023, the working groups on Energy systems, Concentrated solar thermal technologies, and Solar PV updated their implementation plans. Five other plans are currently under revision (see Figure 5.3). Only two implementation working groups have kept the original formulation as their plans were adopted recently and their ongoing actions are aligned with the current ambitions of their respective sector and the EU. Of the twelve groups that have revised or are currently revising their implementation plans, ten noted that the main reason for the changes was to align the work of the respective group with the current EU policy framework and the European Green Deal (JRC, 2023).

Under revision	Revised	Original formulation
Positive energy districts (2018)	Carbon capture and storage – carbon capture and utilization (2020)	Nuclear safety (2019)
Renewable fuels and bioenergy (2018)	Sustainable and efficient energy use in industry (2021)	HVDC and DC (2021)
EE in buildings (2018)	Ocean energy (2022)	
Batteries (2020)	Wind energy (2022)	
Geothermal (2020)	Energy systems (2023)	
	Concentrated solar thermal technologies (2023)	
	Solar photovoltaics (2023)	

Figure 5.3: Status of the SET Plan Implementation Plans (source: JRC, 2023)

The Green Deal strategy which is more relevant to the STRIA is the Sustainable and Smart Mobility Strategy. Other EU initiatives work in high synergy with STRIA: in order to have a complete overview, see Section 3.4.

5.1.4 How to support R&I?

The EC has undertaken a directional policy of national and EU investments to facilitate and coordinate the alignment of R&I investments with EU priorities. A key new feature of Horizon Europe, the EU's R&I framework programme, are the missions that aim to address major societal challenges. The five missions identified cover areas related to climate change, cancer, oceans and waters, climate-neutral and smart cities, and healthy soils (EC, 2020). In December 2022, the EC adopted the work programme which defines the general objectives and specific areas that will receive funding for a total of €13.5 billion in 2023 and 2024. This work programme dedicates €5.67 billion – over 42% of whole budget – to research and innovation for climate action objectives. Moreover, in light of the geo-political situation, this work programme places a special emphasis on actions that help reduce energy dependencies. A package of actions across the clusters for 'Climate, Energy and Mobility', 'Digital, Industry and Space', and 'Food, Bioeconomy, Natural Resources, Agriculture and Environment' in particular, with a budget of nearly €970 million, aims to help speed up the clean energy transition in line with the REPowerEU Plan and reduce energy dependency.[205]

5.1.5 How to implement R&I?

One of the main tools promoted by the EC to implement the EU climate-related objectives and thus concretise the research and innovation activities are industrial alliances. Industrial alliances bring together a wide range of partners in a given industry or value chain, including public and private actors and civil society. Industrial alliances are built around a common goal to implement EU policy objectives and involve all relevant partners. With reference to the energy transition, four industrial alliances play a major role: the European Solar Photovoltaic Industry Alliance, the European Battery Alliance, the European Clean Hydrogen Alliance[206] and the Renewable and Low-Carbon Fuels Value Chain Industrial Alliance. The European Solar Photovoltaic Industry Alliance is one of the concrete initiatives of the EU Solar Energy Strategy, adopted in May 2022 as part of the REPowerEU Plan, which will help the EU reach over 320 GW of newly installed solar photovoltaic capacity by 2025, and almost 600 GW by 2030. The European Battery Alliance and the European Solar Photovoltaic Industry Alliance are led by the European Institute of Innovation and Technology (EIT) InnoEnergy, which also launched the European Green Hydrogen Acceleration Centre. EIT is a body of the European Union established by Regulation (EC) No 294/2008 of the European Parliament and of the Council of 11 March 2008.

205 See at https://cinea.ec.europa.eu/news-events/news/horizon-europe-work-programme-2023-24-now-available-2022-12-07_en.

206 The Clean Hydrogen Partnership's main objective is to contribute to the EU Green Deal and Hydrogen Strategy through optimised funding of R&I activities. The Clean Hydrogen Partnership is the successor of the Fuel Cells and Hydrogen 2 Joint Undertaking (FCH 2 JU) and has taken over its legacy portfolio as of 30 November 2021.

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5.2 Smart city initiatives

Valerie Reif

In this section, we break down smart city initiatives into three parts. We start by explaining why cities are important for climate policy. We then describe what smart cities are, which main pillars they build on and how the concept of smart cities is evolving. Finally, we look at some of the most relevant European instruments to foster smart city projects and initiatives.

5.2.1 Why are cities important for climate policy?

Cities represent both a challenge and an opportunity for climate policy. More than 70% of the EU population lives in cities today.[207] Urban areas are important contributors to the EU's energy consumption and greenhouse gas (GHG) emissions and therefore have a significant impact on efforts to reach the EU's climate targets. At the same time, cities are the main drivers of the EU's economy.

Worldwide, more than half of the population resides in urban areas today. Cities are often seen as centres of economic growth that provide opportunities for study and employment and improved quality of life. In 2050, nearly 7 in 10 people worldwide are expected to live in urban areas.[208] This will increase the demand for services related to energy, water, waste and mobility and others that are essential for the prosperity of cities, but that exercise pressure on related resources and infrastructure.

Both the European Green Deal and global efforts to tackle climate change require solutions that are 'smart.' They need to be highly efficient and sustainable on the one hand and keep generating economic prosperity and social wellbeing on the other. Smart solutions rely on mobilisation of all the resources of a city, active participation by all its citizens and workers, coordination of all relevant actors using new technologies, and development of adequate and forward-looking policies at multiple levels, including the local and city levels.

5.2.2 What are smart cities and how is the concept of smart cities evolving?

The term 'smart city' has been widely used in academic research and marketing by companies and cities, but a common definition does not seem to exist (Caragliu et al., 2009). The concept of smartness is often used in combination with other terms, for example smart governance, smart people, smart living, smart mobility, smart economy and smart environment (Manville et al., 2014), all of which can be part of the smart city concept. De Olivera Fernandes et al. (2011) identify three main characteristics that are typically connected to the smart city concept, namely *'i) friendliness towards the environment; ii) use of information and communication technologies as tools of (smart) management and iii) an ultimate goal of sustainable development'*. Smart cities tend to integrate concepts of sustainability in every policy decision taken at the local level with the aim of significantly accelerating deployment of sustainable measures in pursuit of a low-carbon future, including in energy networks, buildings and transport.

5.2.2.1 Smart city pillars

Cities are very different from one another, not only in terms of their physical and human geography but also in the supply and use of energy, in the available means of transport and in the ways they are managed, etc. Each city has specific characteristics, which means that the most appropriate set of measures to improve a city's performance also differs.

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207 According to Eurostat, in 2018 39.3% of the EU population lived in cities, 31.6% lived in towns and suburbs, and 29.1% lived in rural areas. Source: https://ec.europa.eu/eurostat/web/products-eurostat-news/-/EDN-20200207-1 (accessed 10 February 2023).

208 According to estimates by the World Bank, available at https://www.worldbank.org/en/topic/urbandevelopment/overview (accessed 8 April 2021).

At the time of the SET Plan introduction in the late 2000s (see Section 5.1), the European perspective on smart cities focused on sustainability issues, in particular on energy efficiency, low carbon technologies and smart management of supply and demand in the areas of buildings, local energy networks and transport (EC, 2009).

In the areas of energy and buildings, two types of measures can be broadly distinguished. First, improving the energy efficiency of buildings, which covers the construction of new buildings and the renovation of existing ones with the aim of having a nearly zero-energy building stock, including using energy from renewable sources, smart readiness and building automation and control systems. Second, integrating energy systems with the aim of developing large-scale solutions regarding for example district heating and cooling, photovoltaics, geothermal energy and waste management. Together, these measures aim to improve energy efficiency, generate low-carbon energy, modernise infrastructure and create a high-quality living environment for citizens.

In the area of transport and mobility, measures aim, for example, to improve infrastructure, promote the use of electric vehicles and clean fuels, increase inter-modality between different transport modes and raise the attractiveness of public transport, collective transport and cycling. Such measures not only help increase the attractiveness and competitiveness of cities but also tackle congestion and improve air quality.

Digital and information and communication technologies (ICTs) are considered an integral part of the smart city concept as they allow the integration of different urban systems and their operational processes and enable innovative approaches to enhance citizen engagement. Some of the most widely used ICT solutions are energy management systems, traffic control systems, smart grids, urban data platforms and mobile applications.

5.2.2.2 From 'smart' cities to 'climate-neutral and smart' cities

With the increased climate ambitions in the European Green Deal, the concept of smart cities seems to evolve into a concept of 'climate neutral and smart cities.' The more traditional pillars of buildings, local energy networks and transport are increasingly integrated in a wider 'system innovation' approach to the entire value chain of city investment, which also includes governance, construction and recycling, and even looks towards industry and agriculture, all supported by powerful digital technologies.

An important initiative in this regard is the creation of a Common European Green Deal Data Space (EC, 2020a) to use the great potential of data to support Green Deal priorities on climate change, circular economy, zero pollution, biodiversity, deforestation and compliance assurance. As part of this data space, the European Commission (EC) aims to create a data ecosystem for climate-neutral and smart communities, which will facilitate access to, sharing and re-use of locally relevant data, including in areas such as mobility, energy, climate and zero pollution (EC, 2020b). In a Staff Working Document, the EC specifies that funding for this data ecosystem is provided under the DIGITAL Work Programme, with the aim of first creating a blueprint that connects existing national, regional and local data ecosystems and enables public and private stakeholders to access relevant data, followed by the validation and refinement of the blueprint in pilot projects, and, finally, by the deployment of the data space and a network of Local Digital Twins (EC, 2022a).

5.2.3 European instruments to foster smart city projects and initiatives

In the following we describe a few of the main EU instruments to foster smart city initiatives, namely the Covenant of Mayors, the Strategic Energy Technology Plan, the European Smart Cities Initiative, the European Innovation Partnership, the Smart Cities Marketplace and the new Horizon Europe programme. Note that this description is not exhaustive as a multitude of initiatives relevant to urban development exist in the EU.

5.2.3.1 Covenant of Mayors

The Covenant of Mayors initiative was launched by the EC in 2008. It brings together thousands of local and regional authorities which voluntarily commit to increasing energy efficiency and the use of renewable energy sources in their territories, thereby helping to achieve and exceed the EU climate and energy targets. The initiative has proven successful way beyond expectations and has been attracting local and regional authorities in Europe and beyond. It now operates in the EU's Eastern Partnership countries and has been extended, among other places, to the European Neighbourhood South Region. In 2016, the initiative officially reached a global dimension with the creation of the 'Global Covenant of Mayors for Climate and Energy.' In summer 2024, the global Covenant community includes more than 13,500 cities from six continents and more than 144 countries.[209]

Originally, Covenant signatories aimed to meet and exceed the EU's 20% CO_2 reduction objective by 2020. Later, signatory cities pledged action to actively support achieving the EU 40% GHG emissions reduction target by 2030 and agreed to adopt a joint approach to tackling mitigation and adaptation to climate change and to ensure access to secure, sustainable and affordable energy for all. More recently, signatory cities have pledged action to support the achievement of the EU 55% GHG emissions reduction target by 2030 and the adoption of a joint approach to tackling mitigation and adaptation to climate change. Signatories have also endorsed a shared vision for 2050.

To translate their political commitment into practice, Covenant signatories commit to submitting a Sustainable Energy and Climate Action Plan (SECAP) that describes the steps towards their 2020 or 2030 targets within two years of joining. Every two years thereafter, signatory cities are expected to report on progress in implementing the SECAP. Signatories also share their key actions as a source of inspiration for others.[210]

5.2.3.2 The Strategic Energy Technology Plan and the European Smart Cities Initiative

In its 2009 Strategic Energy Technology Plan (SET Plan), the EC recognised energy efficiency as the simplest and cheapest way to ensure CO_2 reduction and announced a new European Smart Cities Initiative that would aim to create the conditions to trigger mass market take-up of energy efficiency technologies (EC, 2009). The initiative aimed to support 25 to 30 ambitious pioneer cities that would transform their buildings, energy networks and transport systems into those of the future.[211] Importantly, these cities were expected to test and demonstrate the feasibility of transition concepts and strategies towards a low-carbon economy that went beyond the 2020 EU climate and energy targets, instead targeting 40% GHG emissions reduction by 2020.

The initiative built on existing EU and national policies, measures and initiatives and aimed to mobilise local authorities involved in the Covenant of Mayors to multiply its impact. It focused on three main areas:

209 https://www.globalcovenantofmayors.org/.

210 The action plans, progress reports and good practice database are available on the website of the Covenant of Mayors at https://eu-mayors.ec.europa.eu/en/home (accessed 10 February 2023).

211 In their policy brief on the Smart City initiative, Meeus et al. (2011) identified three levels of smartness that ambitious pioneer cities can adopt and recommended that cities are given institutional flexibility in terms of human and financial resources for their implementation. Moreover, the establishment of strict performance reporting methodologies was recommended to ensure the success of the initiative.

- Buildings, with net-zero energy or net-zero carbon emission requirements for new buildings and refurbishment requirements to lower consumption and increase energy standards for existing building;
- Energy networks, with the aim of fostering innovative and cost-effective applications and heating and cooling systems based on renewable sources, co- or tri-generation and district heating and cooling together with smart electricity grids, smart metering and energy management systems, smart appliances and local renewables-based electricity production; and
- Transport, with testing and deployment programmes for low-carbon public transport and individual transport systems, and sustainable mobility.

The cost of this initiative was estimated at €10-12 billion over the following ten-year period.

5.2.3.3 The European Innovation Partnership and the Smart Cities Marketplace

In 2010, the EU launched its ten-year growth and jobs strategy entitled 'Europe 2020' (EC, 2010). The strategy covered three mutually reinforcing priorities for growth (smart, sustainable and inclusive growth), five EU headline targets to be met by 2020 (e.g. the 20-20-20 energy and climate targets) and seven related flagship initiatives. Relevant to smart cities was the smart growth priority (i.e. growth in terms of effective investments in education, research and innovation) and the connected flagship 'Innovation Union' initiative to improve the framework conditions and access to finance for research and innovation. The Innovation Union initiative also aimed to re-focus research, development and innovation (RD&I) policy on societal challenges such as climate change and energy and resource efficiency. To develop the initiative, two types of stakeholder platforms were created, namely industry-led European Technology Platforms (ETPs) and European Innovation Partnerships (EIPs) between the EU and national levels to bring together public and private stakeholders and speed up development and deployment of the technologies needed to meet the challenges identified.

The European Innovation Partnership on Smart Cities and Communities (EIP SCC) was launched in 2012 (EC, 2012). It was set up as a partnership across the areas of urban energy production and use, urban transport and mobility and urban information and communication technology and constituted the next step to scale up the efforts undertaken by the Smart Cities Initiative under the SET Plan. The EIP SCC did not provide direct funding but set up a governance structure that, based on strategic and operational implementation plans, guided implementation projects, some of which were large-scale demonstrations partly financed under the research and innovation funding framework Horizon 2020.

The EIP SCC was later wound up together with the Smart Cities Information System in a new platform called the 'Smart Cities Marketplace.' The Marketplace is an initiative supported by the EC that brings together cities, industries, SMEs, investors, researchers and other smart city actors and aims to deliver practical knowledge, capacity-building opportunities and access to finance and more to establish a European smart city market and make European cities the most liveable places in the world. As of July 2024, the Marketplace community consists of 95 projects.[212]

5.2.3.4 Horizon Europe

Under Horizon Europe, the funding programme for research and innovation for the period 2021-2027, the EC created so-called 'missions,' which are a set of measures to achieve bold inspirational and measurable goals within a set timeframe. There are five main missions under

212 https://smart-cities-marketplace.ec.europa.eu/.

Horizon Europe, one of which is that on ‘Climate neutral and smart cities,’ which aims to support cities in becoming more resilient and smarter.

The aim of the mission is to deliver 100 climate-neutral smart cities by 2030, and to ensure that these cities act as experimentation and innovation hubs to enable all European cities to follow their example by 2050 (EC, 2020b). The mission aims to boost existing efforts under the Covenant of Mayors framework in two ways. First, by setting the GHG emissions reduction target by 2030 at 100%. The cities should deliver a credible climate strategy and action plan for reaching carbon neutrality for each area. Second, by promoting a systemic change and transformation of cities that builds on a ‘by and for the citizens’ approach.

The mission is based on three principles, namely a holistic approach to foster innovation and deployment, integrated and multi-level governance, and deep and continual collaboration among all stakeholders. The cities will sign a ‘Climate City Contract’ as a new mechanism to deliver EU support for cities in the form of more innovation, better regulation and integrated financing. These contracts will be adjusted to reflect the realities of each city and developed in a co-creation process with local stakeholders and citizens to ensure that the voices of the people who live and work in the cities are heard. The signatory cities are expected to develop and implement system innovation in governance, transport, energy, construction and recycling, supported by digital technologies.

In 2022, 377 cities in all the EU member states and nine associated countries and countries negotiating association submitted an expression of interest. After an evaluation of the submissions, the EC announced in April 2022 the 100 cities that will participate in the ‘Climate neutral and smart cities’ Mission (EC, 2022b). The 100 cities come from all 27 Member States, with 12 additional cities coming from countries associated or in the process of being associated to Horizon Europe. They are invited to develop Climate City Contracts, which include an overall plan for climate neutrality across all sectors such as energy, buildings, waste management and transport, together with related investment plans. The plan is to co-create these Climate City Contracts with local stakeholders and citizens and with the help of a Mission Platform that provides the necessary technical, regulatory and financial assistance to cities. Following a favourable review of their Climate City Contracts, 33 cities were awarded a so-called EU Mission Label as of March 2024, a recognition meant to facilitate access to public and private funding and financing. The Horizon Europe Work Programme 2023-2025 includes a budget of €176 million to invest in research and innovation actions linked to the Cities Mission.

5.2.3.5 Other relevant initiatives

Many other initiatives related to urban development and climate (including buildings, mobility, transport and energy) exist, descriptions of which would go beyond the scope of this section. To name a few, they include CIVITAS, the Green Digital Charter, the Green City Accord, European Green Capital Cities, the European Energy Award, BUILD UP, Energy Cities, the European Energy Research Alliance (EERA) Joint Programme Smart Cities, ManagEnergy, the European Urban Knowledge Network and the Urban Agenda for the EU.

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5.3 Digital transformation of the energy sector

Valerie Reif and Sofia Nicolai

This section gives an overview of the ongoing digitalisation of the energy sector with a focus on measures to enhance consumer empowerment. The focus is on the electricity sector, with some references to the gas sector as well. First, we explain more generally the implications digitalisation has for the electricity sector. Second, we look at how digitalisation has been supporting the implementation of new consumer rights. Third, we give an overview of the EU policy and regulatory framework for smart metering systems and access to consumer data. Finally, we provide insights into current policy and legislative developments regarding the digitalisation of the energy sector.

5.3.1 How is digitalisation transforming the electricity sector?

The ongoing digitalisation of electricity infrastructure is transforming the power industry while at the same time enabling its decarbonisation and decentralisation. Digitalisation is not a new phenomenon in the electricity sector. It is a process that has come in successive waves and has had widespread implications for the industry, ranging from technological to organisational, from legal to behavioural.

In Rossetto and Reif (2021), we show that the increasing deployment of technologies to generate, transmit, analyse and use data have had a considerable impact on:

- the way physical assets are planned, maintained and operated;
- the coordination of the various autonomous actors operating in the interconnected electricity system;
- the emergence of new products that empower final customers and open the door to the entry of new players;
- the traditional management of the electricity infrastructure; and
- the organisation and regulation of the sector.

We explain that the first wave of digitalisation covered transmission networks and large generation assets. Usable data on the status of the electricity transmission network were increasingly available, which enabled more efficient and secure operation of the electricity system. Another wave brought the creation of competitive wholesale markets and their regional integration. A more recent development is the digitalisation of distribution networks and final energy consumers, which allows both reduced costs of service and improved quality of service. It has enabled the establishment of innovative retail markets with increasing participation by empowered final consumers and new entrants as well.[213] At the same time, digitalisation has challenged not only the traditional ways of managing electricity infrastructure but also existing approaches to sector regulation.

5.3.2 How is digitalisation supporting the implementation of new consumer rights?

Digitalised electricity infrastructure enables new forms of interactions and exchanges among the actors involved in the electricity sector (Glachant and Rossetto, 2018). It allows the creation of innovative products, pricing and business models, and the emergence of new markets, notably also at the level of distribution grids and retail-size assets owned by households or small businesses. Beyond the traditional supply of a kWh at a predefined price and grid

213 CEER (2022) discusses opportunities, challenges and risks of digitalisation in retail markets from the point of view of the regulator, including on the topic of consumer empowerment.

connection point, a whole new set of energy services and tailor-made products are emerging that address the specific needs and preferences of customers (Rossetto and Reif, 2021). For example, new services can be related to energy efficiency, the concept of energy as a service, the provision of ancillary services or energy with specific attributes such as energy generated locally or exclusively from RES. Another type of service is the provision of new platforms for direct exchange of energy among peers (peer-to-peer energy trading), either individually or as part of larger communities of consumers.

5.3.3 The EU regulatory framework for smart meter roll-out and data access and management

As was described in Section 4.4 on retail markets and the new deal, the Clean Energy Package and, more recently, the Hydrogen and Decarbonised Gas Markets Package have brought a new deal for energy consumers that enhances consumer empowerment and protection. New consumer rights regarding *inter alia* self-consumption, dynamic pricing and the use of intermediaries such as aggregators and energy communities go hand in hand with the need for a widespread roll-out of smart metering systems and proper data access and management policies.

5.3.3.1 Smart meter roll-out

The Third Energy Package included provisions with the aims of fostering the roll-out of smart meters and targeting active participation by consumers in the energy supply market through:

- transparency provided by the meter (timely and accurate information on consumption to increase predictability of costs and customer awareness);
- third-party access to data and interoperability (to facilitate competitive offers at the customer end, facilitate system integration and lower costs); and
- due regard to best practices (e.g. installation of in-home displays, connection to home automation, self-consumption).

However, under the Electricity (2009/72/EC) and Gas (2009/73/EC) Directives, Member States were left with considerable discretion as to the extent to which they rolled out smart meters based on national cost-benefit analyses (CBAs). Provisions in the Electricity Directive were stricter than in the Gas Directive. Where the roll-out of smart meters for electricity was assessed positively in the national CBA, Member States were required to roll-out smart meters to at least 80% of consumers by 2020. The Gas Directive also included a requirement to conduct a national CBA but did not foresee a specific timeline for the implementation of smart meters.

According to the status report ‘Smart Grids in the European Union’ by the Joint Research Centre, 21 Member States have decided to go for a smart meter rollout, 2 Member States have still not completed a CBA or have not shared the results, namely, Bulgaria and Hungary, and 4 Member States had negative or inconclusive CBAs, namely Belgium, Czech Republic, Germany and Slovakia (JRC, 2023).

Currently, 6 countries have reached almost 100% smart meter rollout, namely Denmark, Estonia, Finland, Italy, Spain and Sweden. There are other Member States, with a positive CBA, where the national smart meter rollout is still in progress, but where some DSOs have already finalised their smart meter rollout. These countries are Austria, France, the Netherlands and Portugal. For what concerns Portugal, even though the rollout started late, in 2019, significant progress has been made and full coverage is expected by 2025.

Although the Third Energy Package contributed to the deployment of smart metering systems in some Member States, the fact that deployment rates vary widely across EU countries creates significant differences in the availability and accessibility of data. Therefore, both the CEP and the Hydrogen and Decarbonised Gas Markets Package push for increased deployment of smart meters in the EU.

The Electricity Directive (EU) 2019/944 foresees that Member States with a positive CBA shall equip at least 80% of final electricity consumers with smart meters either within seven years of the date of the positive assessment or by 2024 for the Member States that initiated the systematic deployment of smart metering systems before 4 July 2019. Member States with a negative CBA outcome for either electricity or gas are required to revise the assessment at least every 4 years, or even earlier if significant changes in the conditions considered in the CBA occur. More recent energy legislation both reinforced pre-existing rights and introduced new prerogatives. The revised Electricity Directive under the 2023 electricity market reform (see Section 4.1.7), in order to facilitate the pre-existing right of consumers to sign more than one electricity supply contract, foresees their entitlement to have more than one metering and billing point covered by the single connection point for their premises (art. 4, Council and the Parliament, 2024a). On the other hand, the revised Electricity Regulation, to further favour consumers engagement in flexibility services, introduces an obligation for system operators to use data from dedicated measurement devices for the observability and settlement of flexibility services such as demand response and energy storage, a dedicated measurement device being "*a device linked to or embedded in an asset that provides demand response or flexibility services on the electricity market or to system operators*". (art.2(78), Council and the Parliament, 2024b)

5.3.3.2 Data access and management

Provisions on data access were already included in the Electricity (2009/72/EC) and Gas (2009/73/EC) Directives in the Third Energy Package, which state in their respective Annexes I that consumers should "*have at their disposal their consumption data, and shall be able to, by explicit agreement and free of charge, give any registered supply undertaking access to its metering data. The party responsible for data management shall be obliged to give those data to the undertaking. Member States shall define a format for the data and a procedure for suppliers and consumers to have access to the data. No additional costs shall be charged to the consumer for that service*."

During the implementation phase of the Third Energy Package and in the lead-up to the Clean Energy Package, discussions emerged on how to organise consumer data management across the Member States. In line with the EC's 'better regulation' agenda, a report evaluating the Third Energy Package was published in 2016 (EC, 2016a).[214] It concluded that the package had achieved its main purpose (e.g. more supplier competition) but that some areas of increasing importance were not addressed or not in the necessary detail. More concretely, the report found that the Third Energy Package had not been designed to address emerging challenges in managing large and commercially valuable consumption data flows and that further progress was required in the areas of billing information, comparison tools and consumer ability to easily switch suppliers. It also highlighted the importance of smart meters roll-out, of a proper specification of DSO functions when it comes to consumer data management, and of a need for regulatory oversight.

214 In 2015 the Juncker Commission made 'better regulation' one of its top priorities, which means making sure that legislation is based on solid facts, is cost-efficient and benefits from input from citizens by involving them in the law-making process. It also means making use of evaluations, impact assessments and stakeholder engagement.

The same year, the EC (2016b) published an impact assessment for the Market Design Initiative in the CEP. It underlined the need to set up a non-discriminatory data management framework and to fill gaps in the EU regulatory framework regarding the role of DSOs in data management. The impact assessment looked at different ways to organise data management and concluded that the introduction of a single EU data management model (a data hub) would have high implementation costs, thus reducing the efficiency of the option. The preferred option was a 'flexible legislation' scenario that would lead to the introduction of further specific requirements on data handling responsibilities based on the principles of transparency and non-discrimination. EU consumer data management rules that are independent of the national data management model would be put in place aiming to ensure impartiality of the market actors involved in data handling, eliminate barriers to entry associated with data access and help all market actors provide a higher level of service to consumers.

In the EU, data management models differ from country to country.[215] They typically consist of a set of different roles, responsibilities, legal frameworks, technical standards and informal rules. Schittekatte et al. (2020) explain that these models can be categorised in terms of many different dimensions (e.g. ownership and operation, scope or set of metering points, data types, functionalities, rights of customers, access by third parties), with the 'level of centralisation' (i.e. centralised, partially centralised or decentralised) being the most commonly used.[216]

The Electricity Directive (EU) 2019/944 eventually included more detailed provisions on data management, independently of the data management model chosen at the national level. Member States are required to specify rules for access to consumer data by eligible parties and to authorise and certify (or supervise) the parties responsible for data management. Other provisions cover costs for accessing data, interoperability requirements and procedures for access to data, as is described in the following subsection.

The Gas Markets Directive as part of the Hydrogen and Decarbonised Gas Markets Package (Council and the Parliament, 2024a) mirrors the relevant provisions in the Electricity Directive. It also requires adoption of interoperability requirements and procedures for access to data in hydrogen systems.

5.3.4 Recent EU policy and legislative developments related to digitalisation of the energy sector

In the following we briefly introduce three ongoing initiatives at the EU level that are relevant in the digitalisation of the energy sector: the implementing acts on interoperability requirements and data access, the energy data space, and the Digitalisation of Energy Action Plan.

5.3.4.1 Implementing acts on interoperability requirements and data access

The Electricity Directive (EU) 2019/944 entitles the European Commission (EC) to adopt implementing acts specifying interoperability requirements and non-discriminatory and transparent procedures for access to metering and consumption data, and data on customer switching, demand response and other services. The overall aim of the implementing acts is to facilitate full interoperability of energy services in the EU to promote competition in the retail market and to avoid excessive administrative costs for eligible parties.

215 Some of the main (stakeholder) reports on data management models are CEER (2016), ENTSO-E et al. (2016), ESGTF (2016), Eurelectric (2016), NordREG (2018), TemaNord (2017), THEMA (2017) and Tractebel (2018).

216 Descriptions of the different types of data management models are provided in CEER (2016).

The EC has tasked the European Smart Grids Task Force (ESGTF) with the preparation of these acts (see ESGTF, 2019). The starting point is the diversity of existing solutions across Member States when it comes to handling consumer data. Over the last few years, a consensus has emerged at the EU level that efforts should focus on making the existing solutions interoperable instead of trying to create a common solution for all countries. A contribution to the discussion on the implementing acts can be found in Reif and Meeus (2020), while two contributions to the wider debate on interoperability in the energy system can be found in Reif and Meeus (2022) and in Reif et al. (2023).

The EC published in June 2023 the first implementing act: the Implementing Regulation on interoperability requirements and non-discriminatory and transparent procedures for access to metering and consumption data (EC, 2023). The act aims at improving access to metering and consumption data by introducing requirements and procedures to ensure that data on metering and consumption in EU countries follows a common reference model. The 'reference model' proposed in the act is characterised by a minimum set of requirements to ensure that a given procedure (e.g. access to validated historical metering and consumption data by an eligible party or the final customer) can run correctly, while allowing for national customisation.

Other implementing acts focussed on specific use cases and processes such as energy communities and supplier switching are expected to be adopted in the coming years.

In the context of the Green Deal, the interoperability debate has gained further momentum and has been extended to the gas and buildings sectors. As was mentioned above, the revised Gas Markets Directive (Council and the Parliament, 2024a) requires the adoption of interoperability requirements and procedures for access to data both for natural gas smart meters and in hydrogen systems. Moreover, the revised Energy Performance of Buildings Directive (Council and the Parliament, 2024b) requires the EC to adopt implementing acts regarding interoperability and access to building systems data.

5.3.4.2 The Energy Data Space and Digitalisation of the Energy Action Plan

A broader digitalisation initiative at the EU level is related to creating a single European data space (a single market for data) for personal and non-personal data as set out in the European Data Strategy (EC, 2020a). A common European data space is expected to bring together relevant data infrastructure and governance frameworks to facilitate data pooling and sharing. The aim is to overcome legal and technical barriers to data sharing by combining the necessary tools and infrastructure and addressing issues of trust by means of common rules (ETIP SNET, 2024). The 2020 Data Strategy indicated that it would initially support ten data spaces in different sectors, among them the energy sector. However, in 2024, common European data spaces are being deployed across 14 sectors/domains.

The EC (EC, 2022a) specified that the first steps towards a common European energy data space include:

- energy-sector legislation (under the CEP and Fit for 55 Package) and cross-sectoral data space building blocks (as, e.g., provided by the Data Governance Act (EC, 2022d)) that define the main elements to enable future-proof data exchange among multiple parties in the energy sector and beyond; and

- various innovative national and EU-wide initiatives, including EU R&I projects that explore the potential for data sharing among companies and develop new use-cases for the benefit of the energy transition.[217]

The EC sees a need to connect all these initiatives so that they can be scaled up for the benefit of a strengthened energy market and integrated energy system that make use of innovative and data-driven energy and cross-sectoral services.

In 2022, the EC published the 'Digitalising the energy system – EU Action Plan' (EC, 2022b). It states that the deployment of the common European energy data space, including a solid governance for it, will start no later than 2024. The action plan also specifies that a 'Data for Energy' working group will be formally established to, among other things, support the EC in developing and rolling out the data space. The group will bring together the EC, Member States and the relevant public and private stakeholders.

Beyond the development of an EU framework for sharing data to support innovative energy services, the action plan provides details on actions to promote investments in a smart electricity grid, empower consumers, ensure cybersecurity and resilience, and address the raising energy consumption of the ICT sector.

217 Five projects are funded under Horizon Europe that are expected to establish the grounds for a common European energy data space, namely EDDIE, ENERSHARE, DATA CELLAR, SYNERGIES and OMEGA-X. More details are available on CORDIS at https://cordis.europa.eu/programme/id/HORIZON_HORIZON-CL5-2021-D3-01-01. The Horizon Europe int:net project is expected to cooperate with and provide a common umbrella to the data space projects. More information is available at https://intnet.eu/.

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5.4 Clean Molecules

Ilaria Conti and James Kneebone

In this section we break down the subject of 'clean molecules,' an umbrella term we are using to cover abated fossil gases, low-emission gases, renewable gases, and even emission-negative gases. We cover definitions of clean molecules, what sets them apart from fossil gas and from each other, and some of the associated opportunities and limitations. We also look at the role foreseen for clean molecules in EU strategies, recent legislation, and the European Gas Regulatory Forum ('Madrid Forum'), in addition to some possible ways to stimulate their strategic deployment.

5.4.1 Gas, gaz, plynu, plin…

5.4.1.1 Natural (fossil) gas

When we talk about 'gas' in the energy sector, we are typically referring to 'natural gas.' This is an odourless and colourless mixture of four gases, roughly 80% methane, with smaller quantities of ethane, butane and propane. Natural gas is of fossil origin, the result of heat and pressure applied to organic matter in geological formations for prolonged periods of time. Following extraction, this fossil gas undergoes processing before being transported along a complex supply chain to consumers (API, 2021). Natural gas constitutes roughly 21% of final energy consumption in the European Union (EU) (Eurostat, 2022). In an effort to move away from natural gas to cleaner alternatives, a range of abated fossil, low-carbon, renewable and emission-negative gases are emerging as substitutes.

5.4.1.2 So-called 'clean molecules'

The most prevalent clean molecule in the EU at the moment is 'biogas', a methane-based gas that, when upgraded to 'biomethane', can be used interchangeably and in combination with fossil methane. Like fossil methane, biomethane is also produced from decomposition of organic matter. However, it is not considered a fossil fuel. This is because biomethane is produced from anaerobic digestion[218] of organic matter (e.g. food and animal waste, dedicated crops) above ground rather than being extracted from fossil sources in geological formations underground.

Key emerging but still relatively uncommon clean molecules include low-carbon, renewable and emission-negative hydrogen, as well as what we call 'hydrogen derivatives' – i.e. compounds produced from hydrogen with the addition of other gases, for example carbon dioxide or nitrogen. These can include renewable ammonia and renewably produced synthetic gases (syngases) such as e-methanol, e-methane and e-kerosene (El-Nagar, 2018). This is a complicated and nuanced area, in particular due to the many ways hydrogen and hydrogen-derived gases can be produced. For this reason, we have an entire section dedicated to exploring the hydrogen sector (Section 5.5). In short, hydrogen and its derivates can fall into any of the loose categories of unabated, low-carbon, renewable, and even emission-negative gases.

5.4.2 Conceptual versus legal definitions

As a starting point, it is important to have a fundamental understanding of the difference between conceptual and legal definitions of different gases and the metrics used to distinguish them.

218 Biogas can also be produced through other processes, such as thermal gasification.

5.4.2.1 Conceptual definitions

In a conceptual sense, 'clean molecules' is a non-prescriptive and general term we use to refer to all abated fossil, decarbonised, renewable, and emission-negative gases. These are gases that in some way and to varying extents attempt to provide cleaner alternatives to unabated natural gas or their fossil equivalents, for example renewable versus fossil hydrogen. The following can be considered a descriptive classification.

1. **Abated fossil gases** – Gases of fossil origin, coupled with one or a combination of the following: (i) offsets corresponding to lifecycle emissions, (ii) transformation of hydrocarbon-based gases into non-emitting or lower emitting derivatives.

   Examples: liquified natural gas (LNG) cargoes participating in an accredited emission offset scheme; hydrogen and syngas derivatives produced with fossil gas but with CCS to capture emissions during production.

2. **Decarbonised gases** – Gases of non-fossil origin but that have meaningful associated emissions from production.

   Examples: hydrogen produced via electrolysis utilising low-carbon electricity (e.g. nuclear, mixed grid electricity, or CCGT with CCS); syngases produced with non-biogenic CO_2*.*

3. **Renewable gases** – Gases of renewable origin.

   Examples: biomethane; hydrogen produced from electrolysis fuelled by renewable electricity.

4. **Emission-negative gases** – Gases of renewable origin which sequester carbon dioxide through their production.

   Examples: hydrogen produced through pyrolysis of biomethane feedstock; hydrogen produced through photocatalysis of biomethane feedstock.

Different stakeholders have different perspectives on how to categorise gases, and there is a range of general terminology used to refer to them. Sometimes, for example, 'green gas', 'renewable gas', 'decarbonised gas', and 'low carbon gas' are used interchangeably. These terms have a place, but they are non-scientific and can be misleading or create confusion if not well understood or contextualised. For example, the term 'decarbonised gas' is commonly used to refer to clean molecules with carbon as a core component, such as syngases. In a technical sense, these gases are not 'decarbonised' at all.

To create conceptual taxonomies of gases, each stakeholder makes value judgments on what metrics should be used to classify them, such as origin, production process, final emission intensity, chemical composition, environmental and land-use considerations, etc. At the Florence School of Regulation (FSR) we proposed a taxonomy (Conti, 2020), as have energy companies like Iberdrola (2019) and non-governmental organisations (NGOs) like Bellona (2021a). These are useful lenses to frame the concept, but they are not legal classifications, although inevitably many are developed with the intention of influencing them.

5.4.2.2 Legal definitions in the EU

It is up to policymakers to set formal metrics, thresholds and parameters for these gases and other forms of energy as a basis for differentiating their treatment in regulatory frameworks. The EU is the primary actor here in the context of European energy policy. For example, the definitions in the EU Sustainable Finance Taxonomy guide investment in energy infrastructure, while classifications in the Renewable Energy Directive (RED) and Energy Taxation Directive

(ETD) stipulate the market conditions under which different gases will operate. These formal classifications and frameworks make it possible to incentivise certain products over others, and they go a long way to shaping the sector. Currently there are several existing reference points for the definition of clean molecules in the EU, and this remains an evolving and unfinished landscape.

The recently revised Renewable Directive (RED III) is the core legal framework for the development of renewable energy in the EU, covering relevant rules, objectives and principles to remove barriers, stimulate investment and drive cost reduction in renewable energy technologies (EP and the Council, 2023b). RED III defines renewable energy as "*energy from renewable non-fossil sources, namely wind, solar (solar thermal and solar photovoltaic) and geothermal energy, osmotic energy, ambient energy, tide, wave and other ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas, and biogas;*" (see also Section 2.4).

The RED III also creates a number of specific incentives for Renewable Fuels of Non-Biological Origin (RFNBOs), i.e. renewably produced hydrogen or hydrogen-derived fuels by RFNBOs must account for at least 42% of the hydrogen used in industry by 2030 and 60% by 2035. However, several exceptions apply, and the Member States have the discretion to decide on the specifics of transposition – making the final implementation quite unclear. The overall obligation for the transport sector is also designed as a share of the total consumption, with 1% of the fuel supplied to the transport sector by 2030 needing to originate from RFNBOs. The FuelEU Maritime Regulation covering seaborne transport set a sub-target of 2% uptake by 2033 if the target of 1% is not met by 2031. The ReFuelEU Aviation agreement includes a target of 2% of energy supplied to aviation to come from sustainable aviation fuels (SAFs) by 2025, rising to 6% by 2030. All targets are to be implemented and transposed individually by the Member States, with no mechanism for trading and sharing the burden between them. If successfully enforced, the RED mandates would equate to roughly 5mt of clean hydrogen demand based on current consumption of fossil hydrogen in the relevant industrial and transport sectors.

The conditions for production of this hydrogen, and the methodologies for calculating the impact on embedded emissions were specified in two delegated acts published in February 2023. The first delegated act[219] defines the temporal and geographical conditions for the operation of electrolysers required to ensure that electricity used for the production of hydrogen (and subsequent derivatives) is truly 'renewable' and as such does not create undue emissions. The second delegated act[220] sets the methodology to calculate the GHG emissions savings from these RFNBOs and recycled carbon fuels. Both delegated acts make reference to the 70% GHG saving criterion versus fossil equivalents established in Article 25(2) of RED II.

219 Commission Delegated Regulation (EU) 2023/1184 of 10 February 2023 supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by establishing a Union methodology setting out detailed rules for the production of renewable liquid and gaseous transport fuels of non-biological origin. Available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023R1184&qid=1704969010792.

220 Commission Delegated Regulation (EU) 2023/1185 of 10 February 2023 supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by establishing a minimum threshold for greenhouse gas emissions savings of recycled carbon fuels and by specifying a methodology for assessing greenhouse gas emissions savings from renewable liquid and gaseous transport fuels of non-biological origin and from recycled carbon fuels. Available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023R1185.

5.4.3 What are the opportunities for and limitations of green gases?

5.4.3.1 Clean molecules in the context of EU climate and energy objectives

The EU 2050 long-term strategy outlines a vision to bring the bloc in line with the Paris Climate targets of keeping the global temperature increase well below 2°C and as close to 1.5°C as possible. This overarching framework comes as part of the EU's own climate commitments: (i) climate neutrality by 2050 as outlined in the EU Green Deal; and (ii) an increased ambition of a 55% reduction in emissions by 2030 specified in the 2020 Communication on Stepping up Europe's 2030 Climate Ambition (EC, 2022d).

In line with the above-mentioned roadmaps, the Energy System Integration (ESI) strategy envisages a meaningful role for clean molecules in the future decarbonised energy system (EC, 2020b). Subsequent to energy efficiency and electrification (the two main pillars of the strategy), clean molecules are considered a suitable energy vector in hard-to-abate sectors, where electrification is not efficient or effective with current technology.

In 2021, the 35th meeting of the European Gas Regulatory Forum ('Madrid Forum', see also Section 1.4) addressed the subject of clean molecules in detail, concluding that efforts should be made to facilitate the certification of renewable and low-carbon gases and the growth of a dedicated market and corresponding rules and regulations.[221] Building on these outcomes and the ambitions of the Fit for 55 Package that followed in the summer, the European Commission proposed its Hydrogen and Decarbonised Gas Market Package (HDGMP) in December 2021 (EC, 2021b).[222] In the 36th Madrid Forum these commitments to clean molecules were reaffirmed and even raised in the context of REPowerEU and the EU's corresponding aims to substitute Russian fossil fuels with cleaner alternatives (Conti and Kneebone, 2022). The proposals included in the HDGMP were eventually adopted by the European Parliament on 11 April 2024 and by the Council on 21 May 2024 and are now in force.[223]

5.4.3.2 Opportunities for clean molecules

Clean molecules are likely to directly substitute fossil gas in some cases and carve out a market share in new applications previously served by other non-gaseous energy vectors. In 2022, power and heating generation represented the largest share of natural gas use in the EU at roughly 32% of overall consumption. Household consumption accounts for ~25%, and industry a further ~24% (European Council, 2023).

A significant amount of this demand is likely to be electrified in the future as it is typically more efficient in the context of a renewable-dominated energy mix. Within this context, projections for the gas sector broadly envisage a diminished overall role for molecules, as is shown in Figure 5.4 and Figure 5.5.

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221 The conclusions of the 35th meeting of the European Gas Regulatory Forum on 29-30 April 2021 are available at https://commission.europa.eu/document/download/ea10fdb9-ca54-49bc-8599-69bb96801e91_en?filename=35th_mf_final_conclusions.pdf.

222 See also recordings of the following FSR online events: "The Commission's new Gas and Hydrogen Package," available at https://fsr.eui.eu/event/the-commissions-new-gas-and-hydrogen-package/, and "Competitive Decarbonised Gas Markets – What should be in the future Hydrogen Legislative Package?" available at https://fsr.eui.eu/event/competitive-decarbonised-gas-markets-what-should-be-in-the-future-hydrogen-legislative-package/.

223 To know more about the HDGMP, have a look at the FSR news piece 'The EU Hydrogen and Decarbonised Gas Market Package
An inside look into the recently adopted Gas Package', available at https://fsr.eui.eu/the-eu-hydrogen-and-decarbonised-gas-market-package/.

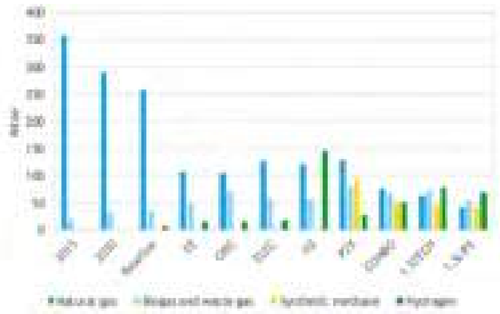

Figure 5.4: EU demand for gaseous fuel scenarios (source: Frontier Economics, 2019)

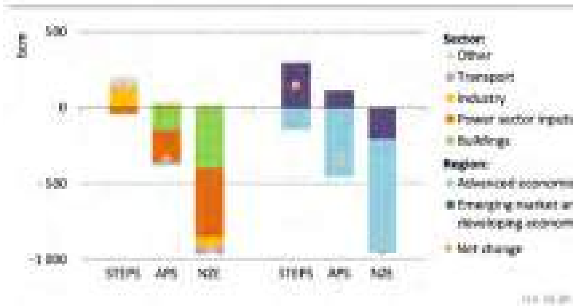

Figure 5.5: Change in global annual gas demand by sector in three scenarios: the Stated Policies Scenario (STEPS), Announced Policies Scenario (APS) and the Net Zero Emissions by 2050 scenario (NZE) (source: IEA, 2022)

However, it is likely that significant volumes of molecular energy will still be needed in the coming years. This is due in part to the physical properties of energy in this form. Two key advantages of molecular energy over electrical energy can be identified that make it an important component in future energy systems.

First, gases such as methane and hydrogen are more effective than electrical energy in certain applications where high temperatures are required. This is because with current technology molecular energy can often be delivered more quickly (in terms of ramp-up speed) and has higher stability (in terms of maintaining temperature) compared to electricity. The second key advantage of molecular energy is that it can be stored for extended periods of time at very low marginal cost relative to electricity. Figure 5.6 gives an illustration of the price competitiveness of storing electricity in batteries versus hydrogen storage coupled with fuel cells. The Levelised Cost of Electricity (LCOE) for each technology indicates that hydrogen technologies could be more economical than batteries for storage duration beyond 15 hours. It is worth noting that there are various promising technologies competing for a share of this market.

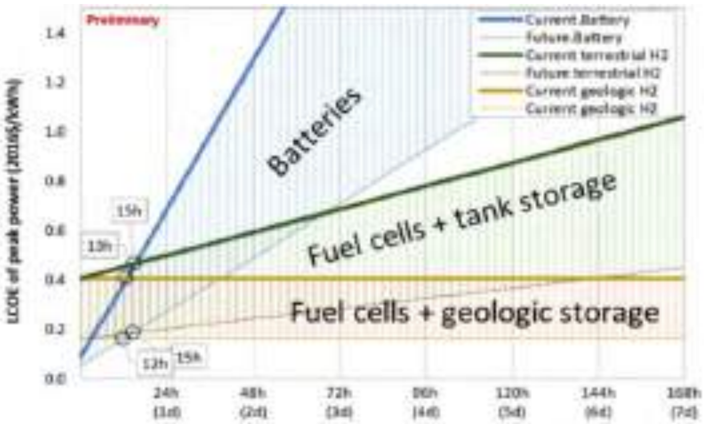

Figure 5.6: Economic performance benchmarks for current & future hydrogen and batteries (source: NREL, 2019)

Clean molecules can have a role in sector coupling as an energy vector, helping to balance the electricity and gas grids by providing medium to long-term storage and dispatchable power, for example through power to gas facilities. This balancing component is likely to grow in importance as the EU electricity mix becomes increasingly characterised by variable renewable sources. Furthermore, much of the storage and transport infrastructure that currently exists in the natural gas network can be cost-effectively repurposed for clean molecules, thus reducing the requirement for infrastructure investment and easing pressure on the electricity grid.[224]

Clean molecules also have an increasingly important role in achieving greater energy independence and overall security of energy supply in Europe. Currently the EU is roughly 90% dependent on imports for its gas supply (EC, 2022c). The EU has been attempting to ameliorate this dependence and improve security and competitiveness in the gas sector since the early 2000s by diversifying suppliers, liberalising the internal market, developing interconnections between national gas grids, and imposing solidarity requirements between Member States (EC, 2017). Although many of these initiatives have been successful, particularly regarding the development of an internal market within the EU, overall dependency on Russian gas reached historic highs (~45% of total imports) in the months prior to Russia's invasion of Ukraine in February 2022.

Since then, the EU has proposed measures to aggressively divest from Russian gas imports, as well as oil and coal, for which the EU has been heavily dependent on Russia (EC, 2022d). By the end of 2022 the EU had reduced its share of Russian pipeline gas to just over 10% of the overall volumes – a massive turnaround in a short period (European Council, 2022). Most of the reduction in Russian gas use has been achieved through increased flows from other sources, including LNG from the US, as well as a roughly 12% drop in overall consumption relative to the two previous years (McWilliams and Zachmann, 2023). Figure 5.7 shows how EU natural gas consumption evolved in 2022 and early 2023.

224 As of 2022, gas TSOs are required to include hydrogen infrastructure in their Ten-Year Network Development Plans (TYNDPs), see https://tyndp2020.entsog.eu/.

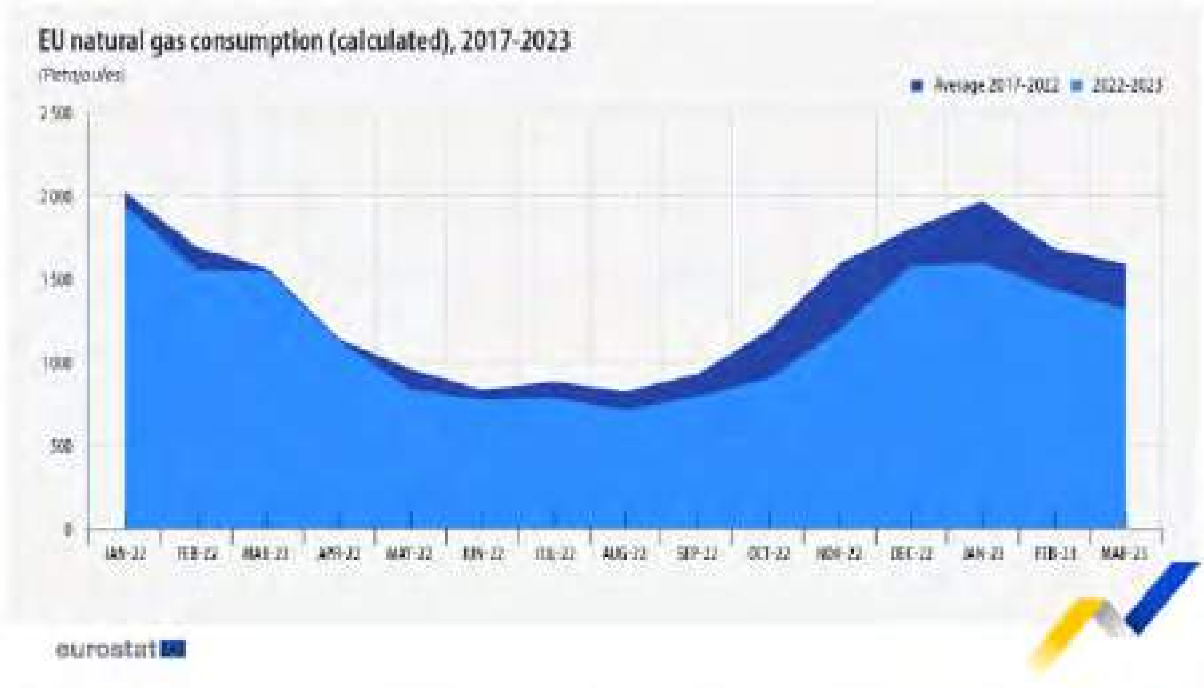

Figure 5.7: EU natural gas consumption (calculated), 2017-2023 (source: Eurostat, 2023)

However, moving forward the EU plans to use biomethane and renewable hydrogen as a long-term replacement for large volumes of fossil fuel imports, as they are typically produced locally or at least can be supplied by a large number of parties (Conti and Kneebone, 2021). This development represents a driver of localisation and democratisation of the sector as compared to the current system, which is controlled by those countries endowed with deposits of natural resources and with whom the EU is connected by means of rigid (pipeline) infrastructure (IRENA, 2022).

5.4.3.3 Limitations of clean molecules

Despite the opportunities mentioned above, there are limitations and bottlenecks foreseen for the growth of clean molecules in the EU energy mix.

First, there is the issue of lifecycle emissions. One aspect of this is fugitive emissions, which unfortunately do not disappear with the departure of fossil gas. Clean molecules can also be climate forcers.[225] For example, biogas is not of fossil origin, but it is primarily composed of methane and therefore acts as a climate forcer when it escapes, just like fossil methane.[226] The EU is attempting to address this with measures outlined in its Methane Strategy (EC, 2020a). There have been several studies assessing the emission intensity of hydrogen produced with differing levels of fugitive methane emissions, including one comparing steam methane reforming (SMR) with CCUS with unabated SMR, fossil gas and coal use (Howarth and Jacobson, 2021). Similarly, in the event of a leak, hydrogen itself is an indirect greenhouse gas as it enhances the lifespan and warming potential of greenhouse gases already present in the atmosphere.

225 The University of Calgary (2020) defines climate forcing as "*the physical process of affecting the climate on the Earth through a number of forcing factors. These factors are specifically known as forcings because they drive the climate to change, and it is important to note that these forcings exist outside of the existing climate system.*"

226 See United Nations Economic Commission for Europe (UNECE). The Challenge, available at https://unece.org/challenge.

Another aspect of lifecycle emissions is the opportunity cost in the allocation of scarce resources depending on the production process (SMR, pyrolysis, electrolysis, photocatalysis, etc.) and corresponding conditions. For example, 'green hydrogen' is produced through electrolysis, a process of passing renewably produced electricity through water, splitting it into hydrogen and oxygen. Roughly 25% of the energetic value of the renewable electricity input is lost in the hydrogen production process, with a further ~25% energy loss if it is subsequently reconverted back into electricity. These losses are relatively unproblematic in a scenario of abundant renewable electrons, but while they remain scarce (see Figure 5.8 below) their allocation to one activity incurs an opportunity cost elsewhere.

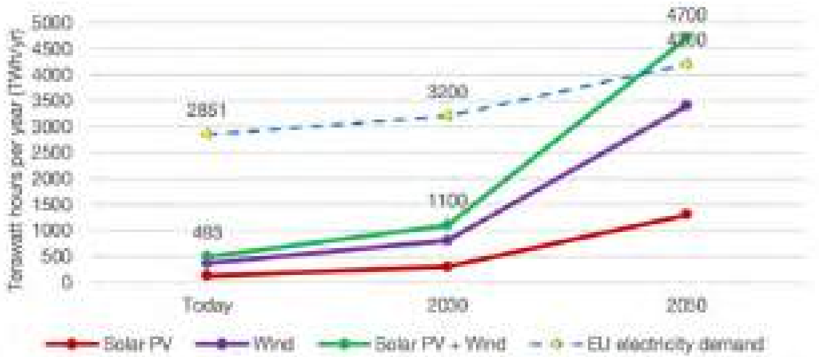

Figure 5.8: Total estimated realistic energy potential for cumulative installed capacity of renewable electricity in the EU, present, 2030, and 2050 (source: elaboration based on Belmans et al., 2021)

Different EU initiatives aimed at decarbonisation may end up competing for the same renewable electricity, for example electrification of road transport and electrolyser capacity for hydrogen production. Where fossil electricity generation is required to cover renewable electricity diverted away from direct consumption in the electricity grid to serve electrolysers, the resulting green hydrogen will have considerably higher emissions than hydrogen produced with fossil fuels (Belmans et al., 2021). With this in mind, it will be important for the overall decarbonisation of the sector for clean molecules to be deployed strategically where they are the most effective.

Second, the scope of clean molecules to decarbonise existing energy demand will to a considerable extent be dictated by their cost-effectiveness compared to alternatives, and the speed at which they can be scaled. These conditions depend to a large extent on the cost and availability of renewable electricity, as well as the support schemes introduced by governments. Unsubsidised, renewable hydrogen, for example, typically remains uncompetitive with fossil hydrogen in the majority of circumstances. However, support schemes are emerging in Europe (see Section 5.5.), the US and elsewhere that try to narrow these gaps, with a view that in the foreseeable future renewable electricity could be in surplus. Getting costs down as quickly as possible is key to ramping up the uptake of clean molecules in sectors where they are competing with other disruptive technologies (e.g. electric arc furnaces in the steel sector, or flow batteries in energy storage). Figure 5.9 below illustrates how these cost conditions may evolve in the coming years.

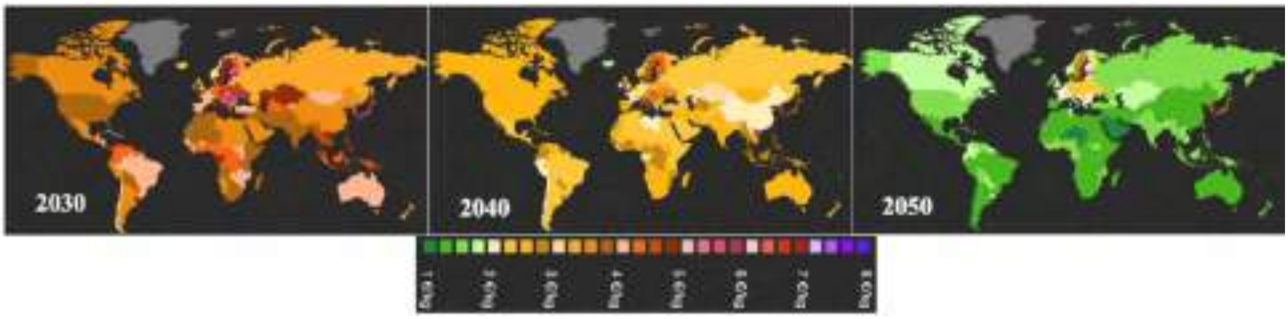

Figure 5.9: Cost of renewable hydrogen production in 2023 (left), 2030 (centre), 2040 (right) (source: PWC, 2022)

Finally, it is also worth noting that not all clean molecules are created equally, and each have scalability challenges. Different gases each have unique properties and therefore need to be deployed in an optimal combination. For example, hydrogen has the highest energy density of any known substance by mass. However, by volume it has relatively low energy density. For context, substituting 5% volume of natural gas or biomethane with hydrogen would only cover 1.6% of the energy content, requiring higher overall volumes of gas for the same quantity of energy. It is therefore uneconomical and wasteful to use hydrogen as a direct substitute for methane in residential heating applications, for example. However, it can have value as a reducing agent in the production of iron and steel, for example, replacing coking coal (Bellona, 2021b).

Biomethane is among the most viable substitutes for natural gas due to similarities in chemical composition and therefore compatibility with existing infrastructure. However, in 2020 the EU produced only 44TWh (~4 billion cubic metres (BCM)) of biomethane (Sia, 2023), equal to less than 2% of overall gas consumption (fossil gas and clean molecules combined). Although biomethane production is envisaged to increase massively in the coming years due to ambitious national initiatives[227] and the EU's own 35BCM 2030 target (Conti and Kneebone, 2022), sustainable biomethane is not an infinitely scalable energy vector and therefore is limited in its scope to displace fossil methane. Furthermore, there is a risk of creating perverse incentives in which significant support for biomethane can lead to more animal farming and therefore higher overall methane emissions (EC, 2020a).

5.4.4 How can the growth of clean molecules be stimulated in an effective and targeted way?

The following section outlines some different approaches available to policymakers to foster the growth of clean molecules, focusing predominantly on some of those already implemented or proposed.

5.4.4.1 Establishing areas for 'no regret' implementation

There are significant uncertainties in the development of the clean molecule sector moving forward. Key variables include: (i) the price of renewable electricity, (ii) demand for clean molecules, (iii) which clean molecules to use where, (iv) technological development, and (v) infrastructure capacity and suitability. Due to the number and unpredictability of variables in this sector it is difficult to decide on objective technology preferences, for example. Nevertheless, to keep pace with EU climate targets and to move the EU away from fossil fuel

227 See Section 5.4.4.2 on 'Support schemes' below for examples.

dependence as quickly as possible, there is mounting pressure on policymakers to accelerate the transition of the gas sector.

In the light of these conditions, policymakers may choose to compartmentalise the issue, intervening first in areas where a cost-benefit analysis (CBA) reveals a clear case for one specific technology or product, subsequently expanding and evolving the approach as the outlook becomes clearer. This can be characterised as a 'no-regret' strategy focusing on the clearest use cases, and it is often discussed as a means to stimulate the growth of the sector with a high-level of effectiveness and minimal risk of stranded assets.[228] Strategic build-out of expensive infrastructure can also be key to minimising the cost of the final product. Figure 5.10 below outlines one conceptual hierarchy for use cases of clean hydrogen, for example.

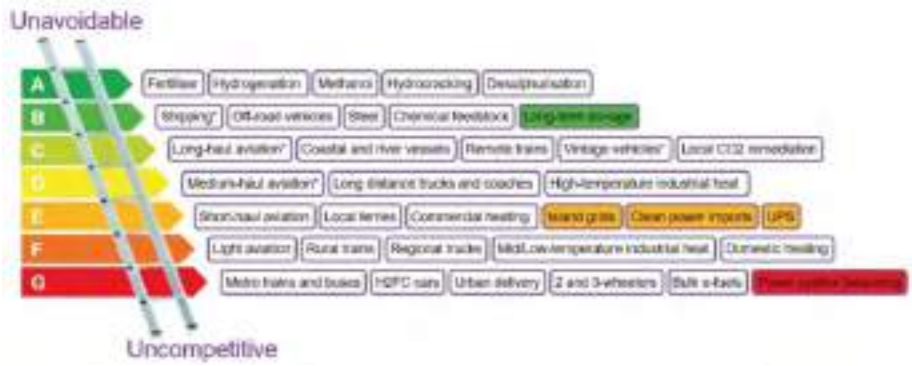

Figure 5.10: The Clean Hydrogen Ladder, Version 4.0, (source: Liebreich Associates, Adrien Hiel, Energy Cities, 2021)

Note: *via ammonia or e-fuel rather than H2 gas or liquid.

5.4.4.2 Support schemes

Once a certain technology or product has been identified for a given application, there is a number of tools at the disposal of policymakers to support its competitiveness. We split them here into three overarching groups.

First, 'push factors' can be used to make established products and technologies less competitive or entirely uncompetitive, encouraging or forcing the market to react and adopt alternatives. The EU has attempted to do this through several means, including broadening the scope of the EU Emissions Trading System (ETS) while quickly reducing the availability of free credits and simultaneously introducing a Carbon Border Adjustment Mechanism (CBAM) to avoid carbon leakage (Kneebone, 2021b). Under the proposed revision of the Energy Taxation Directive (ETD), the Commission also adjusts the taxation rates for different gases, putting unabated fossil gas in the highest tax category, while advanced sustainable biofuels, biogas and RFNBOs such as renewable hydrogen are in the lowest tax category.[229]

A second approach is for regulators to loosen restrictions on market participants in a targeted way to help ensure the recovery of capital expenditure (CAPEX) and operational expenses (OPEX), thus lowering barriers to entry. This is a form of 'pull factor'. Measures can be permanent or temporary derogations and cover entire value chains or be strictly limited in scope. For example, exemptions to certain unbundling rules in the gas sector would allow network operators to own production facilities in the same value chain, thus guaranteeing cost

228 For example, Agora Energiewende and AFRY conducted a study assessing this issue, specifically for hydrogen (Agora Energiewende and AFRY, 2021).

229 Low-carbon hydrogen and related fuels will also benefit from this treatment for a transition period of 10 years.

recovery for the gas produced.[230] Under the HDGMP, alternatives are presented to temporarily waive or adjust certain tariffs. Renewable gas will receive a 100% discount and low-carbon gas will receive a 75% discount from various entry and exit tariffs as per Article 18 of the revised Gas Regulation. Moreover, from 5 August 2025, network users shall obtain a discount of 100% on the capacity-based tariff from the transmission system operator at interconnection points between Member States, for renewable gas and 75% for low-carbon gas. This effectively functions as a cross-subsidisation mechanism from natural gas to clean molecules, narrowing the cost-competitiveness gap.

A third approach and another kind of pull factor is to directly incentivise a specific technology or product with financial support, narrowing the gap between the market rate and the fixed and variable costs of the alternative. This has been a common approach in the energy sector, for example, direct subsidies and carbon contracts for difference (CCfD) for solar and wind power. See Section 5.5 for details on how the EU is doing something similar for clean hydrogen production. In parallel, the Fit for 55 Package proposes measures to mandate offtake. For example, the ReFuel EU Aviation initiative mandates that fuel suppliers will have to incorporate 2% Sustainable Aviation Fuels (SAF) in 2025, 6% in 2030, with increasing percentage targets until 70% in 2050 (EP and the Council, 2023). Moreover, there are diverse initiatives at the Member State level. France, for example, in its final updated National Energy and Climate Plan (NECP) 2021-2030, proposed a target of 15 % renewable gases injection into the gas network in 2030.[231] Italy is investing €4.7 billion in supporting the transport and distribution of advanced biofuels for the transport sector (EC, 2018b). In Denmark, subsidies for biomethane plants have historically covered as much as 40% of the CAPEX and Green Certificates (GCs) are provided upon injection of biomethane into the grid (Decorte et al., 2020).

230 The possibility of applying this approach to power-to-gas facilities on a temporary basis was explored in a February 2021 FSR online event on "The Regulation of Power-to-Gas Facilities and Regulatory Sandboxes," available at https://fsr.eui.eu/event/the-regulation-of-power-to-gas-facilities-and-regulatory-sandboxes/.

231 See the French National Energy and Climate Plan, available at https://commission.europa.eu/publications/france-final-updated-necp-2021-2030-submitted-2024_en.

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5.5 Hydrogen in the EU Green Deal

Ilaria Conti and James Kneebone

Achieving the ambitions of the EU Green Deal will require innovation across virtually all areas of the economy. One tool which is believed by many to be useful in addressing tricky decarbonisation issues in multiple sectors is clean hydrogen. In this chapter, we aim to map the contemporary hydrogen landscape by responding to six common questions. What is hydrogen? What are the current and potential uses of hydrogen? How is it produced? What do hydrogen supply chains look like? Which strategies and laws are aimed at supporting a clean hydrogen economy in the EU? How is the uptake of hydrogen being financed?

5.5.1 What is hydrogen?

Somewhat confusingly, we can talk about hydrogen in both its atomic and molecular forms (see Figure 5.11). The hydrogen atom is by a huge margin the most common atom in the known universe, making up roughly three-quarters of its mass. However, hydrogen in molecular form, 'H_2,' i.e. two hydrogen atoms bonded together, is scarce on the Earth and is typically found in combination with other atoms, like oxygen in the case of water (H_20) or carbon in the case of methane (CH_4).

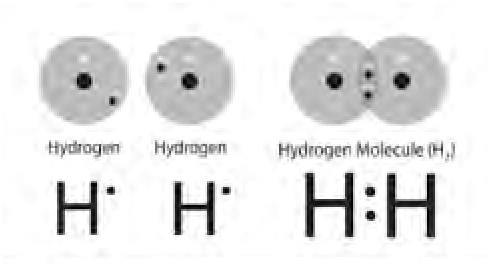

Figure 5.11: Hydrogen atom (left) vs. hydrogen molecule (right) (source: own illustration, 2023)

Hydrogen molecules are the focus of this section. At room temperature, hydrogen molecules are an odourless and colourless gas with the lowest density of any gas. As we typically do not extract gaseous hydrogen as we can with some other energy vectors, we must liberate it from other products such as methane, water, coal or biomass. This can be done through a variety of processes, which we will explore later.

5.5.1.1 What current and potential future uses are there for hydrogen?

We focus on two broad applications of hydrogen (i) as an industrial feedstock and reductant, and (ii) as an energy vector in the power system. The EU currently consumes roughly 8 million tonnes (Mt) of hydrogen per year, equivalent to around 2% of energy demand.

More than 90% of the existing demand for hydrogen in the EU is related to industrial processes, in which hydrogen is a feedstock and a reductant. In particular, hydrogen is used:

1. for removing impurities during the crude oil refining process (~50% of total);
2. as a feedstock (i.e. raw material) by chemical plants to produce a wide variety of products including ammonia (NH_3), methanol (CH_3OH), fertilisers, household products and industrial solvents (~40% of total);

3. for steel production from direct reduced iron (DRI) and other industrial uses, e.g. as a blanketing gas and a coolant (~5%);
4. for other uses (~5%).

In a decarbonised future we can expect that demand for crude oil will drop considerably due to electrification, whilst the EU is also hoping to reduce fertiliser use by 20%[232] by 2030, cutting another substantial chunk of hydrogen demand. What remains of current fossil hydrogen demand will need to be replaced with more sustainably produced hydrogen.

In recent years, hydrogen has also caught the attention of other new sectors, as a means of 'in-direct electrification', i.e. transforming clean electrons into molecules, giving it different properties that make it useful in a wider range of applications.

Four new categories of energy sector applications for hydrogen moving forward can be identified (European Parliament, 2021):

- Buildings (e.g. space heating, water heating, cooking);
- Industry (e.g. high-temperature steam in the glass and cement industries);
- Mobility (e.g. for heavy-duty vehicles, derivatives for aviation);
- Electricity generation and grid balancing (e.g. seasonal storage of electricity – stored as hydrogen – and electricity generation during peak loads from hydrogen-based gas turbines or fuel cells).

It is worth noting that virtually all these new uses are still subject to a technology race against other decarbonisation solutions. Clean hydrogen can be useful in a huge range of applications, but it is rarely the *optimal* tool for the job. We can say with relative certainty that hydrogen will continue to be needed in the chemicals sector, for DRI, and to produce a minimum of synthetic fuels for heavy transport. In the EU this could be less than half of the current 8 Mt[233] of consumption; any additional demand uses are subject to a technology race, or strategic technology picking on the part of governments, policymakers, and industry leaders.

5.5.2 How is hydrogen produced?

The key reason why clean hydrogen is rarely the optimal tool for decarbonisation is that it is quite inefficient to produce. As discussed earlier, we typically liberate hydrogen from other products (e.g. H_2O or CH_4), and breaking those chemical bonds incurs significant energy losses versus using the energy source directly (methane, coal, electricity, biomass). Currently, hydrogen is produced either at dedicated facilities (~60%) or as a by-product of other energy-intensive chemical production processes, e.g. chlorine production.

Below we explore the main ways in which hydrogen is produced at dedicated facilities and how clean they are (Figure 5.12).

- **Black** – produced by gasification of 'black' coal.
- **Brown** – produced by gasification of 'brown' coal.
- **Grey** – produced by thermochemical conversion of fossil gas, either Auto-thermal Reforming (ATR) or Steam Methane Reforming (SMR).

232 See https://agriculture.ec.europa.eu/sustainability/environmental-sustainability/low-input-farming/nutrients_en.

233 See https://www.agora-energiewende.org/fileadmin/Success_Stories/PW/PW_EU_Green-H2/A-E_241_Succ_Stor_Pathways_EU_H2_hubs_WEB.pdf.

- **Blue** – produced by ATR or SMR of fossil gas, with the addition of carbon capture (use) and storage (CC(U)S).
- **Turquoise** – produced by pyrolysis of methane (fossil or bio-based) driven by electricity, either renewable or non-renewable (Conti et al., 2021).
- **Pink** – produced via electrolysis of water, utilising electricity of nuclear origin.
- **Green** – produced via electrolysis of water, driven by renewable electricity.
- **Yellow** – produced via electrolysis of water, utilising grid-based electricity.

Figure 5.12: Visual classification of ways of hydrogen production by emission profile, (source: own illustration, 2023)

Currently, only 0.3%[234] of the hydrogen produced in the EU is of renewable origin, almost all production is 'grey', contributing roughly 2% of total emissions. Globally, the story is similar, albeit with higher utilisation of more emission intensive coal-based (black or brown) hydrogen in East Asia. It is important to keep in mind that lifecycle greenhouse gas (GHG) emissions also depend on emissions associated with supply chains. For example, the GHG emissions of the natural gas supply chain can be significant and highly variable due to methane leaks. Although emissions from electricity supply chains can be negligible if the electricity is from renewable sources, fossil-origin electricity (i.e. from coal or gas power plants) can produce electrolytic ('yellow') hydrogen with higher emissions than grey hydrogen. This is one of the challenges in the certification of hydrogen.[235]

5.5.3 What do hydrogen supply chains look like?

The vast majority of hydrogen currently consumed is produced at the point of consumption or nearby, typically connected via a short private network. However, different forms of clean hydrogen require various conditions, such as abundant renewable electricity or suitable geological conditions for the storage of CO_2. In these new value chains, there is a requirement

234 See https://euhydrogenweek.eu/wp-content/uploads/2023/12/Clean-Hydrogen-Monitor-2023-Presentation.pdf.

235 See https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Mar/IRENA_Green_Hydrogen_Certification_Brief_2022.pdf.

for storage and transport infrastructure to bring the hydrogen to demand centres, or for demand centres to relocate closer to the supply.

Hydrogen can be stored in different ways[236] depending on its state (gaseous or liquid). For example, gaseous hydrogen can be stored in salt caverns or pressurised tanks. Geological storage is far cheaper and more scalable than above-ground storage in manmade infrastructure.

There are two transportation options for hydrogen, with very different infrastructural implications:

- Pipelines (gaseous): transporting either pure hydrogen or hydrogen blended into the existing methane network;
- Shipping (liquid): either as hydrogen (once cooled to -252°C), or embedded in a 'carrier' like ammonia, methanol, or dibenzyltoluene.

Transport costs can vary greatly according to the volume of hydrogen demand and the distance required for it to be transported. Repurposed gas pipelines are widely believed to be the cheapest[237] method of transporting hydrogen under most circumstances, where available. Even where new pipelines would be required, pipeline technology remains typically the more cost-effective option, provided a minimum (large) volume can be reached. This is mostly due to the equipment, processing, and energy required to convert gaseous hydrogen either into liquid form or transform it into a carrier, and then reverse these processes upon delivery. These complexities are compounded by equipment costs and a shortage of skills for handling these products at scale. Nevertheless, for small quantities, and particularly where there is alignment between the shipping medium and the final demand (e.g. ammonia kept as ammonia), it can be a cost-effective and practical solution[238]. See Figure 5.13 below for a visual comparison of technology options and costs, also relative to a high-voltage direct current (HVDC) electricity cable.

236 See https://assets.publishing.service.gov.uk/media/659e600b915e0b00135838a6/hydrogen-transport-and-storage-cost-report.pdf.

237 See https://www.agora-energiewende.org/publications/no-regret-hydrogen.

238 See https://cadmus.eui.eu/handle/1814/75533;jsessionid=4FDB8F5983C186050D639E7F4637EE0F.

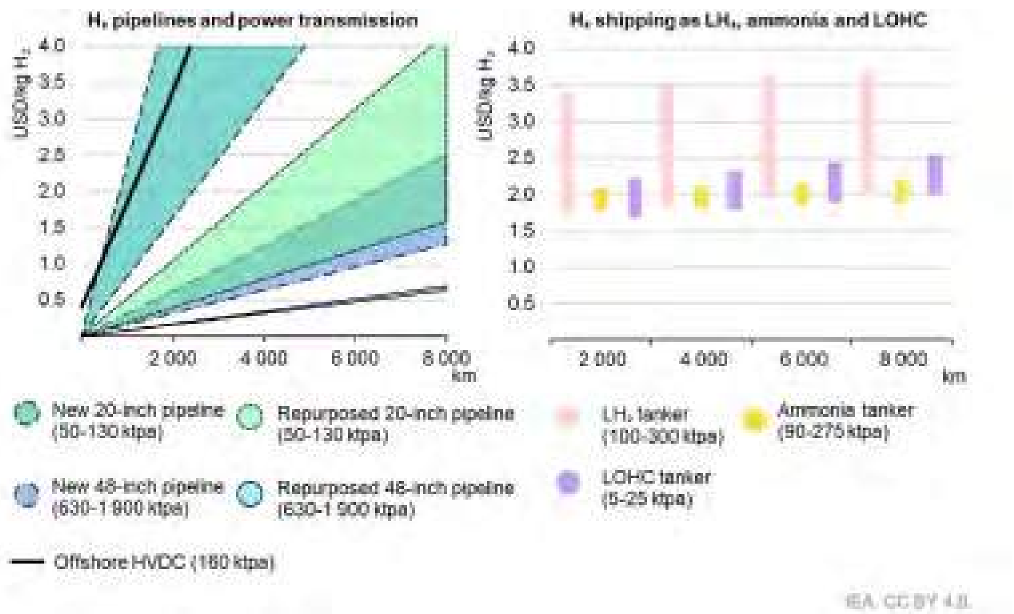

Figure 5.13: Cost comparison of hydrogen transport options (USD/kg) (source: IEA, 2023)

5.5.4 What strategies and laws are most relevant to clean hydrogen in the EU?

As part of the European Green Deal, the European Commission's complementary strategies 'A hydrogen strategy for a climate-neutral Europe' (Hydrogen Strategy) and 'An EU Strategy for Energy System Integration' (ESI Strategy) both identify 'clean' hydrogen and other synthetic fuels as necessary to reach full decarbonisation.

The ESI Strategy describes the *"use of renewable and low-carbon fuels, including hydrogen, for end-use applications where direct heating or electrification are not feasible, nor efficient or have higher costs"* as some of the most important uses of hydrogen in the context of energy system integration. Moreover, electrolysers are one of the key tools for sector coupling between renewable electricity and renewable gas networks. This approach is consistent with the logic of using primarily electrolytic renewable hydrogen as 'in-direct electrification' where electrons are not well suited.

The Hydrogen Strategy identifies cumulative investment needs and policies to promote the development of value chains for low-carbon and renewable hydrogen. These aims are broken down into the following three phases:

- Phase 1 (from 2020 to 2024): installation of at least 6 gigawatts (GW) of electrolyser capacity in the EU by 2024, corresponding to annual production of up to 1 million tonnes of renewable hydrogen[239]. This objective was not reached.
- Phase 2 (from 2025 to 2030): installation of at least 40 GW of electrolyser capacity in the EU by 2030, with a further 40 installed in the neighbourhood region (Ukraine and North Africa) – corresponding to ~6MT of renewable hydrogen production per year in the EU.
- Phase 3 (from 2030 onwards and towards 2050): renewable and low-carbon hydrogen technologies should reach maturity and be deployed on a large scale.

239 2024 data is not available at the time of writing, but it is virtually impossible that the EU gets anywhere near this number. Total installed capacity was less than 0.2GW by the end of 2023 and optimistic scenarios suggesting 1.4GW could be possible by 2025 (EC JRC, 2023).

The 'REPowerEU' documents released in March and May 2022 in response to the Russian invasion of Ukraine increased these targets considerably, to leverage hydrogen and other clean molecules to enhance energy security (Conti and Kneebone, 2022). The total production and import targets for renewable and low-carbon hydrogen rose to 20 million tonnes by 2030, in the hope that this could replace 27 billion cubic metres (BCM) of Russian gas. The Communications on REPowerEU also emphasised the need to ramp up the development of corresponding infrastructure, including storage, and promised expedited assessment and processing of hydrogen projects under the 'Important Projects of Common European Interest' (IPCEI) and state aid procedures.

The 'Hydrogen and Decarbonised Gas Market Package' (HDGMP) is perhaps the most important development since the ESI and Hydrogen Strategies of 2020, particularly in terms of setting the incentives and market conditions for the uptake of hydrogen and other clean molecules (European Commission, 2024d). The HDGMP is the fourth iteration of comprehensive legislation in the sector, following the 'Third Energy Package' of 2009 and it formally integrates hydrogen into the normal functioning of the natural gas market. The Package proposes to recast the Regulation on conditions for access to natural gas transmission networks (715/2009) ('Gas Regulation') and the Directive on common rules for the internal market for natural gas (2009/73) ('Gas Directive').

The core aims of the updates are to (i) establish the conditions for facilitating rapid and sustained uptake of renewable and low-carbon gases, (ii) improve market conditions and increase engagement of gas consumers, (iii) better account for contemporary security of supply concerns, (iv) address price and supply concerns at the Union level, and (v) recalibrate the structure and composition of regulatory bodies.

For hydrogen specifically, the package attempts to (i) define more clearly the different forms of clean hydrogen, (ii) provide incentives for the uptake of clean hydrogen, (iii) propose a specific framework for the management and planning of a clean hydrogen sector, (iv) as well as provide clarity to enhance interoperability across the Union.

I. There is a definition of 'low-carbon hydrogen' and 'low-carbon gases' more widely in Articles 2 and 9 of the Gas Directive, which establishes a greenhouse gas emission reduction threshold of 70% versus a fossil fuel comparator, defined at 94 g CO2 /MJ under the Renewable Energy Directive (RED). Methodologies for calculating the emission intensity of 'low-carbon' and 'renewable' are defined separately in Delegated Acts. The methodology for defining renewable fuels of non-biological origin (RFNBO's) has already been adopted (EU) 2023/1185, (EU) 2023/1184. Whilst the methodology for low carbon was recently proposed by the European Commission and is under public consultation at the time of writing.

II. Regarding regulatory incentives, low-carbon gases will receive a 75% discount from various entry and exit tariffs in the network, whilst renewable gases receive a 100% discount, as per Article 18 of the Gas Regulation. Moreover, for the first year after entry into force of the regulation, tariffs will not be chargeable against the transmission of renewable gases across interconnection points between Member States, with a 75% discount for low carbon gases (Article 18(4)). To qualify for an exemption on charges, a "sustainability certificate" must be provided in line with Articles 29 and 30 of the RED.

III. Regarding management and planning of the network, a network association will be established for hydrogen transmission network operators, 'The European Network for Network Operators of Hydrogen' (ENNOH) (Article 57, Gas Regulation). The tasks of ENNOH include writing relevant network codes, in some cases in cooperation with the

European Network for Transmission System Operators for Gas (ENTSOG), as well as developing union-wide, non-binding ten-year network development plans (TYNDPs) for the hydrogen sector, full details can be found in Articles 59 and 60. The ENNOH shall consist of hydrogen transmission network operators certified pursuant to Article 71 of the Gas Directive.

IV. Finally, in an effort to facilitate the use of the existing natural gas network in the transmission of hydrogen, blends of 2% hydrogen volume into natural gas flows must be accepted and facilitated at cross-border points (Article 21, Gas Regulation). Adjacent transmission systems are free to set local thresholds higher than this if they wish to. Nevertheless, in the preamble (74) of the regulation, it is noted that this hydrogen blending should be considered a ‘last resort’ use case, again reflecting its scarcity and therefore the importance of using it in a targeted way.

For more details, see Kneebone (2024).

5.5.5 How is the uptake of hydrogen being financed?

The funding landscape for clean hydrogen in Europe is very complex, as the value chains can touch everything from technology, research and innovation to major infrastructure, energy credits, and much more besides. The diagram below illustrates where hydrogen is included in the scope of available European funds; however, only in the ‘hydrogen specific funds’ is all the money earmarked for hydrogen. There are also several national-level schemes and private-public blended finance schemes in place, as shown by Figure 5.14 below (Kneebone, 2023).

Since the mid-2010’s, financial support mechanisms for clean hydrogen have moved away from research and innovation, support for pilot projects, and towards production credits. This can be seen in the mandate of the Fuel Cells and Hydrogen 2 Joint Undertaking (FCH2JU) from 2014 – 2020 which was focused on research, technological development, and demonstration, relative to the Clean Hydrogen Joint Undertaking (CHJU) that succeeded it. Although the CHJU is still focused on innovation, projects are typically more mature, focused on ‘market entry’ and ‘deployment’, rather than proof of concept (Clean Hydrogen Partnership, 2024c).

Moreover, in early 2024 the EU conducted its first auction for renewable hydrogen production credits, under the Innovation Fund backed ‘EU Hydrogen Bank’ (European Commission, 2024c). The first round of auctions had a budget of €800m and attracted 132 bids. Given that the Bank has various pre-qualification criteria and an obligation that projects enter operation within 5 years of signing the support grant, the high level of interest suggests that there might be a critical mass of production coming online before 2030. For an analysis of the results of this first auction, see McWilliams, Kneebone (2024).

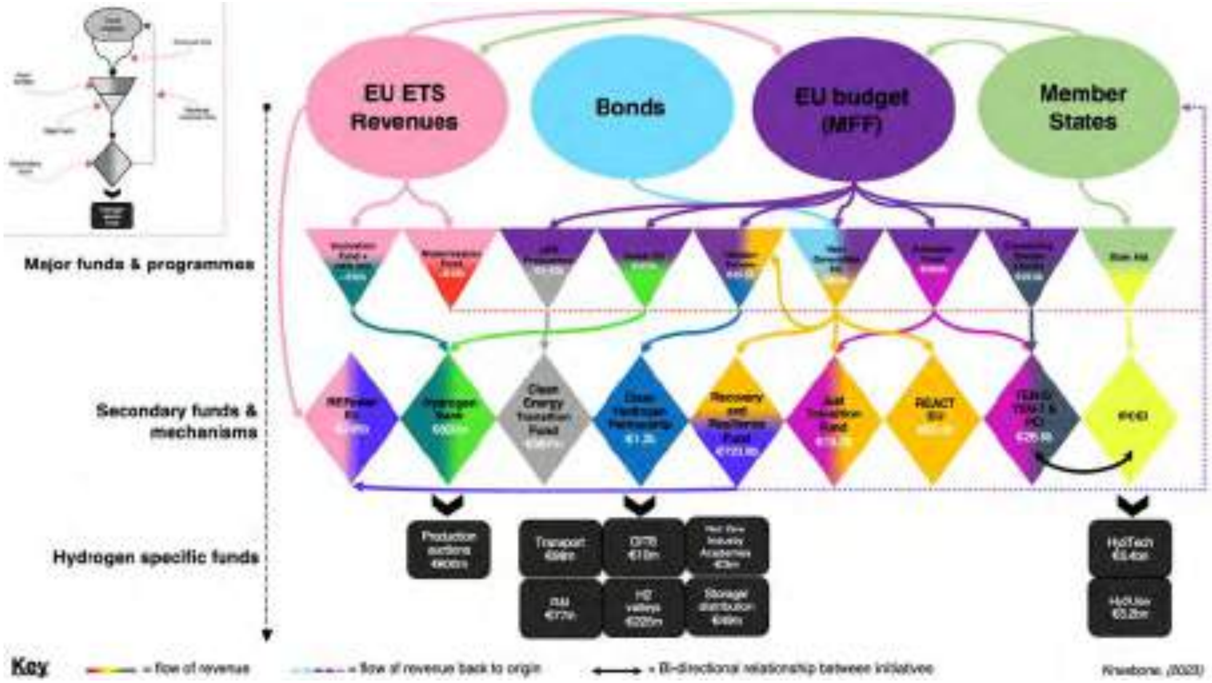

Figure 5.14: Map of EU-specific hydrogen funding flows (source: Kneebone, 2023)

Another key support mechanism in the EU are IPCEIs, which are specific Member State funded projects with a wider EU value. To date, there have been three rounds of IPCEI projects for hydrogen, totalling more than €15 billion in support. To receive an exemption to state aid rules, projects need to demonstrate their 'common value' for the EU, or at least to multiple Member States; nevertheless, projects remain heavily concentrated within a handful of Member States who have the fiscal capacity to invest. The most recent round 'Hy2Infra' (European Commission, 2024a) included electrolyser projects, transmission and distribution pipelines, import terminals, and storage facilities, which is emblematic of the EU's attempts to support all segments of the value chain in parallel. For a more detailed breakdown, see Kneebone (2023).

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6. EU sustainable finance

Sustainable finance is an important tool for meeting the objectives of the European Union (EU) Green Deal, as it can help redirect capital and channel investments towards sustainable activities and projects. This chapter aims to provide a comprehensive overview of the main objectives of sustainable finance, focusing on the case of the EU and highlighting some global efforts and initiatives that seek to promote the fight against climate change and manage financial risks arising from it.

In the first part, we will briefly discuss the main elements and key concepts within the world of sustainable finance and provide an overview of the building blocks of the EU Sustainable Finance Action Plan. The second section will present some instruments of sustainable finance, in particular sustainable debt instruments and products, such as green bonds, as they are key to redirect investments towards financing the net-zero transition and achieving sustainability goals. This section will also highlight some of the key actors involved in sustainable finance markets and their roles.

Furthermore, in part three of this chapter we will discuss the challenge of greenwashing and how the EU has positioned itself as a key actor to address this phenomenon and contribute to tackling climate-related risks, by seeking to improve existing classification systems for green and sustainable activities and enhance transparency and reporting requirements, through key pieces of legislation applicable to companies, financial institutions and investors, like the Taxonomy Regulation, the Sustainable Finance Disclosure Regulation (SFDR) and the Corporate Sustainability Reporting Directive (CSRD).

The fourth section of the chapter will provide a snapshot of the global financial architecture, highlighting some examples relevant to the greening of the global financial system and current international efforts towards the development of global sustainability-related and climate-related reporting frameworks, like the standards set by the International Sustainability Standard Board (ISSB). Finally, the fifth section will introduce the EU Certification Framework for Carbon Dioxide Removals, which aims to scale up carbon removal activities and fight greenwashing.

6.1 A snapshot of sustainable finance

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This section will provide an overview of the key concepts within the world of sustainable finance and highlight the core elements of the EU Sustainable Finance Action Plan, its main objectives and building blocks.

Figure 6.1: A systemic approach to sustainable finance (source: own illustration, 2023)

Sustainable finance has positioned as a growing phenomenon that has been gaining significant relevance in the last decades. The effects of climate change in the environment, society and economy coupled with the anthropogenic change have driven the emergence of sustainable finance as a means to address these challenges and to support the transition to a more sustainable world. Alongside environmental degradation caused by natural disruptions, mainly due to rising global temperatures, our planet is also facing serious societal challenges and problems, including major demographic changes due to overpopulation, urbanisation and migration. The latter can influence the growth of the economy, the structural productivity growth and can also have an impact on inflation rates, living standards, among others, also increasing socio-economic inequalities.

It is well-recognised that the finance sector "*can play a role in allocating investment to sustainable corporates and projects and thus accelerate the transition to a low carbon and more circular economy*" (Schoenmaker and Schramade, 2022: 7). As shown in Figure 6.1, sustainable finance relates to how finance (mainly investment and lending) interacts with social, economic and environmental issues. Thus, sustainable finance is not only linked to the protection of the environment and the transition to a low carbon economy, but rather, to sustainable development in general.

According to the European Commission, sustainable finance "*refers to the process of taking environmental, social and governance (ESG) considerations into account when making investment decisions in the financial sector, leading to more long-term investments in sustainable economic activities and projects*".[240]

240 See European Commission, 'Overview of Sustainable Finance', accessed 22 February 2024 at: https://finance.ec.europa.eu/sustainable-finance/overview-sustainable-finance_en.

Sustainable finance became a key consideration in the global policy agenda particularly since the signature of the Paris Agreement (2015) and the launching of the UN Sustainable Development Goals (SDGs). As highlighted in Section 2.1, the Paris Agreement sets a global framework to limit global warming to well below 2°C relative to pre-industrial levels and to strengthen the efforts to limit it to 1.5°C. It also aims to strengthen countries' ability to deal with the impacts of climate change and support them in their efforts to reduce global greenhouse gas emissions and move towards a climate-neutral world by 2050. Likewise, the 17 SDGs are an urgent 'call for action' by all countries to eradicate poverty, strengthen global peace and conserve our planet and climate. The 17 goals and their 169 targets balance the three dimensions of sustainable development: economic, social and environmental.[241]

The Paris Agreement also recognised the relevant role that the finance sector can play in contributing to achieve the SDGs: "*Implementing the Paris commitment means limiting global warming to below 2°, striving even for 1.5°. In practice, this implies the radical decarbonisation of our economies, which entails fundamental changes in the financial world towards what has been termed 'green finance'*" (Berensmann and Lindenberg, 2016).

Many of the current sustainability policy initiatives and current regulatory frameworks reflect the need to finance the 'green' transition and other sustainability objectives as well as to limit the possibility of climate and environmental hazards and threats that could undermine economic and financial stability. Such a prudential and risk-management approach often takes the denomination of ESG, capturing the combination of environmental, social and governance factors. The acronym is widely used in the banking, insurance and investment sectors, which are expected to commit to building a resilient and sustainable financial system.

In the last decades we have seen national and international policymakers increase their focus on sustainable finance as they have been trying to embed key principles and guidelines of international sustainability-related agreements into policies and regulations with the aim of encouraging the finance sector to adopt a sustainable approach in their decision-making and business models.

6.1.1 The ESG framework

As previously mentioned, ESG stands for environmental, social and governance aspects, which appear as key elements of sustainable finance. In a nutshell, environmental issues refer to the quality, features and functioning of the natural environment, ecosystems and the preservation of the integrity of the biosphere, such as greenhouse gas emissions, biodiversity loss, renewable energy, energy efficiency, natural resource depletion or pollution, waste management, changes in land and water use, and ocean acidification among others. Social aspects usually refer to the well-being and interests of people within communities and the respect of human rights, labour standards, health and safety relationships, and consumer protection within companies. And finally, governance issues relate to the management of companies at the board level and the relation of the board with shareholders and stakeholders. The latter issues include board structure, size, diversity, inclusion, skills, shareholder rights, internal controls and risks management (Thompson, 2017).

However, in the world of sustainable finance, there is a great variety of notions and frameworks to characterise ESG. It can encompass labels, standards, metrics, indicators and ratings that basically seek to measure companies' decision-making practices and risks assessment procedures. In sustainable finance, ESG usually translates into a series of indicators to measure companies' performance and behaviour, which also represent a tool for investors to

241 See United Nations, 'SDGs – Goals', accessed 14 March at: https://sdgs.un.org/goals.

screen potential investments. Policymakers in the EU and globally have increasingly sought to make these indicators more transparent and uniform through the development of reporting frameworks.

6.1.1.1 ESG reporting frameworks

One of the main legal strategies which policymakers in the EU and globally have adopted to foster and regulate sustainable finance has been disclosure. A multitude of currently debated policy initiatives and of recently approved rules require financial market actors to publish more information about how sustainability-related risks affect individuals and organisations as well as about their own impact on environmental and social factors. Alongside the development of rules, some regulators have also engaged in the development of uniform ESG metrics and indicators.[242] The rationale behind the focus on disclosure has been the increasing awareness of the financial impact of environmental and social risks, which would not always be captured by market prices. Thus, rules imposing the dissemination of data on environmental and social matters would address the asymmetry of information, currently preventing market actors from accurately assessing the 'sustainable' profile of financial products and companies. They would also prevent potential 'negative externalities' associated with climate risks, such as systemic negative effects which may derive from the incorrect quantification of climate-related risks.[243] The indirect consequence of these rules should also be to encourage and boost investments towards sustainability-related projects and thereby bridge the current funding gap to meet the SDGs.

One of the first and most widely used frameworks to report about climate-related risks is the one developed by the Task Force for Climate-related Financial Disclosure, which will be examined below (see Section 6.4). Disclosure plays a crucial role in the context of financial instruments which advance sustainability objectives, such as bonds and loans. Over the most recent years, financial market associations and regulators have started to develop reporting frameworks which should provide more transparency around the environmental, social or governance goals that market actors pursue when they issue sustainable financial instruments. These frameworks should not only address ESG risks and promote investments, but also prevent false and misleading claims by market actors regarding their alleged environmental and sustainability-related commitments ('greenwashing' practices[244]). To evaluate the reporting frameworks of financial market actors, there is a wide variety of ESG ratings and scores (see Box 6.1).

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242 See next subsection for more details.

243 Network for Greening the Financial System (2021), "Sustainable finance: market dynamics", p. 3, accessed 14 March 2023 at https://www.ngfs.net/sites/default/files/media/2021/06/17/ngfs_report_sustainable_finance_market_dynamics.pdf; Tröger, T.H. and S. Steuer, (2022) 'The Role of Disclosure in Green Finance', *Journal of Financial Regulation*, 8, 1–50 https://academic.oup.com/jfr/article/8/1/1/6539733.

244 On the notion, see also Section 6.3.

Box 6.1: A deep dive on ESG raters and ESG ratings

ESG ratings are opinions provided by third party actors on the performance of companies and/or portfolios and products of financial institutions. MSCI, Refinitiv, RepRisk and S&P Global count among the most prominent raters.

ESG ratings are based on both qualitative and quantitative criteria. What is now well established is that ESG raters' methodologies greatly diverge and so do their scores. According to an analysis by the MIT project named 'Aggregate Confusion', only 54% of ESG ratings of the most prominent agencies were correlated on average, compared to 92% correlation between S&P and Moody's credit ratings (Berg, Kölbel and Rigobon, 2022). The research has identified three areas of divergence: differences in scope, measurement and weights attributed within ESG ratings. Others have argued that ESG ratings are more subjective than objective (Gargantini and Siri, 2022).

In contrast to Credit Rating Agencies (CRAs) to which ESG raters are often compared, ESG rating agencies are currently subject to a very light regime of regulation, which gives them ample freedom. They are not obliged to disclose their methodologies, are allowed to advise clients that they also rate and are generally not subject to authorization and registration requirements in order to be able to operate. This has led the European Commission to consider whether a dedicated regulatory regime for ESG raters would be necessary in order to 'strengthen both the reliability and comparability' of ESG ratings. In a 2022 consultation, respondents generally recognized the high opacity characterizing the methodologies of ESG raters' assessments. [245] Thus, the Commission has issued a Proposal for a ESG ratings regulation in 2023; the European Parliament adopted the Act on 24 April 2024 and the adoption by the Council is now pending.[246]

6.1.2 The EU Sustainable Action Plan in a nutshell: from the EU Green Deal to a renewed focus on EU sustainable finance

Sustainable finance has only fallen under the radar of the European Union (EU) after the Paris Agreement, as a result of the awareness of the need to mobilise substantial private capital towards sustainability purposes. The wide array of EU sustainable finance initiatives can be retraced to the original agenda-setting work of the High-Level Group on Sustainable Finance (HLEG), created in 2016. The objectives set by the HLEG were then greatly amplified by the EU Green Deal drive.

Sustainable finance has reached the status of a dedicated EU policy area with the release of the Action Plan on Sustainable Finance in 2018.[247] Largely side-lined due to the COVID outbreak and the resulting health crisis management needs, the EU sustainable finance agenda faced a significant risk of ending up in the European Commission's drawers, like many regulatory initiatives before that. Yet, as sustainability concerns came back to the fore of EU agenda-setting, already in the summer of 2020, EU policymakers, stakeholders and the wider

245 See also European Commission (2022), Consultation document - targeted consultation on the functioning of the ESG ratings market in the European Union and on the consideration of ESG factors in credit ratings, accessed 14 March 2023 at https://finance.ec.europa.eu/system/files/2022-04/2022-esg-ratings-consultation-document_en.pdf.

246 See https://www.europarl.europa.eu/doceo/document/TA-9-2024-0347_EN.html.

247 See European Commission (2018), "Communication from The Commission to the European Parliament, the European Council, the Council, the European Central Bank, the European Economic and Social Committee and the Committee of The Regions, Action Plan: Financing sustainable growth", accessed 14 March 2023 at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52018DC0097.

public showed a renewed concern to preserve our environment. After the first waves of Covid-19 receded and the EU's flagship response to Covid-19 (Next Generation EU[248]) was agreed and implemented, the Commission invested again time and energy to come up with an attempt of revitalising its sustainable finance agenda through the publication of its Renewed Sustainable Finance Strategy in July 2021.[249]

Sustainable finance has now solid roots within the EU Green Deal agenda[250] but has in many ways also spilled out from it. It has gained its own traction, especially ever since the new programmatic work elaborated and set out under the Renewed Sustainable Finance Strategy. In this sense, one of the most compelling definitions refers to "*finance to support economic growth while reducing pressures on the environment (…), taking into account social and governance aspects*".[251] The Strategy underlines the crucial role of sustainable investments in achieving the objectives of the Green Deal (for recollection, the European Commission committed to mobilize at least one trillion euros over the period 2020-2030) and also in supporting the recovery from the COVID-19 Pandemic.[252]

Sustainable finance in the EU can be narrowed down to three central building blocks which will be explored in turn in the following sections: (1) a set of EU financial capacities ('funds' in Figure 6.2 below), (2) a two-legged approach to definitional standards, and (3) regulatory initiatives on disclosure. Taken together, these blocks are thought to contribute to significantly increase the amount of private capital poured into European sustainable investments.

Sustainable finance in the EU takes many shapes and forms. All instruments will have effects on their own. Yet, they will also interact and can therefore be best described as a mix of mutually reinforcing carrots and sticks. The virtuous circle is indeed at play to ensure that new and more rigorous sustainability standards are both supported by a host of newly injected funds as well as new data. The following graph illustrates this dynamic.

248 NGEU is covered in further details in the next paragraphs.

249 European Commission (2021), 'Strategy for financing the transition to a sustainable economy', accessed 29 October 2024 at https://finance.ec.europa.eu/publications/strategy-financing-transition-sustainable-economy_en.

250 See European Commission (2019), Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic And Social Committee and the Committee of the Regions: The European Green Deal, accessed 14 March 2023 at https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1588580774040&uri=CELEX%3A52019DC0640.

251 European Commission, Overview of Sustainable Finance, accessed 29 Oxctober 2024 at: https://finance.ec.europa.eu/sustainable-finance/overview-sustainable-finance_en.

252 European Commission (2021), 'Introduction - Enhancing the EU sustainable finance framework' in Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions - Strategy For Financing The Transition To A Sustainable Economy (2021) 390 final.

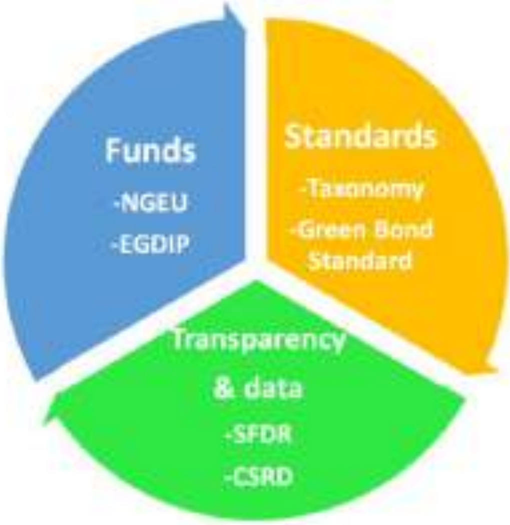

Figure 6.2: Overview of the EU sustainable finance key building blocks (source: own illustration, 2023)

6.1.3 A set of EU financial capacities

On the carrot side, two key instruments stand out: (a) the European Next Generation EU instrument (NGEU), and (b) the European Green Deal Investment Plan (EGDIP). While the two instruments speak to different target groups as we shall see, they all aim at the same objective of ensuring a macro-significant impact on the development of sustainable finance markets in the EU. They all derive from a market-making logic.

6.1.3.1 The European Next Generation EU instrument (NGEU)

NGEU was adopted in principle in July 2020 (and formally in December 2020) as a temporary instrument/economic package, running from 2021 to 2026 in order to enhance Europe's recovery from COVID. It consists of a total envelope of 750 billion euros provided to EU Member States in either grants or loans. NGEU is largely financed through the issue of EU debt on capital markets. The Commission has undertaken to raise up to one third of NGEU funds via NGEU green bonds,[253] thereby implementing itself its sustainable finance agenda of scaling the size of sustainable finance markets. On 12 October 2021, the Commission launched its first green bond under the NGEU, raising €12 billion to be used exclusively for green and sustainable investments across the EU. This represents the world's largest green bond issuance to date.[254]

6.1.3.2 The European Green Deal Investment Plan (EGDIP)

The EGDIP, sometimes referred to also as the Sustainable Europe Investment Plan (SEIP), should be looked at as the real 'investment pillar of the European Green Deal'.[255] Rather than being an articulated instrument, EGDIP should best be regarded as an overall umbrella plan with a strong headline target of one trillion euros of funds mobilized for sustainable investments

253 See European Commission (2021), 'Commission Staff Working Document - Next Generation EU - Green Bond Framework', available at: https://commission.europa.eu/document/download/8d800c26-3ab6-4c78-8923-238eb7b0e9c8_en?filename=nextgenerationeu_green_bond_framework.pdf accessed 22 February 2024.

254 An overview of the debt issuances under the NGEU is available at: https://commission.europa.eu/strategy-and-policy/eu-budget/eu-borrower-investor-relations/eu-debt-securities-data_en accessed 22 February 2024.

255 See Section 1.1 and European Commission (2020) *The European Green Deal Investment Plan and Just Transition Mechanism explained,* accessed 14 March at https://ec.europa.eu/commission/presscorner/detail/en/qanda_20_24.

by 2030.[256] These funds come partly from the EU budget (directly and indirectly through a complex system of leverage and guarantees) and partly from the European Investment Bank. Two strategic instruments of the EGDIP are worth mentioning: the InvestEU Programme, a 250 billion euros programme financed by the EIB, and the Just Transition Mechanism, which totals 100 billion euros of investments from 2021 to 2027 for EU citizens/workers adversely impacted by the energy transition. Because of partial overlaps between the above instruments and NGEU, it will be very difficult for external analysts to track progress made on the one trillion euros objective.

6.1.4 A two-legged approach to definitional standards

Besides funding capacities, the EU also launched a series of strategic initiatives to accompany the EU Green Deal following a market-shaping approach. Due to words constraints, we will only focus on two of the most salient EU legislative initiatives in this field: the EU Taxonomy Regulation and the EU Green Bond Standard.

6.1.4.1 The EU Taxonomy Regulation

The much-maligned EU Taxonomy is a classification exercise that defines with a set of criteria which economic activities are sustainable. Taxonomy Regulation 2020/852 therefore provides uniform definitions, but, concerning ESG, focusses mostly, so far, on the E and less on the S and the G. According to the Taxonomy, 'environmentally sustainable economic activities' should comply with the following criteria (cumulatively) (art. 3): contribute substantially to one or more of the environmental objectives; not significantly harm any of the environmental objectives,[257] comply with minimum social safeguards as well as with technical screening criteria established by the Commission. With a view to facilitating transition investments but at the risk of blurring lines between what is sustainable or not, the Taxonomy also includes two other types of economic activities: transitional activities, a transitional activity being an "*economic activity for which there are no technologically and economically feasible low-carbon alternatives*", and enabling activities, i.e. "*activities which enable other activities to make a substantial contribution to one or more of the environmental objectives*".[258] The Taxonomy Regulation will be discussed in detail in Section 6.3.

6.1.4.2 The EU Green Bond Standard

Alongside the efforts on the Taxonomy, the European Commission has also undertaken to define what makes bonds 'green'. Building on the existing Green Bond Principles by the International Capital Markets Association (ICMA), a regulation was introduced establishing a voluntary EU green bond standard (EUGBS) in 2023.[259] This should promote trust and credibility in sustainable financial products whilst avoiding greenwashing. It appears more ambitious and prescriptive than ICMA's Principles, as it sets a list of technical requirements to be met for the use of the 'EU Green Bond' label. The EUGBS will be further discussed in Section 6.2.[260]

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256 Ibid.

257 The six environmental objectives are: "climate change mitigation; climate change adaptation; sustainable use and protection of water and marine resources; transition to a circular economy; pollution prevention and control; protection and restoration of biodiversity and ecosystems", Taxonomy Regulation, art. 9.

258 See Article 10(2) and 16 of the Taxonomy Regulation.

259 See Regulation (EU) 2023/2631 of the European Parliament and of the Council of 22 November 2023 on European Green Bonds and optional disclosures for bonds marketed as environmentally sustainable and for sustainability-linked bonds, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02023R2631-20240109.

260 Specifically in Box 6.2.

6.1.5 Regulatory initiatives on disclosure

Following the same concern to increase trust in sustainable financial products via enhanced transparency, the EU is rolling out an ambitious agenda in terms of disclosure obligations. The two flagship initiatives in this field are the sustainability-related disclosure in the financial sector (SFDR) and the Corporate Sustainability Reporting Directive (CSRD). They both complement the Taxonomy work and the legislative proposals made on EU labels such as climate and ESG benchmarks. In the next sections we will further discuss the rationale and policy objectives of all these legislative pieces.

Conclusions

The expanding role of the EU in sustainable finance is particularly puzzling because of the mutually reinforcing dynamics at play between its financial capacity instruments, its standards and its regulatory instruments. In this policy area and more than in other policy areas, the European Commission acted both as a policy agenda developer and as a policy agenda implementer. Having access to a host of instruments to finance sustainable projects, the Commission can equally use these instruments to ensure that the definitional standards it promotes have a market uptake. This is abundantly clear in the cases of the green bond standard and of the Taxonomy, which has been made operational through the eligibility criteria of the NGEU. The Taxonomy, however, also helps to structure the more detailed and broader reporting foreseen by the CSRD. Having said all that, at the time of writing the jury is still out as regards the effectiveness of the EU sustainable finance strategy that, if one were to simplify, can amount to the financial arm of the EU Green Deal. Implementation strategies across EU Member States will also play a key role in ensuring the effectiveness of the strategy.

One of the most controversial aspects of the strategy is the scope of the EU Taxonomy: in particular, the Commission's decision to include natural gas and nuclear as transitional activities has sparked a lot of criticism.[261] While it is too early to tell, several voices are also questioning the loopholes in the ESG ratings area due to the lack of transparency and the wide divergencies (Gargantini and Siri, 2022). Regulatory and supervisory measures for ESG ratings appear as the new frontier of this very vibrant policy area.

261 See next section.

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6.2 Sustainable finance instruments and actors

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In this section we will provide an overview of the role of the finance sector in supporting sustainability and the universe of sustainable finance instruments, principles and standards. We will also introduce 'green' and other sustainable financial instruments, i.e. bonds and loans, delve into the most relevant reporting frameworks, and briefly describe the roles of the key actors involved in sustainable finance.

The financial sector has a vital role to play in allowing us to respond to social and environmental challenges and in achieving SDGs. Market actors can:

- Allocate (or fail to allocate) capital, channelling investments where needed;
- Design financial products and instruments that channel money into those areas where investment is needed – thereby supporting sustainability objectives;
- Nudge companies and governments to take action towards the net-zero transition.

Since 2015, we have seen greater commitment from governments, financial institutions and companies as they are setting carbon neutrality targets. For the latter, we have also witnessed a significant shift in their business models, which are increasingly taking ESG aspects into account. According to the European Commission, "*sustainable finance has a key role to play in delivering on the policy objectives under the European Green Deal as well as the EU's international commitments on climate and sustainability objectives. It does this by channelling private investment into the transition to a climate-neutral, climate-resilient, resource-efficient and fair economy, as a complement to public money. Sustainable finance will help ensure that investments support a resilient economy*".[262]

Market participants, such as banks, insurance companies and investors, have committed to sustainability objectives mainly through financing activities that have a positive social and environmental impact i) by managing and disclosing the social and environmental risks to which they are exposed and ii) by developing new sustainable debt instruments such as green bonds, social bonds or sustainability-linked bonds.

While sustainable finance comprises ESG factors, green finance focuses on the "E" element. It has been often seen as strategic to comply with the SDGs and the Paris Agreement, and specifically to contribute to the fight against climate change and to the transition to a low-carbon economy.[263] Green assets, especially debt securities ('green bonds') and other financing techniques, are currently the most prominent form of sustainable finance products. They mainly support projects and activities that aim to reduce greenhouse gas emissions (climate change mitigation or decarbonisation activities), and to improve the resilience to the effects of climate change (climate change adaptation activities). Some examples of the former include renewable energy systems to reduce carbon emissions or cleaner transport systems. As for climate change adaptation, we find activities addressing the effects of climate change that are already visible, e.g. the implementation of measures to reduce coastal community flooding caused by rising sea levels. It may also encompass activities which are aimed to anticipate the medium-term impact of global warming, e.g. the development of new agricultural crops and techniques to reduce water use.

262 See European Commission, *Overview of sustainable finance*, accessed 14 March 2023 at https://finance.ec.europa.eu/sustainable-finance/overview-sustainable-finance_en.

263 Thompson, Simon (2017), *Green and sustainable finance. Principles and practice.* Chartered Banker Institute

6.2.1 'Green' and other 'sustainable' bonds

Green bonds are key examples of green financial instruments that support activities or projects which contribute to environmental objectives. They are debt securities whose proceeds are earmarked for environmental projects. The International Capital Market Association (ICMA) Green Bond Principles (GBP) represent the most common framework used for the issuance of green bonds. These principles consist of a set of voluntary guidelines on transparency, disclosure and reporting for market participants: they "*seek to support issuers in financing environmentally sound and sustainable projects that foster a net-zero emissions economy and protect the environment. GBP-aligned issuance should provide transparent green credentials alongside an investment opportunity*".[264] The GBP have four core components:

1. Use of proceeds,
2. Process for project evaluation and selection,
3. Management of proceeds,
4. Reporting.

In other words, green bond issuers complying with the GBP disclose to the public how the issuance contributes to environmental goals, report about the allocation and impact of the finance raised and obtain external reviews. The latter should verify the robustness of the 'green' credentials. The GBP also recognise a set of eligible 'green project categories', that include renewable energy, energy efficiency, pollution and prevention control, water management, clean transportation, climate change adaptation projects, and sustainable land use, among others.

Another very common framework for green bonds is the Climate Bonds Standard by the Climate Bonds Initiative (CBI). The Standard certifies green bonds which contribute to addressing climate change. The Climate Bonds Standard is made up of two parts:

- Climate Bonds Standard Framework (CBS), consisting of guidelines for the choice of climate-related projects, the management and reporting processes;
- Sector-specific criteria, that specify the requirements assets must meet to be eligible for the Climate Bonds Certification.[265]

The CBS should also operate as a screening tool for investors and issuers and assist them in prioritising investments that truly contribute to addressing climate change.

As discussed in Section 6.1, the EU has also taken active steps towards the development of a green bond standard for the EU market.

It is relevant to highlight that the green bond market has expanded significantly for many years. The first green bond was issued by the European Investment Bank (EIB) in 2007 and was labelled by the institution as a 'Climate Awareness Bond'.[266] The EU market has been a leader globally for the issuance of green bonds since then.

264 ICMA (2021), 'Green bond principles: Voluntary Process Guidelines for Issuing Green Bonds', accessed 14 March 2023 at https://www.icmagroup.org/assets/documents/Sustainable-finance/2022-updates/Green-Bond-Principles-June-2022-060623.pdf.

265 See Climate Bonds Initiative, 'Climate Bonds Standard 4.0', accessed 14 March 2023 at https://www.climatebonds.net/climate-bonds-standard-v4.

266 EIB (2022a), '15 years of EIB green bonds: leading sustainable investment from niche to mainstream', accessed 14 March 2023 at https://www.eib.org/en/press/all/2022-308-15-years-of-eib-green-bonds-leading-sustainable-investment-from-niche-to-mainstream.

Over the last years, the EU green bond market has experienced a considerable growth: "*Annual worldwide issuances have increased from EUR 6.5bn in 2013 to EUR 72bn in 2016, EUR 185bn in 2019 and almost EUR 250bn in 2020 and more than the half of the global issuance in 2020 came from EU companies and EU public bodies*" (Maragopoulos, 2022). The recovery from the Covid-19 pandemic also represented an opportunity for the EU to increase its green bond issuance.[267]

Along with green bonds, other relevant sustainability debt instruments have been developed to finance specific types of social or sustainability projects, such as social bonds, sustainable bonds and sustainability-linked bonds. For these types of bonds, ICMA has developed principles and guidelines similar to the GBP.[268] The growth of sustainable finance instruments is largely a response to the evolution of global policies towards sustainability and to the growing recognition of the important role of the financial sector in helping to address sustainability challenges. It also responds to the increasing pressure from regulators, consumers and investors for companies to prioritise ESG and sustainability aspects in their business and investment models.

Type of bonds	**Characteristics**
Social bonds	The proceeds of this type of bonds should be allocated to projects which pursue a positive social outcome, such as access to health, education and affordable housing. Another example could be gender bonds, which support women empowerment and gender equality.
Sustainability bonds	The proceeds of this type of bonds are used to finance a combination of green and/or social projects or activities.
Sustainability-linked bonds	These instruments are performance-based and mainly allow to achieve certain ESG objectives through Key Performance Indicators (KPIs). Failing to meet the objective generally leads to a variation of the financial characteristics of the bond, like the adjustment of the interest rate.
Transition bonds	The proceeds of this type of bonds should support a business or company's transition towards the reduction of greenhouse gas emissions and a low-carbon business model.
Blue bonds	They are usually issued by development banks or governments to fund projects that aim to protect and preserve marine ecosystems.

Table 6.1: Typology of bonds

Other relevant sustainable debt instruments which lack a unique set of principles include 'transition bonds', which should support the transition towards low carbon solutions and net zero.[269] There have also been examples of social bonds labelled as 'gender bonds', since they finance social projects supporting gender inclusion and diversity, or 'pandemic

267 See Section 6.3 below.

268 ICMA (2021), Social Bond Principles - Voluntary Process Guidelines for Issuing Social Bonds, available at https://www.icmagroup.org/assets/documents/Sustainable-finance/2023-updates/Social-Bond-Principles-SBP-June-2023-220623.pdf; ICMA (2021), Sustainability Bond guidelines, available at https://www.icmagroup.org/assets/documents/Sustainable-finance/2021-updates/Sustainability-Bond-Guidelines-June-2021-140621.pdf.

269 E.g. those issued by the European Bank for Reconstruction and Development (EBRD), EBRD (2022) 'EBRD's Green Transition Bonds – Frequently Asked Questions', accessed 14 March 2023 at: https://www.ebrd.com/documents/treasury/faqebrds-green-transition-bonds.pdf.

bonds‘ supporting the health sector during the Covid-19 pandemic. There are also other categories of sustainability bonds, such as ’SDG bonds’, usually issued by sovereigns to finance concrete projects aimed at achieving specific SDG targets.[270]

The figure below illustrates the breakdown of various types of ‘sustainable’ bonds since 2019 and the forecasts for 2024.

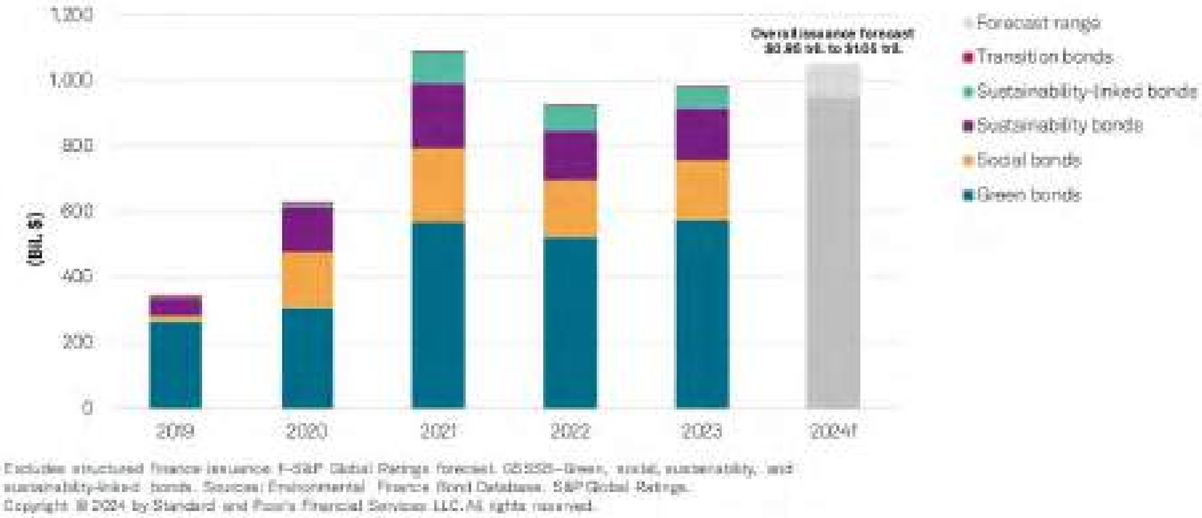

Figure 6.3: Breakdown of ‘sustainable’ bonds 2019-2024 (source: S&P Global, Ratings, 2024)

Box 6.2: A deep dive on the EU Green Bond Standard
The Regulation establishing a voluntary EU green bond standard (EUGBS) was approved on 22 November 2023 and will apply from 21 December 2024. It defines clearer conditions for the use of the ‘EU Green Bond’ label. These relate to the use of proceeds (which will need to comply with the criteria of the EU taxonomy), reporting and the need to obtain external reviews assessing ‘green’ credentials. Green bond reviewers are also subject to approval and registration by the European Securities and Markets Authority (ESMA), the EU financial watchdog. When proposing the new Standard, the Commission stressed it expects that “*issuers will have a robust tool to demonstrate that they are funding legitimate green projects aligned with the EU taxonomy. And investors buying the bonds will be able to more easily assess, compare and trust that their investments are sustainable, thereby reducing the risks posed by greenwashing*” (EC, ‘Commission Proposal for a European Green Bond Standard, 2021).

270 See for example SDG bonds issued by the government of Uzbekistan, Dimovska, M. (2021), SDG Bonds: A contribution to Building Forward Better, UNDP, accessed 14 March 2023 at: https://www.undp.org/eurasia/blog/sdg-bonds-contribution-building-forward-better or the Gobierno de Mexico, ‘SDG Sovereign bond framework’, accessed 14 March 2023 at https://www.finanzaspublicas.hacienda.gob.mx/work/models/Finanzas_Publicas/docs/ori/Espanol/SDG/UMS-SDG_Sustainable_Bond_Framework.pdf.

6.2.2 Other sustainable finance instruments and products

Alongside the evolution of green and sustainability-linked debt instruments, innovation in the sustainable finance sector has also culminated in the issuance of loans which seek to advance environmental, social and other sustainability goals.[271] A trend which has developed in parallel to 'green bonds' has been the issuance of 'green loans'. The three leading loan market associations (Loan Market Association (LMA), Loan Syndications and Trading Association (LSTA) and the Asia Pacific Loan Market Association (APLMA)) have developed Green Loan Principles (GLP), structured around the same four components of the GBP.

However, the appetite and popularity of green loans has been considerably lower than the one for sustainability-linked loans, despite a growth in 2023, as Figure 6.4 below illustrates.

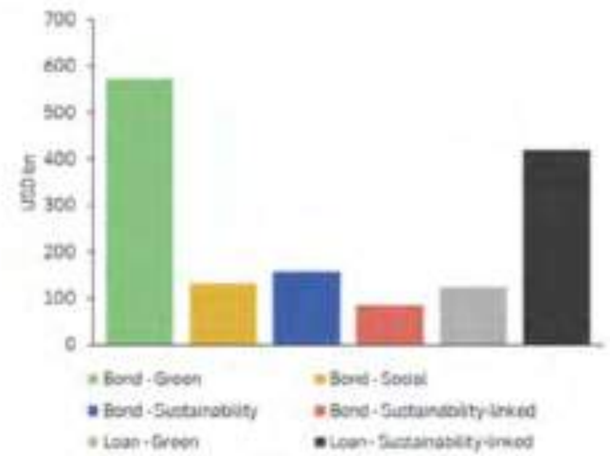

Figure 6.4: Global sustainable debt market by product type in 2023 (source: Climate Bonds Initiative, 2023)

The latter instruments, in line with sustainability-linked bonds, also revolve around sustainability performance targets measured by KPIs. Market actors have noted the wider accessibility of sustainability-linked loans as they could be used to support general corporate purposes and any type of business activity. By contrast, green loans would pose several constraints to borrowers due to the need to identify specific environmentally friendly projects and to allocate the proceeds accordingly (Sathyamoorthy et al., 2023).

The figure below illustrates the annual issuance of 'sustainable' bonds and loans between 2019 and 2023. Overall, it shows an upward trend in the issuance of both instruments, with a decline in 2022 which, according to market analyses, is not linked to a decrease in demand, but instead to the broader macro-economic conditions and to the broader contraction of the corporate bond market.[272]

271 A loan is a contract that is bilaterally negotiated between a lender (like a bank) and a borrower (like a company or an individual). A bond is a financial instrument issued by a company or a bank that can be traded on capital markets. Investors acquire a right to be repaid at the bond maturity. Both bonds and loans represent widely used financing options among companies. The choice between requesting a loan and issuing bonds will depend on a number of factors, like interest rates, fiscal considerations and the size of the company.

272 S&P Global Ratings, Global green bond issuance poised for rebound in 2023 amid policy push, 2023, accessed 29 October 2024 at: https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/global-green-bond-issuance-poised-for-rebound-in-2023-amid-policy-push-73931433.

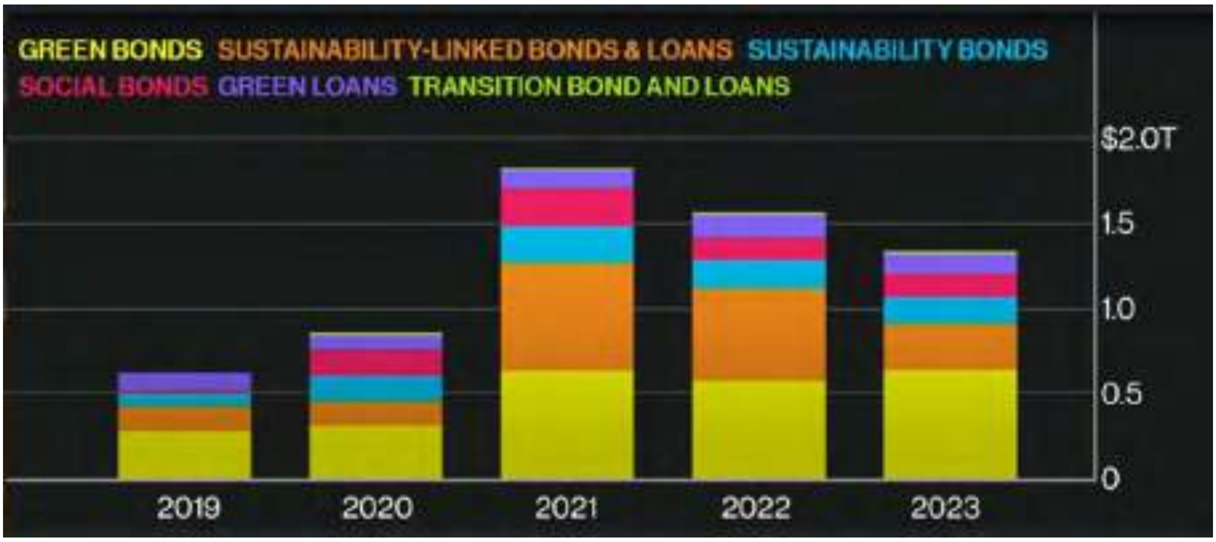

Figure 6.5: Annual sustainable debt issuance 2019-2023 (source: Bloomberg NEF, Bloomberg Terminal, 2024)

Furthermore, market actors like commercial banks, multilateral development banks (MDBs) and financial institutions have also incorporated sustainability considerations in the design of securitisation operations. Securitisation is a financing technique following from the assignment of a series of loans and longer-term claims to a distinct entity (special purpose vehicle, SPV) and from their conversion into securities traded on capital markets. There have been cases of 'green securitisations' where market actors have either undertaken to use the proceeds raised from the securities to implement environmentally friendly projects or to only use 'green'" claims, like leases and loans towards energy-efficiency building or electric vehicles, for the operation.[273]

6.2.3 The application of sustainable finance to blended finance

Sustainable financial instruments also play a crucial role in the sustainable development agenda. The G20 and G7 have widely recognised the value of 'blended finance' (i.e. the combination of public and private funds) as a decisive tool to mobilise more capital towards developing countries.[274] MDBs and other development finance institutions, like the EIB, the EBRD and the World Bank, have already engaged in the direct issuance of the above mentioned green and sustainability-linked bonds and securitised products.[275] According to the OECD, there is room for MDBs to also support other market actors as they approach sustainable finance: for instance, they could take on credit risks from commercial banks which issue their own sustainable financial instruments. Drawing from their expertise, they could also

273 For an exhaustive analysis of 'green securitisation', see Petit, C. and P. Schlosser (2020), 'Rationale, Potential and Pitfalls of Green Securitisation' Working Paper, EUI RSCAS, 2020/35, Florence School of Regulation, https://cadmus.eui.eu/handle/1814/67018.

274 See OECD (2021), 'Making blended finance work for sustainable development: the role of risk transfer mechanisms', accessed 14 March 2023 at https://www.oecd.org/content/dam/oecd/en/publications/reports/2021/09/making-blended-finance-work-for-sustainable-development_86e69cb7/52138dbb-en.pdf.

275 See, among others, EBRD, *EBRD's green bond issuance,* accessed 14 March 2023 at https://www.ebrd.com/work-with-us/sri/green-bond-issuance.html.

provide technical assistance for the design of these securities and products.[276] The interaction between public and private finance for climate action is further discussed in the next sections.

6.2.4 Key actors involved in sustainable finance

There are many actors that intervene in the world of sustainable finance markets. In this sub-section we will briefly define their key roles.

Issuers are the entities that create and sell bonds or issue securities. They can be individuals, companies, governments, municipalities, development banks (such as the Interamerican Development Bank), other banks (such as commercial banks, i.e. Crédit Agricole, BBVA), and international organisations that seek funding to finance particular projects or activities. The main issuers of bonds include banks, financial institutions, governments, investment banks (such as the EIB) and international bodies (such as the World Bank).

Investors (or lenders) are individuals or institutions that provide capital to bond issuers. Banks, asset managers and pension funds provide investment opportunities to individuals, governments and businesses. Lenders expect financial returns, and when they invest in sustainable or green projects or activities, they also expect to have relevant sustainability impact. We can distinguish between two main types of investors:

1) *Institutional investors*: companies or organisations that invest money on behalf of clients or members. Some examples of institutional investors are banks, pension funds (asset owners), investment managers, insurance companies, foundations and charities. They have played a central role in the development of sustainable finance and have pushed different types of companies[277] to strengthen their reporting on ESG issues. On many occasions, institutional investors also work with policymakers and regulators to develop new guidelines, frameworks and standards.
2) *Retail investors*: usually individuals that purchase securities and that are not part of a company or an organisation.

Financial intermediaries and underwriters are market players that bring issuers and investors together. The former provide advice and support to capital seekers and connect them to investors. Some examples of financial intermediaries are investment banks, financial advisors and brokers. The latter buy securities from issuers and distribute them to investors. Banks can also act as underwriters.

Stock exchanges provide relevant information that help investors to identify and invest in environmentally aligned companies. They facilitate the trading of bonds and other financial products in financial markets and, in principle, they facilitate sustainability investments by revealing information on specific green or sustainability-aligned companies and products (examples of stock exchanges that promote green and sustainable products are Nasdaq, Luxembourg Green Exchange, and Euronext).

External reviewers also play a quite important role in the sustainable and green bonds market, as their main goal is to provide independent opinions confirming the alignment of green, social or sustainability-linked bonds with a specific green bond framework or standard. External reviews serve to inform investors that the bond proceeds are funding sustainable or

276.OECD (2021), Making blended finance work for sustainable development: the role of risk transfer mechanisms', accessed 14 March 2023 at https://www.oecd.org/content/dam/oecd/en/publications/reports/2021/09/making-blended-finance-work-for-sustainable-development_86e69cb7/52138dbb-en.pdf.

277 These include, for example, companies from a variety of sectors and industries such as agriculture, textile, cosmetics, automotive, energy, tourism, retail, manufacturing, and real estate, among many others.

environmentally responsible projects. In the case of green bonds, investors rely on external reviews, especially second-party opinions and verifications, as a source of proven information on the 'greenness' of green bonds. In particular, investors "*reward the integrity (expressed by second-party opinions) of green bond issuers with lower expected returns*" (Dorfleitner, Utz and Zhang, 2022). The ICMA GBP contemplate four main types of external reviews.[278]

Regulators and policymakers also play a fundamental role in sustainable finance and in green bond markets as they introduce requirements, rules and guidelines for financial institutions to disclose sustainability-related information or to manage climate- and sustainability-related risks. Policies are key tools not only to accelerate progress towards net zero, but also to achieve the main SDGs. Policymakers and regulatory authorities are responsible for implementing policies and rules which ensure a sustainable financial system.

Since the Paris Agreement, policy developments in the area of sustainable finance and rules that seek to regulate the behaviour of market participants in relation to sustainability and climate-related issues have significantly increased. Such policies range from the strengthening of the prudential framework to incorporate climate and environmental risks to rules imposing more stringent reporting requirements on banks and financial market participants.[279]

278 These include: 1) Second Party Opinions, providing "assurance that the bond framework is aligned to recognised market principles or standards and that the proceeds of the bond or loan, as set out in the framework, are aligned to market practices and expectations from the investment community"; 2) Verifications, conducted "against a designated set of criteria, typically relating to environmental/social/sustainability targets or Key Performance Indicators (KPI)"; 3) Third Party Certifications of green and other sustainability-aligned bonds. In other words, the features of a bond can be certified against a particular framework, standard or label (e.g. the ICMA GBP); 4) Ratings: Credit Rating Agencies can also rate the incorporation of ESG factors, as well as the environmental impact of the use of proceeds of bonds. See ICMA (2023), Green Bond Principles; ICMA (2022), Guidelines for Green, Social, Sustainability and Sustainability-Linked Bonds: External Review, accessed 14 March 2023 at https://www.icmagroup.org/assets/documents/sustainable-finance/guidelines-for-greensocialsustainability-and-sustainability-linked-bonds-external-reviews-february-2021-170221.pdf. On the challenges and policy initiatives on ESG ratings, see Section 6.1 and Box 6.1.

279 See also NGFS (2021), 'Sustainable finance: market dynamics', accessed 14 March 2023 at https://www.ngfs.net/sites/default/files/media/2021/06/17/ngfs_report_sustainable_finance_market_dynamics.pdf.

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6.3 Greenwashing and recent EU policy efforts

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In this section, we outline the policy instruments adopted by the EU as part of its sustainable finance strategy to channel capital flows towards more sustainable investments and foster transparency and long termism in the financial sector (EC, 2021). The EU has been at the forefront of efforts to enhance sustainable finance governance and limit greenwashing, particularly through the enactment of three legislative acts, which form the backbone of its wider sustainable finance framework: the EU Taxonomy Regulation,[280] the Sustainable Finance Disclosures Regulation (SFDR)[281] and the Corporate Sustainability Reporting Directive (CSRD).[282] A parallel initiative is the Corporate Sustainability Due Diligence Directive (CSDDD).[283] Similarly to the CSRD, this directive also addresses greenwashing and unsustainable business practices across supply chains.

6.3.1 The challenge of greenwashing

In recent years, the EU has taken a variety of measures to strengthen and harmonise disclosure rules on sustainability-related information, not least to limit 'greenwashing' practices. Greenwashing can be understood as "*a strategic decision on the part of a firm to mislead investors and consumers that the firm has committed itself to environmental, social and/or governance policies that enhance the value of the firm through the products and services it sells*" (Gregory, 2021).

There exist a multitude of greenwashing examples[284] (see Box 6.3 below on the case of the German firm DWS). In 2021, for instance, Shell launched a campaign ('Drive CO2 Neutral'), claiming that those buying petrol and diesel could choose to pay an extra fee to offset the emissions that would be generated by their vehicles (Euractiv, 2021). A Dutch advertising watchdog claimed that the Shell carbon 'compensation' adverts were misleading, as the oil giant provided no evidence that the offsetting would be equivalent to the generated greenhouse gas (GHG) emissions.

In recent years, the massive proliferation of net-zero claims made by private companies has raised increasing greenwashing concerns, as many companies use carbon credits to 'offset' their emissions, thereby claiming that their products or services are carbon or climate 'neutral' (Cornillie et al., 2021). Since the European Green Deal assigns to the corporate and financial sectors a central role in achieving a climate-neutral economy, the challenge for the EU is to ensure that the massive quantity of investments needed flow into actually sustainable economic activities.[285] On the one hand, companies and financial market actors increasingly use reporting to make sustainability-related claims. On the other hand, the lack of standardized rules makes it hard to distinguish whether the disclosed information reflects actors' real ESG

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280 Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088.

281 Regulation (EU) 2019/2088 of the European Parliament and of the Council of 27 November 2019 on sustainability-related disclosures in the financial services sector.

282 Directive (EU) 2022/2464 of the European Parliament and of the Council of 14 December 2022 amending regulation (EU) no 537/2014, Directive 2004/109/EC, Directive 2006/43/EC and Directive 2013/34/EU, as regards corporate sustainability reporting.

283 Directive of the European Parliament and of the Council on Corporate Sustainability Due Diligence and amending Directive (EU) 2019/1937 and Regulation (EU) 2023/2859.

284 For more information on different 'types' of greenwashing, see https://www.buildinggreen.com/news-article/nine-types-greenwashing, last accessed 29 August 2023.

285 The European Commission has pledged to mobilise at least one trillion euros in sustainable investments in the period 2020-2030 to reach the 2030 climate and energy targets.

performance, not least given that stakeholders like investors or consumers suffer from asymmetric information (Zharfpeykan, 2021). The inaccurate or misleading disclosure of financial products' sustainability-related information can constitute a risk for market stability and credibility. Therefore, setting stricter disclosure rules aims at improving the integrity of companies and financial market actors' sustainability performance. This is understood in terms of both the sustainability risks they are exposed to and the nature of ESG impacts they exert.

Box 6.3: Case study on the issue of greenwashing: DWS greenwashing allegations

DWS (Deutsche Asset & Wealth Management) is a global investment management firm headquartered in Germany. It has been listed on the Frankfurt Stock Exchange since 2018 and it is part of Deutsche Bank, which controls approximately 80% of its shares. As of June 2022, DWS manages assets worth over EUR 900 billion across various investment vehicles such as mutual funds, exchange-traded funds, and institutional accounts.

In late 2020, a whistleblower named Desiree Fixler, at the time Head of Sustainability at DWS, raised concerns to the management board about the company's ESG practices. Fixler claimed that the 2020 annual report of EUR 459 billion 'ESG-integrated' investments was inflated many times.

After Fixler's allegations became public, there has been intense scrutiny by national, European and US authorities. On August 26, 2021, the media reported that two separate investigations into DWS's ESG practices had been started by the Security and Exchange Commission (SEC) and the German financial watchdog BaFin. In the successive months, the European Central Bank investigated corporate governance issues surrounding Asoka Wöhrmann, then CEO at DWS. Additionally, an investigation was started by Frankfurt prosecutors that led to a raid of DWS and Deutsche Bank's headquarters on May 31, 2022.

The greenwashing allegations have had a significant impact on DWS's reputation and stock price. Following the news of the raid, DWS's shares fell by more than 13% prompting Asoka Wöhrmann resignation the day after. Despite DWS rejects the accusation of any wrongdoing, the 2021 company's annual report indicates only EUR 115 billion 'ESG assets' and attribute the difference from the 2020 report (down 75%) to having dropped their proprietary 'Smart Integration' approach to rating ESG investments.

The DWS greenwashing case is a prominent example of the growing scrutiny that asset managers are facing over their ESG practices. As more investors focus on sustainable investing, there will be increased pressure on companies to demonstrate that their investments are genuinely sustainable. Regulators are likely to step up their enforcement efforts to prevent greenwashing, and whistleblowers may continue to play an important role in exposing any wrongdoing.

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6.3.2 The EU Taxonomy Regulation

To tackle greenwashing and set a clear framework towards more sustainable technologies and businesses, in 2020 the EU adopted the Taxonomy Regulation. The Taxonomy is an EU-wide unified classification system laying down specific criteria for companies, investors and policymakers, defining whether a given economic activity qualifies as environmentally sustainable.[286] By creating a common language for all actors in the financial system, a unified EU taxonomy was expected to put some order in the variety of standards and labels for sustainable financial products being used in the European financial market, thereby helping the EU to scale up sustainable investment and implement the European Green Deal (EP, 2021a).

By listing a wide range of environmentally sustainable economic activities, the taxonomy aims: i) to boost investors' confidence that the activities in which they invest contribute to environmental objectives; ii) give investee companies incentives to make their business models more sustainable and; iii) scale up sustainable investment.

The EU taxonomy sets six broad environmental objectives, namely: a) climate mitigation; b) climate adaptation; c) sustainable use of and protection of water and marine resources; d) transition towards a circular economy; e) pollution prevention and control, and f) protection and restoration of biodiversity and ecosystems (Article 9 EU Taxonomy Regulation). To qualify as sustainable, an economic activity needs to 'contribute substantially' to one or more of these six objectives, i.e., it needs to deliver a certain threshold of performance level, adhere to minimum social safeguards and cause no significant harm to any of the other objectives (Article 3(b) and Article 17 EU Taxonomy Regulation).

Under the Taxonomy Regulation, the European Commission (EC) is tasked with the adoption of delegated acts establishing the list of economic activities that can be classified as sustainable. The role of the EC is also to define technical screening criteria, which set thresholds for determining how each economic activity substantially contributes to one or more environmental objectives without harming any of the others.

A first EU Taxonomy Climate Delegated Act – adopted in December 2021 and applicable since January 2022 – introduced technical performance requirements that economic activities need to meet to contribute substantially to climate change mitigation and adaptation, while not exerting a significant negative impact on the other objectives.[287] Importantly, the screening criteria introduced by the Delegated Act for climate change mitigation and adaptation are evolving on a continuous basis and will be subject to regular review. The application of the technical screening criteria is instrumental for undertakings to demonstrate their alignment with the Taxonomy.[288]

By way of example, the Taxonomy lists the criteria under which batteries manufacturing substantially contributes to climate change mitigation, while not causing harm to other environmental objectives.[289] According to the Act, such an activity makes a substantial contribution if it "*manufactures rechargeable batteries, battery packs and accumulators (and their respective components), including from secondary raw materials, that result in substantial GHG emission reductions in transport, stationary and off-grid energy storage and other*

286 For more information, see the website of the European Commission, accessed 20 February 2023 at https://finance.ec.europa.eu/sustainable-finance/tools-and-standards/eu-taxonomy-sustainable-activities_en.

287 See Annex I, III, IV, Commission Delegated Regulation (EU) 2021/2139 of 4 June 2021 supplementing Regulation (EU) 2020/852 of the European Parliament and of the Council by establishing the technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to climate change mitigation or climate change adaptation and for determining whether that economic activity causes no significant harm to any of the other environmental objectives.

288 As also illustrated by European Commission (2023). Commission Notice on the interpretation and implementation of certain legal provisions of the EU Taxonomy Regulation and links to the Sustainable Finance Disclosure Regulation 2023/C 211/01. accessed 20 October 2024 at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.C_.2023.211.01.0001.01.ENG&toc=OJ%3AC%3A2023%3A211%3ATOC.

289 See Annex 1, 3.4, Commission Delegated Regulation (EU) 2021/2139.

industrial applications; or the economic activity recycles end-of-life batteries".[290] The Act also delineates the criteria according to which this activity does no significant harm to other environmental objectives: among others, it does no significant harm to the objective of reaching a circular economy when, for manufacturing new batteries, the activity assesses the availability of reuse and use of secondary raw materials and reused components in manufactured products; or when the activity uses techniques that support (a) design for high durability, recyclability, easy disassembly and adaptability of manufactured products and (b) information on and traceability of substances of concern throughout the life cycle of the manufactured products.

A further delegated act supplementing Article 8 of the Taxonomy Regulation ('Delegated Disclosures Act') was adopted in December 2021 and entered into force in January 2022. The Act provides templates specifying the content, methodology and presentation of information to be disclosed by financial and non-financial actors concerning environmentally sustainable economic activities. Furthermore, a 'Complementary Climate Delegated Act', including specific nuclear and gas energy activities in the list of economically sustainable activities covered by the EU taxonomy, was adopted in July 2022, and became applicable in January 2023. Finally, in June 2023, the Commission adopted the final Environmental Delegated Act which contains a new set of technical screening criteria for economic activities making a substantial contribution to one or more of the four non-climate environmental objectives set out in the Taxonomy Regulation (EC, 2023). The Commission also adopted amendments to the Climate Delegated Act and the Delegated Disclosures Act (ibid).

6.3.3 The Sustainable Finance Disclosure Regulation

As part of its effort to reorient capital flows towards more sustainable investment products and verify sustainability claims made by financial market actors, in May 2018 the EC launched a proposal for a regulation on disclosures relating to sustainable investments and sustainability risks, amending Directive (EU) 2016/2341. The Sustainable Finance Disclosure Regulation (SFDR) proposal was adopted in 2019 as part of the sustainable finance package and came into force on 10 March 2021. The SFDR establishes a set of rules mandating all market participants that offer financial products in the EU to be transparent about the sustainability risks[291] and possible adverse sustainability impacts of their investments, as well as to provide sustainability-related information regarding financial products (Article 1 SFDR). 'Financial market participants' comprise, among others, asset managers, pension funds, and insurance companies.[292]

The SFDR is closely linked to the EU Taxonomy, as it compels issuers to prove that their investments align with the Taxonomy in the pre-contractual documentation phase and annual reporting. In these pre-contractual disclosures, financial market actors must also provide information on how they intend to integrate sustainability risks in their investment decision-making process and the results of the assessment of the likely impacts of sustainability risks on the returns of the financial products they make available. In case financial actors deem sustainability risks not to be relevant, they are obliged to provide an explanation (Article 6 SFDR).

Additionally, the SFDR establishes transparency rules concerning adverse sustainability impacts of investment decisions at both entity and financial products levels (Article 4 SFDR).

290 Ibid.

291 According to the SFDR, Article 2(22), a sustainability risk is understood as "*an environmental, social or governance event or condition that, if it occurs, could cause a negative material impact on the value of the investment*".

292 See SFDR, Article 2(1). Some provisions also apply to financial advisers (Article 5, Article 6 (2)).

Financial market participants are required to disclose information on the possible negative environmental externalities and social impact of their investment decisions/advice and on how this is reflected at the product level. The reason is that investment decisions and financial advice might cause, contribute to or be directly linked to negative material effects on the environment and society, regardless of whether the investment strategy pursues a sustainable objective or not.

Furthermore, the SFDR mandates financial market participants to clarify whether their financial products promote environmental or social characteristics or have sustainability as an objective (Article 5 SFDR). In this case, the information to be disclosed must specify how those characteristics are met; and if an index has been designated as a reference benchmark, whether and how this index is consistent with those environmental or social characteristics (Article 8(1) SFDR).

In April 2022, the EC adopted technical standards to be used by financial market participants when disclosing sustainability-related information under the SFDR[293]. The technical standards consist of disclosure templates that specify the exact content, methodology and presentation of the information to be disclosed, thereby improving its quality and comparability. Under these rules, financial market participants shall provide detailed information about how they intend to tackle and reduce any possible negative impacts that their investments may have on the environment and society at large. Moreover, these new requirements will help to better assess the sustainability performances of financial products.

By setting mandatory disclosure rules on investments' sustainability risks and impacts, the regulation aims to increase data availability, make data more comparable, and bring more transparency and clarity to end investors. While the adoption of the SFDR in itself is no guarantee that the number of sustainable activities will increase (Cornillie, 2022), it certainly signals the Union's efforts towards integrating sustainability considerations into investment decisions. It also indicates the bloc's recognition that a lack of harmonised rules on sustainability-related disclosure and of common transparency standards prevents comparability among financial products in different Member States with respect to both their ESG risks and sustainable investment objectives (Article 9 SFDR).

6.3.4 The Corporate Sustainability Reporting Directive

In the framework of its renewed strategy aimed at strengthening the foundations for sustainable investment, limiting greenwashing and improving companies' accountability regarding their impacts on the environment and society, in April 2021 the EC advanced a proposal for a Corporate Sustainability Reporting Directive (CSRD). In November 2022, the directive was adopted and entered into force in January 2023.[294] This directive reviews Directive 2014/95/EU on the disclosure of non-financial and diversity information (referred to as the 'Non-financial Reporting Directive – NFRD).[295] The NFRD had already set the EU on a

293 Commission Delegated Regulation (EU) 2022/1288 of 6 April 2022 supplementing Regulation (EU) 2019/2088 of the European Parliament and of the Council with regard to regulatory technical standards specifying the details of the content and presentation of the information in relation to the principle of 'do no significant harm', specifying the content, methodologies and presentation of information in relation to sustainability indicators and adverse sustainability impacts, and the content and presentation of the information in relation to the promotion of environmental or social characteristics and sustainable investment objectives in pre-contractual documents, on websites and in periodic reports.

294 The CSRD took effect in January 2024, for all companies already subject to the NFRD, with reports due in 2025. See Directive (EU) 2022/2464 of the European Parliament and of the Council of 14 December 2022 amending Regulation (EU) No 537/2014, Directive 2004/109/EC, Directive 2006/43/EC and Directive 2013/34/EU, as regards corporate sustainability reporting.

295 Directive 2014/95/EU of the European Parliament and of the Council of 22 October 2014 on the disclosure of non-financial and diversity information.

path towards enhanced business transparency and accountability on social and environmental issues, but its implementation revealed some deficiencies, relating for instance to a lack of comparability, reliability and relevance of the non-financial information provided by companies (EP, 2021b). The reviewed directive aims to set more detailed, standardised and stringent non-financial reporting requirements for all corporates, not only those active in the financial sector, by making it mandatory for all large companies and listed small and medium enterprises (SMEs) to report on the sustainability risks and opportunities they face. This with a view to help investors, civil society organisations, consumers and other stakeholders to better evaluate companies' sustainability performance.

The CSRD broadens the scope of the NFRD by setting mandatory reporting requirements for a broader number of European companies – approximately 50,000 companies compared to the previous 11,700.[296] Starting from 2028, the directive will apply likewise to non-EU companies with significant EU subsidiaries or a branch in the EU. The new directive also expands on the range of NFRD reporting requirements, as it mandates disclosure of information on intangible resources, including social, human and intellectual capital (Article 1(2) CSRD), and it requires that reporting to be consistent with the SFDR and the EU Taxonomy. The CSRD and the SFDR are complementary: to fulfil their reporting requirements under the SFDR, financial market participants rely on adequate sustainability information from the companies in which they invest. In turn, the CSRD aims to ensure that investee companies provide the necessary information to financial market participants so that they can meet their obligations.

Companies will have to report based on a 'double materiality' perspective, wherein it is required to disclose information both on how sustainability issues affect a company's development, performance and position, and on the impact of the companies' activities on sustainability (Article 1(4) CSRD). Additionally, the CSRD mandates a third-party assurance obligation on reporting companies, requiring information reported to be certified by an accredited independent body to improve transparency and credibility of non-financial information and boost investors' trust.

According to the CSRD, corporations must report based on European Sustainability Reporting Standards (ESRS), which were developed by a technical advisory body called EFRAG (European Financial Reporting Advisory Group). These standards, divided into two 'cross-cutting' standards and ten 'topical' standards covering sustainability across environmental, social, and governance matters, specify the kind of information to be provided by companies on, among others, their business strategy, targets (e.g., GHG emissions reduction targets), policies related to sustainability matters, actual or potential adverse effects connected with an entity's own operations and value chain, principal risks and how these are managed.[297] EFRAG submitted the first draft of the Standards to the EC in November 2022.[298] After a consultation period with EU bodies and Member States and based on extensive feedback from various stakeholders, the EC adopted the final standards as delegated acts in July 2023. The final

296 Companies under the scope of the CSRD will be large companies, defined by three criteria: (1) more than 250 employees; (2) more than EUR 40m turnover and (3) more than EUR 20m total asset. For more information, see https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en. See also https://www.europarl.europa.eu/news/en/press-room/20221107IPR49611/sustainable-economy-parliament-adopts-new-reporting-rules-for-multinationals.

297 Articles 29(a) and 29(b), CSRD. For more information, see also https://www.bdo.global/getmedia/64b7ae4d-0188-4a0f-983b-8162b10dac3b/ISRB-2022-07-CSRD-finalised-and-first-batch-of-ESRS-delivered.pdf.aspx.

298 EFRAG (2022), First set of ESRS. Available at https://www.efrag.org/en/sustainability-reporting/esrs/sector-agnostic/first-set-of-draft-esrs#:~:text=About%20the%20draft%20ESRS.%20In%20April%202021,%20the%20European%20Commission.

standards introduce some modifications to the drafts delivered by EFRAG, particularly by phasing-in certain reporting requirements, giving companies more flexibility to assess what issues are material to them and making several disclosure requirements voluntary as opposed to mandatory.[299] Additionally, EFRAG launched a consultation in January 2024, open until May 2024, on a draft version of simplified standards for SMEs. These standards are designed to ensure that reporting requirements are proportionate to SMEs' size and complexity and take into account their needs and circumstances. The simplified standards will be issued as a Delegated Act and will be effective on 1 January 2026 with the option to opt out for an additional two years.[300] Moreover, to reduce administrative burdens for companies, in February 2024 the EC decided to postpone by two years the adoption of 'sector-specific' ESRS, to give companies time to comply with the horizontal standards already adopted.

6.3.5 Corporate Sustainability Due Diligence Directive

An additional noteworthy EU initiative is the Corporate Sustainability Due Diligence Directive (CSDDD)[301], which aims at further strengthening sustainable and responsible behaviour of companies throughout global value chains. It will require companies "*to identify and assess actual and potential adverse impacts arising from their own operations or those of their subsidiaries and, where related to their chains of activities, those of their business partners […]*" (Article 8); adverse impacts comprise both environmental and human rights impacts. It will also require companies referred to in Article 22 to "*adopt and put into effect a transition plan for climate change mitigation which aims to ensure, through best efforts, that the business model and strategy of the company are compatible with the transition to a sustainable economy and with the limiting of global warming to 1.5°C in line with the Paris Agreement and the objective of achieving climate neutrality […]*".

Conclusions

By establishing a science-based taxonomy of sustainable activities and legally binding rules on non-financial sustainability-related risk disclosure (see Figure 6.6 below), the regulatory efforts sketched above set the way for the EU to become a pioneer of corporate sustainability reporting at the international level. While the EU is certainly not alone in this effort, the bloc is the first jurisdiction to establish mandatory legislation in the sustainability reporting field (Cornillie, 2022). Having put in place a comprehensive set of measures to reorient funding towards more sustainable investment, the next phase will focus on the implementation of the different regulations and on what this entails for financial and non-financial actors. Whether the EU 'learning by doing approach' will provide a lesson for other jurisdictions to push for more stringent sustainability reporting rules in the corporate and financial sectors is yet to be seen.

299 For more information, see https://ec.europa.eu/commission/presscorner/detail/en/qanda_23_4043 (accessed 29 August 2023).

300 EFRAG, https://www.efrag.org/en/projects/esrs-lsme-esrs-for-listed-smes/exposure-draft-consultation accessed 23 July 2024.

301 Directive of the European Parliament and of the Council on Corporate Sustainability Due Diligence and amending Directive (EU) 2019/1937 and Regulation (EU) 2023/2859.

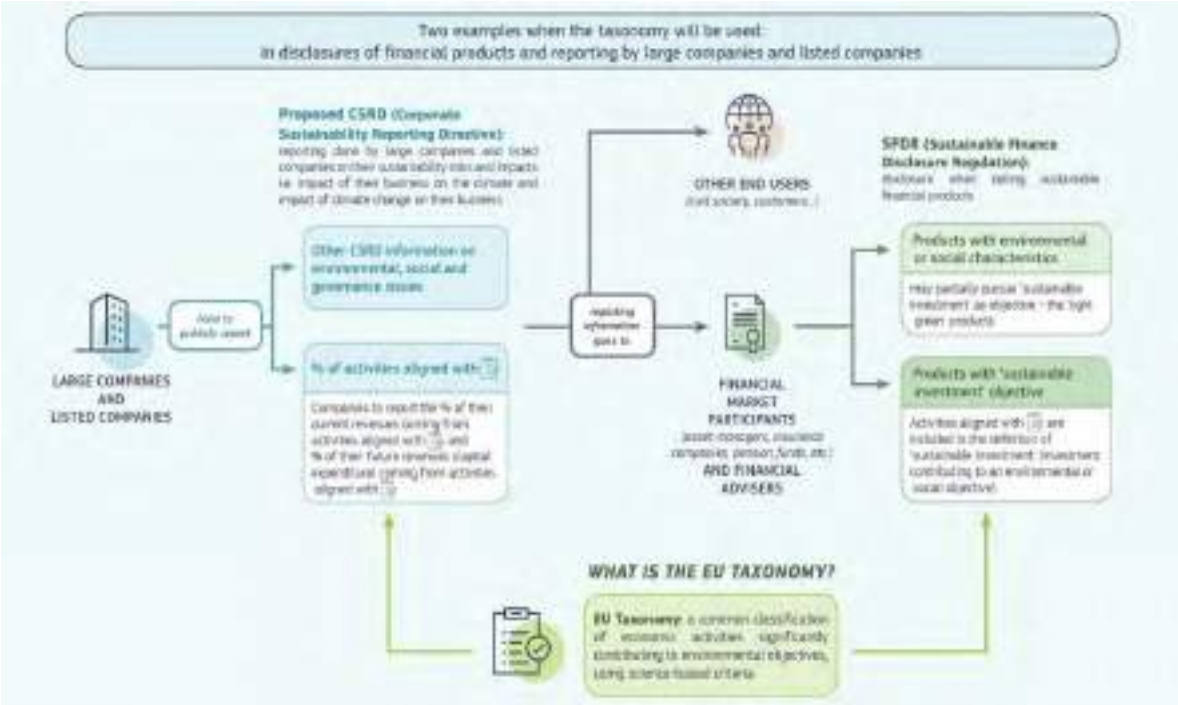

Figure 6.6: How the EU Taxonomy fits within the sustainable finance framework (source: EC, 2022)

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6.4 Global climate finance architecture

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This section places the EU sustainable finance strategy within a wider context by providing an overview of the global climate finance architecture. It proceeds in three steps. First, we look at some examples of current efforts to green the global financial system to support the implementation of the Paris Agreement climate goals, particularly the European Investment Bank Group (EIB Group) Roadmap strategy. Second, we provide a snapshot of current global climate finance commitments and initiatives by focusing on three dimensions, namely climate finance sources, scope, and geography. Lastly, we give an overview of the variety of existing international sustainability reporting standards and how they relate to the EU sustainable finance framework.

6.4.1 Overview of global efforts to green the financial system

In recent years, the financial sector has become increasingly aware of the complex risks posed by climate change to its stability and to the economy more broadly. Numerous transnational networks and initiatives have been formed, aimed at integrating climate-related risks in the financial system and scaling up sustainable finance, thereby aligning financing activities with the Paris Agreement's objectives.

6.4.1.1. EIB Roadmap

As a multilateral development bank, the EIB Group is one of the main multilateral finance providers for climate-related and environmental sustainability projects worldwide (EP, 2021). To support the European Green Deal, the EIB Group has set out an ambitious climate strategy (a 'Roadmap') for the period 2021 to 2025 to step up action towards financing long-term green investments through the provision of a wide range of financial products and advisory services (EIB Group, 2020). This strategy is set to transform the Group from an 'EU bank supporting climate' into the 'EU climate bank'.

The EIB Group roadmap has three main objectives:

1. To support EUR 1 trillion worth of investments to accelerate climate action and environmental sustainability between 2021 and 2030.
2. To gradually increase the share of its financing dedicated to support climate action and environmental sustainability to over 50% of its operations by 2025.
3. To align all its financing activities to the goals and principles of the Paris Agreement by the start of 2021.

To reach these goals, the roadmap focuses on four key areas, namely: (1) increasing green investment and supporting long-term innovation and new business models; (2) ensuring that the transition is 'just for all' – particularly by supporting regions that currently rely on carbon-intensive industries as a major source of local employment and income, and by working to support communities exposed to structural change or climate risks; (3) ensuring that all these activities are consistent with the path to low-carbon and climate-resilient development set by the Paris Agreement; and (4) guaranteeing that the various activities take place within a coherent policy approach towards supporting sustainable finance, in line with the EU Sustainable Finance Action Plan.

According to the 2021 EIB Group Status Report, in 2021 the EIB financed approximately EUR 27.6 billion of climate action and environmentally sustainable investment — a share of 51% of total EIB own financing — and supported a volume of green investment reaching EUR 75 billion (EIB Group, 2022). Additionally, in 2021 the EIB made progress towards supporting climate change adaptation, by lending EUR 1.3 billion in adaptation projects.

6.4.1.2. The European Central Bank climate-related statistical indicators

As an element of its Climate Action Plan to improve assessment of climate-related risks and monitor the development of sustainable finance, in January 2023 the European Central Bank (ECB) published a first set of climate-related statistical indicators (ECB, 2023). Developed together with the national central banks of EU Member States, these indicators are meant to contribute to analyse more effectively how climate risks affect monetary policy, price stability and the financial system; support the green transition; and enhance transparency on climate-related matters.[302]

The indicators include: (1) experimental indicators on sustainable finance focusing on relevant green financial instruments and financial institutions' carbon footprint; and (2) analytical indicators on carbon emissions financed by the financial sector and the associated climate-related risks in the context of the transition to a carbon-free economy. The former group of indicators include sustainable finance indexes that provide an overview of the issuance and holding of debt instruments with sustainability characteristics by residents in the euro area (ECB, 2023). The latter group includes indicators on financial institutions' carbon emissions that provide information on the carbon intensity of the securities and loan portfolios of those financial institutions. In addition, they include indicators focused on physical risks deriving from the impact of natural hazards, such as floods, wildfires or storms, on the performance of loans, bonds and equities portfolios. While these statistical indicators are a work in progress, they represent a first important step towards better capture of data on climate-related risks, reporting, comparability and the achievement of a green transition more broadly. An update to the indicators on 'Carbon emissions' and 'Physical risks' was published in April 2024.[303]

6.4.1.3. The Task Force on Climate-related Financial Disclosures

The industry-based Task Force on Climate-related Financial Disclosures (TCFD or Task Force) is one of the earliest global initiatives created to enhance transparency on financial sector investments by exposing climate-related financial risks and opportunities. Established in 2015, it aims to provide a transparency framework for companies and other organisations to develop more effective disclosure systems of climate-related financial information through their existing reporting processes (Ngo et al., 2022). In particular, the Task Force developed a set of recommendations for assessing more effectively the impact of climate-related matters (and especially climate change) on companies' performance. Both the CSRD and the SFDR largely align with and build on the recommendations of the Task Force (and vice versa) and can be used by companies world-wide across all industries. The recommendations are structured around four main areas:

1. Governance: reporting the firm's governance of climate-related risks and opportunities;
2. Strategy: reporting the actual and potential impacts of climate-related risks and opportunities on a firm's businesses, strategy and financial planning;

302 For more information, see 'Towards climate-related statistical indicators – Technical Annex (as updated on 29 November 2023) at: https://www.ecb.europa.eu/stats/ecb_statistics/sustainability-indicators/data/shared/files/technical_annex202311.hu.pdf accessed 23 February 2024.

303 See ECB (2024), 'Climate change-related indicators. Reference material from the current data release - November 2023 / April 2024. Technical Annex, available at' https://www.ecb.europa.eu/stats/all-key-statistics/horizontal-indicators/sustainability-indicators/data/shared/files/Technical_annex.en.pdf accessed 23 July 2024.

3. Risk management: reporting the processes that are used to identify, evaluate and manage climate-related risks;
4. Metrics and targets: reporting the metrics and targets that are used to evaluate and control the relevant climate-related risks and opportunities (TCFD, 2017).

As of November 2022, over 4,000 organisations from more than 100 countries with a combined market capitalisation of USD 27 trillion have endorsed the Task Force's recommendations (TCFD, 2023). Exposing climate-related risks and opportunities to global scrutiny for all the main financial actors will lead investors to progressively move from 'brown to green', i.e. away from risky carbon-intensive assets to low-carbon opportunities, thereby benefiting from the enhanced market and value of low-carbon investments (Ameli et al., 2020). The Task Force officially dissolved in November 2023, and its legacy will be carried by the IFRS Foundation, which will continue monitoring the progress of companies' climate related disclosures.

6.4.1.4 The Network of Central Banks and Supervisors for Greening the Financial System

Another notable initiative representing central banks' increasing recognition that climate-related risks constitute a source of financial risks is the Network of Central Banks and Supervisors for Greening the Financial System (NGFS). The network works to strengthen the global response required to meet the goals of the Paris Agreement by improving the identification and measurement of the financial sector's exposure to climate-related risks, devising climate change stress tests for financial institutions and mobilising capital for green and low-carbon investments in the broader context of environmentally sustainable development (NGFS, 2023). To this end, the NGFS defines and promotes best practices to be implemented within and outside of its membership and conducts or commissions analytical work on green finance.

6.4.2 Global climate finance commitments and initiatives

International climate finance is a critical enabling driver of climate action. While there is no single definition of climate finance, the term is broadly defined by the United Nations Framework Convention on Climate Change (UNFCCC) as "*the financial resources devoted to addressing climate change by all public and private actors from global to local scales, including international financial flows to developing countries to assist them in addressing climate change*". International climate finance deployment suffers from capital misallocation and underperformance (IPCC, 2022). As a crucial element of the decarbonisation compound, appropriate financial support needs to be consistent with low-carbon and climate-resilient pathways as laid out in the Paris Agreement (Article 2). As the window of opportunity to limit global warming to well below 2°C is rapidly closing and the financing gap widening, efficiently and effectively delivering climate finance stands as a pressing issue (UNEP, 2022).

Despite global climate finance having almost doubled in the past decade, investments are required to rise by a 20% year-on-year by 2030 to reach the needed USD 4.3 trillion (CPI, 2021). In 2021/2022, average annual climate finance flows reached almost USD 1.3 trillion, nearly doubling compared to 2019/2020 levels, due primarily to a significant increase in mitigation finance – especially in the renewable energy and transport sectors – and more data availability (CPI, 2023). To provide an overview of the complex climate finance ecosystem and inherent interactions, in this section we focus on three key elements of global climate finance, namely finance sources (private vs public), finance scope (mitigation vs adaptation), and finance geographies (domestic vs international). We then close the section by listing some of the main challenges and opportunities.

6.4.2.1 Climate Finance Sources (2021-2022)

Between 2021 and 2022, public finance[304] delivered 51% of the total finance flow (USD 640 billion), drawing from various sources (CPI, 2023). Development finance institutions (DFIs) accounted for the lion's share, contributing with about USD 238 billion, 74.1% of the public total. Despite national DFIs being the main driver of this large contribution, multilateral DFIs are expected to accelerate their role in the coming years as commitments proliferate. For instance, the International Development Finance Club has committed to mobilise up to USD 1 trillion in contributions by 2025 (IDFC, 2022) and multilateral development banks have set progressively ambitious targets.[305] In this context, the World Bank continued to be the main multilateral distributor of climate-targeted finance in developing countries, with USD 31.7 billion delivered in 2022 (World Bank, 2022). Second were state-owned financial institutions (USD 45 billion), followed by direct financial flows from domestic and international governments (USD 38 billion). Lastly, Multilateral Climate Funds (MCF) provided USD 3 billion, representing 0.5% of public climate finance. The largest MCFs are the World Bank-administered Clean Technology Fund (CTF), the Green Climate Fund (GCF) and the Global Environment Facility (GEF). Private finance[306] provided the remaining 49% of global climate finance (USD 625 billion), a significant increase compared to previous years. Corporations were responsible for USD 192 billion or 31% of private flows, with commercial finance institutions (banks) providing 38%. An important role was played by households and individuals. Household spending on climate mitigation reached USD 184 billion in 2021/2022, an increase of USD 130 billion from 2019/2020 (CPI, 2023).

6.4.2.2 Climate Finance Scope (2021-2022)

Mitigation efforts continued to be the predominant recipient of global climate finance in 2021 and 2022. Within the mitigation sectors, the highest share of investments flew towards low-carbon energy systems, reaching USD 510 billion per year (or 44% of total mitigation finance), of which USD 490 billion went to renewable energy generation (CPI, 2023). Low-carbon transport finance accounted for 29% of all mitigation climate finance. Adaptation has chronically suffered from scarcer finance than mitigation, despite having increased in recent years. Almost all adaptation finance is traced back to public sources, with multilateral DFIs leading the way. As identified by the latest UNEP report, the adaptation finance gap particularly weighs on the shoulders of developing countries, and without shifting gears, adaptation action risks being eclipsed by intensifying climate impacts (UNEP, 2023). According to a comprehensive assessment carried out by the UNEP, despite clear signs of accelerating climate risks and impacts worldwide, the adaptation finance gap keeps widening, standing at between USD 194 billion and USD 366 billion per year in 2023.[307] In this context, a substantial contribution comes from the Adaptation Fund created by the UN, which since 2010 has committed over USD 1 billion to finance projects and programs that help vulnerable communities in developing countries to adapt to climate change and which has set an ambitious Medium-Term Strategy for the years 2023-2027 that focuses on promoting locally-

304 Public finance includes funds provided by governments, their agencies and companies, state-owned entities and financial institutions, climate funds, and development finance institutions (DFIs).

305 For more information, see the document by the World Bank, accessed 21 February 2023 at https://pubdocs.worldbank.org/en/622841485963735448/dc2015-0002-e-financingfordevelopment.pdf.

306 We consider five categories of private actors: non-financial corporations, commercial financial institutions (banks), households, institutional investors (including asset managers, insurance companies and pension funds), and a mixture of private equity, venture capital and infrastructure funds.

307 Ibid.

led adaptation.[308] Similarly, the Sharm-El-Sheik Adaptation Agenda aims to make 4 billion vulnerable people climate-change resilient by 2030.[309]

6.4.2.3 Climate Finance Geographies (2021-2022)

Between 2021 and 2022, a vast majority of tracked climate finance (USD 1 trillion) flowed within national borders, constituting domestic finance. This represents a persisting trend, whereby the bulk of climate finance is derived from domestic sources. Domestic climate finance was heavily concentrated in East Asia and the Pacific, particularly in China. When comparing the share of domestic and international finance, however, major destinations were Sub-Saharan Africa and South Asia, underpinned by high reliance on public finance. It is worthwhile reminding that at the 15th Conference of the Parties (COP15) in 2009, developed countries pledged to mobilise USD 100 billion per year to developing countries by 2020. According to OECD estimations, developed countries have to date failed to meet their financial promise. Given this shortcoming, toning up the climate financial flow will be necessary to fulfil the extension of the goal to 2025, as formalised in COP21 in 2015. Additional international finance is expected to flow towards developing countries. An example is the Loss and Damage Fund to support vulnerable countries dealing with the effects of climate change, which was created at COP27 and made operational at COP28 in December 2023.

6.4.2.4 Challenges and opportunities

Public and private finance enhancement faces multiple barriers, some of which are under the control of legislative authorities whilst others are contingent on broader macroeconomic and geopolitical trends. Public policy holds the responsibility to ensure intervention integrity, just impacts triggered by financial flows, and to create local enabling environments (Bhandary et al., 2019). The current panorama lacks a coherent public climate action with governments continuing to subsidize fossil fuels (IMF, 2023). Public finance can also play a key role in leveraging private capital, especially towards developing countries, by facilitating low-carbon technologies development, offering reassurance on perceived investment risks and profitability, and powering platforms for information-sharing. Information asymmetries related to large data gaps, unharmonized and inadequate classification of sustainable investment, and data provision cost-ineffectiveness are some of the areas that could be further remediated.

6.4.3 Global rulemaking on sustainability reporting standards

EU action on strengthening sustainability disclosure rules and enhancing transparency and accountability does not happen in a vacuum. Rather, it builds on and supports a variety of international sustainability standard-setting initiatives aiming to develop a comprehensive global corporate reporting system. Noteworthy international initiatives include the Global Reporting Initiative (GRI); the Sustainability Accounting Standards Board; the International Integrated Reporting Council (IIRC); the International Accounting Standards Board; the Carbon Disclosure Standards Board (CDSB); the Carbon Disclosure Project (CDP); and the International Financial Reporting Standards (IFRS) Foundation. Taken together, these standard-setters lead most of the existing sustainability and integrated reporting systems. The EU actively fosters alignment with these international initiatives, as it acknowledges that progressive harmonisation of sustainability reporting standards will benefit European

308 For more information, see the Adaptation Fund Medium-Term Strategy 2023-2027, accessed 20 February 2023 at https://www.adaptation-fund.org/wp-content/uploads/2022/12/Medium-Term-Strategy-2023-2027.pdf.

309 See 'Sharm-el-Sheikh Adaptation Agenda', 2023, available at https://climatechampions.unfccc.int/system/sharm-el-sheikh-adaptation-agenda/.

companies and investors that operate globally and help avoid negative consequences deriving from unnecessary regulatory fragmentation.

On a global scale, the Global Reporting Initiative (GRI) is one of the oldest and most acclaimed sustainability reporting organisations and a pioneer of sustainability disclosure standards. The GRI takes a rather wide approach towards sustainability matters and views economic, ecological and social performance levels as equally relevant for reporting purposes (Baumüller and Sopp, 2022). The GRI standards are applicable to all organisations regardless of size, sector or region and are based on an independent, multi-stakeholder approach. In October 2021, the GRI launched a set of 'Universal Standards', which aim to configure a new global benchmark for transparency and enable companies to best respond to emerging regulatory requirements, such as the EU's CSRD (GRI, 2022).

The International Integrated Reporting Council (IIRC) is another multi-stakeholder initiative which primarily targets investors and addresses the need to create a comprehensive and comparable reporting framework, combining both material, financial and non-financial information. Launched in 2011, the IIRC reporting framework centres around the concept of integrated reporting, which focuses on strengthening the integration of ESG components with business strategies and risks in a company's reporting system. Integrated reporting based on this framework provides investors with valuable information about how a company interacts with the external environment to create, preserve or erode value over the short, medium or long term (Baumüller and Sopp, 2022).

Complementing the landscape of international sustainability reporting are non-governmental standard-setting organisations such as the Carbon Disclosure Project (CDP) and the Climate Disclosure Standards Board (CDSB). The CDP is a not-for-profit organisation at the fore front of the global disclosure system for investors, companies, cities, states and regions to manage their environmental impacts (CDP, 2022). The CDP aims to align its standards to those set by other initiatives, including the GRI and the TCFD, alongside introducing a sectoral focus and adopting a forward-looking approach to climate-risk disclosure (CDP, 2023).

The CDSB is an international consortium of business and environmental NGOs, hosted by the CDP. The consortium is committed to advancing and aligning the global mainstream corporate reporting model to equate natural and social capital with financial capital. This is done by offering companies a framework for reporting environment- and social-related information with the same rigour as financial information. This helps companies to provide investors with useful environmental information via the mainstream (annual) corporate report, thereby enhancing the efficient allocation of capital (CDSB, 2022).

Finally, another notable initiative directed at developing standards targeted at investors for the disclosure of sustainability-related financial information is the International Financial Reporting Standards (IFRS) Foundation. The IFRS Foundation is an umbrella organisation, comprising several investor-oriented sustainability standard-setting bodies under the banner of the IFRS Foundation's International Sustainability Standards Board (ISSB). The GRI has signed a collaboration agreement with the ISSB to coordinate their work programmes and standard-setting activities to connect capital market and multi-stakeholder standards (IFRS, 2022a). Part of the IFRS Foundation is also the Sustainability Accounting Standards Board (SASB), an independent non-profit organisation whose mission is to develop and disseminate sustainability accounting standards that help public corporations disclose material, decision-useful information to investors.

SASB standards identify the subset of environmental, social, and governance issues most relevant to financial performance within 77 industrial sectors. Importantly, EU regulatory action on sustainability reporting has taken place within the context of these different standard-setting organisations and aims to ensure a high level of alignment and interoperability with global disclosure standards.

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6.5 Financing carbon dioxide removal

Elena Marro

Against a backdrop of proliferating private and public net-zero commitments, carbon dioxide removal (CDR) is increasingly gaining momentum on the global climate agenda as its deployment is urged by policymakers, researchers and investors (Smith et al., 2024). Broadly defined, CDR consists in removing carbon dioxide from the atmosphere and durably storing it in geological, terrestrial reservoirs or products.[310] As highlighted by the latest Intergovernmental Panel on Climate Change (IPCC) report (IPCC, 2023), global mitigation scenarios consistent with limiting the temperature rise to 1.5°C require rapid and deep emissions reduction efforts and deploying removal activities to compensate for hard-to-abate residual emissions (see Figure 6.7 below). As part of a long-term climate strategy, CDR's role should complement, rather than replace, deep emission reductions efforts.

As enshrined in the European Climate Law (EP and the Council, 2021), the EU aims at contributing to the Paris Agreement target by becoming the world's first climate-neutral continent by 2050. Consequently, cutting its emissions to a minimum is of foremost importance and shall be complemented by removing several hundred million tonnes of carbon dioxide per year from the atmosphere. As stated in the Sustainable Carbon Cycles Communication, CDR will need to be deployed at scale to balance unavoidable emissions and be thereafter enhanced to achieve post-2050 climate-negative objectives (EC, 2021).

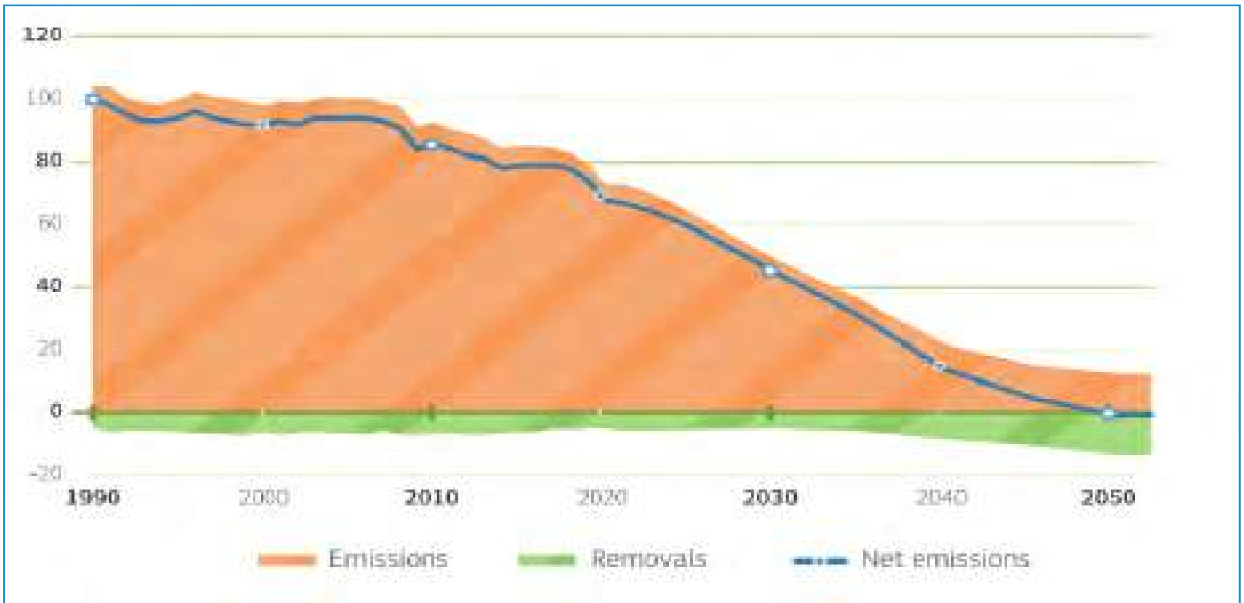

Figure 6.7: Role of CDR in the EU's carbon neutrality strategy (source: EC, 2022)

Notwithstanding CDR's critical role, its implementation has suffered from significant drawbacks while its scalability faces multiple barriers (C2ES, 2022). The mitigation potential of removals appears locked, and its exploration process is at the infancy stage, resulting in a limited uptake of carbon removal tools (Geden and Schenuit, 2020). At present, the EU is falling short in delivering the appropriate volume of CDR solutions needed to meet its net-zero target: nature-

310 Conventionally, CDR can be divided into nature-based solutions – such as af/re-forestation and soil carbon sequestration – and technological options – such as bioenergy with carbon capture and storage, and direct air capture and storage.

based removals have shown a downward trend in recent years[311] and no significant technologically driven removal is hosted by the EU. According to the European Commission's impact assessment (EC, 2022), three interconnected problems bring about this underperformance, namely:

- **Heterogeneity of certification**: multiple certification schemes and underlying standards fuel opacity, complexity and inconsistency in the CDR ecosystem with buyers struggling with evaluating the removals' veritable value due to accessibility and comparability (Arcusa and Sprenkle-Hyppolite, 2022). High-quality carbon removals are not systematically classified and easily identifiable, partially due to monitoring, reporting and verification (MRV) discrepancies across certification schemes.
- **Distrust in certification**: environmental integrity concerns for CDR robustness, further worsened by scandals in carbon markets, fuel buyers' scepticism for certification quality thresholds.
- **Financial barriers**: CDR providers face high transaction costs resulting in limited removal embracement due to financial scarcity. Across-the-board costs include i) navigating the different certification procedures (search costs) and ii) targeting diverse funding opportunities (switching costs). Currently, different certification schemes target different financial models, making the utilization of certificates narrowly focused on and employable for a specific economic source.

Without increased regulatory oversight and a robust governance structure, the barriers preventing the CDR from consolidating and mainstreaming are likely to persist. In this context, the EU has taken initiative by providing an EU regulatory level-playing field for high-quality CDR certification.

6.5.1 EU Framework for the certification of carbon dioxide removal

In November 2022, the EC published a legislative proposal for establishing the first EU-wide voluntary framework for the certification of carbon removals (EC, 2022). The initiative aims at identifying high-quality carbon removals while building trust with stakeholders and preventing greenwashing. It applies to CDR activities that take place in the Union and it is non-obligatory by nature. Initially denominated as 'Union Certification Framework for Carbon Removals' by the EC, the text was subject to some important changes by the EP and EC throughout ordinary legislative procedure. In April 2024, the EP adopted the revised regulatory text now entitled 'a Union certification framework for permanent carbon removals, carbon farming and carbon storage in products' (EP, 2024). This modification in the title was due to the inclusion of soil emission reduction activities, representing an extension of the scope of the regulation *vis à vis* the EC's Proposal. While CDR still represent the core of the legislative text, emissions reductions from biogenic carbon pools are explicitly acknowledged under the EP text. The EP adopted text distinguishes four types of certifiable activities:

1. Permanent carbon removal: carbon removal activities capturing and storing atmospheric or biogenic carbon dioxide for several centuries. Examples of such activities include Bio-Energy Carbon Capture and Storage (BECCS) and Direct Air Carbon Capture and Storage (DACCS). On the positive side, both solutions have large uptake capacity, low vulnerability and durable permanence. On the negative side, BECCS requires a large amount of land whilst DACCS demands a substantial input of

311 "*In only five years, from 2013 to 2018, almost a fifth of the net carbon removals in the LULUCF sector were lost*". See https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A52021SC0609 (last accessed 25 February 2023).

energy. Finally, both systems currently lack scale which drives prices up (Merchant et al., 2022).

2. Carbon farming: activities related to either i) temporary carbon removal activities or ii) soil emission reduction activities. These activities include, but are not limited to, afforestation/reforestation, agroforestry, and peatland restoration. Despite these solutions being the most popular and cost-effectively available to date, their performance is associated with high reversal risks[312], large MRV costs, and potential socio-economic and environmental trade-offs.
3. Carbon storage in products: activities capturing and storing atmospheric or biogenic carbon in long-lasting material or products, such as wood-based materials and construction products. Currently, these products suffer from a small market share in the EU and accounting hindrances.

Considering that the three CDR typologies differ in terms of opportunities and threats, their features call for specific certification methodologies tailoring technical aspects. Nonetheless, attention to specificities should not come at the cost of hindered standardisation: specific methodologies shall build upon a harmonised common ground whose compliance transcends peculiarities. Therefore, to address the problem of certification heterogeneity affecting CDR, the EC proposal sets a common denominator consisting of four certification criteria (the so-called QU.A.L.ITY):

1. **QUantification** (Article 4): activities should trigger a net carbon removal benefit[313] whose calculation shall be carried out in a "*relevant, accurate, complete, consistent, comparable, and transparent*" way with uncertainties being duly reported and accounted for.
2. **Additionality** (Article 5): activities should go beyond Union and national statutory prerequisites and be enabled by the certification incentive.
3. **Long-term storage** (Article 6): activities should store or aim at securing long-term carbon storage while monitoring and mitigating reversal risks. In the case of carbon release, operators should be subject to a liability mechanism.
4. **sustainabilITY** (Article 7): carbon removal activities should trigger a neutral impact or generate co-benefits, ranging from climate change mitigation and adaptation to biodiversity conservation.

These cross-cutting criteria were maintained in the EP adopted text. To finalise the legislative procedure, the text has to be adopted by the Council. As the Certification Framework represents the building block of carbon removal enhancement, the next steps will revolve around operationalising the technicalities of the overarching supervisory apparatus. The EC in conjunction with an Expert Group on Carbon Removals should develop and adopt detailed certification methodologies for the different carbon removal activities and implement acts on harmonized rules and procedures.

6.5.2 Applicable disclosure and reporting rules

The EU Certification Framework for permanent carbon removals, carbon farming and carbon storage in products aims to foster trust and prevent greenwashing practices by enhancing

312 Reversal risks encompass intentional and non-intentional release of carbon dioxide back to the atmosphere, such as land-use change, droughts or fires.

313 Net carbon removal benefit = CRbaseline – CRtotal – GHGincrease > 0. Baselines represent the standard carbon removal performance in a counterfactual scenario where the carbon removal activity does not take place.

disclosure. The Framework follows the experience of a flourishing landscape of existing MRV regulation, among which the rules governing the ETS monitoring and reporting of the EU ETS (EC, 2018). Carbon removal quantification of permanent carbon storage shall be in line with the methodologies developed by the EC under the Innovation Fund. Similarly, monitoring and reporting of carbon farming and carbon storage products should be performed following the provisions laid out in the LULUCF[314] Regulation (EP and the Council, 2018). As suggested by the latter, the utilization of remote sensing and other digital databases represent cost-effective tools to minimise the financial burden of MRV procedures in the land-management sector.

To tackle the problem of stakeholders' suspicion and disenchantment regarding the reliability of certification schemes, the EC holds the right to recognize certification schemes that may be used by operators to demonstrate compliance with the Certification Framework defined by the regulation's provisions. Certification schemes shall annually report on their activities and operate according to the following transparency rules:

1. **Scheme management**: certification schemes should comply with best-in-class procedures, among which are internal due diligence, grievance processes, stakeholder consultation and involvement, and public information;
2. **Independent verification**: third-party certification bodies should audit, validate, and verify the carbon removal activities' fulfilment with QU.A.L.ITY criteria;
3. **Full disclosure**: certification schemes should make their fees to the public as well as set up easily accessible compliant and appeal procedures. Certification schemes must run interoperable registries collecting certification documents. The EP appointed the EC to establish Union wide registry four years after the entry into force of the regulation (Article 12). The Union registry will should make publicly available and traceable all the information related to the certification process to enable the tracking of the certified units and avoidance of fraudulent practices including double counting.

Lastly, the certificates – the outcome of the certification process – should report all relevant information about the carbon removal activity, including net carbon removal contribution, expiry date and co-benefits. The Certification Framework's objective to enhance transparency and reliability is synergetic with the EU's sustainable finance policy measures, such as the Taxonomy Regulation, the Corporate Sustainability Reporting Directive, and the European Sustainability Reporting Standards (see Section 6.3).

6.5.3 EU Removal support and financing mechanisms

The EC proposal for Certification Framework refrained from regulating the final use of certified units. Its primary focused was to provide standardized criteria or the identification and promotion of high-quality carbon removals. This approach was modified by the provisional agreement reached by the EP and EC and reflected in the text adopted by the EP. The co-legislators enriched the preliminary scope of the regulation - establishing the quality criteria and the general provisions for their operationalisation – with rules for the issuance and use of certified units.

The regulation aims at supporting the EU achievement of climate neutrality by 2050 at the latest as laid down in in the European Climate Law (EP and the Council, 2021). Therefore, the certified units generated under the Framework must contribute to the Union NDC and cannot be internationally transferred as these would imply the application of corresponding

314 LULUCF stands for Land Use, Land Use Change and Forestry.

adjustments[315] as per Article 6 of the Paris Agreement. As a result, certifies units cannot be used towards other countries' NDCs or international compliance schemes such as CORSIA. Aside from explicitly excluding the use of certified units for the above-mentioned goals, the EP adopted text supports the deployment of certified units for multiple other end-uses.

Certificates of compliance could be used to substantiate green claims at the corporate level. Using certifies units to support corporate climate-related claims holds the possibility to strengthen the cohesion among the legislative components of the EU governance ecosystem, in particular between the Certification Framework and the proposed 'Green Claims' Directive (EC, 2023). The latter is currently under negotiations. The EP position on the directive envisioned a strong link between the Certification and the directive, calling for offsetting claims to be underpinned by a compensation of residual emissions with units certified under the Framework (EP, 2024; Delbeke et al. 2024). This connection between the two legislative pieces, however, is no longer present in the most recent version of the directive text, namely the general approach of the Council (Council of the EU, 2024).

Additionally, certified units can be exchanged through Voluntary Carbon Markets. In these arenas, nature-based CDR trading at a significant premium price but their volume remains relatively low. Industrial removal activities are a nascent niche segment of the market whose affordability still scores low. Most importantly, market imperfections (risky projects, low-quality MRV, dubious environmental integrity, poor transparency) must be addressed to direct needed capital toward impactful climate solutions (WEF, 2023). To this end, the EP calls on the Commission to assess the alignment of the Framework with the best practices in the voluntary carbon markets and in the international cooperative approached under the Paris Agreement Rulebook for Articles 6.2 and 6.4.

Finally, it is important to note that the EP adopted text requires the EC to review the regulation by 31 July 2026. In the context of this review, a possible categorisation of different end-use of the certified units should be envisioned as well as the application of corresponding adjustment for private actors or third parties. By the same date, the EC shall report to the Parliament and the Council on how permanent carbon removals could be integrated into the EU ETS (EP and the Council 2023).

Once formally adopted by both the Parliament and the Council institutions, the regulation will constitute the first global Certification Framework for carbon removals and emission reductions. It represents an important step to contributing to the EU's goal of reaching climate neutrality by 2050, as set out in the European Climate Law.

315 Corresponding adjustments are accounting mechanisms designed to prevent the double counting of emissions reductions or removals across countries. They are a form of double entry bookkeeping: when a country transfers an emission reduction or removal unit to another country, the country must adjust its emissions inventory downward by the amount of the transferred reduction. This means that the emissions reduction no longer counts toward the seller's NDC. Conversely, the receiving country must adjust its emissions inventory upward by the same amount, as it now counts the emissions reductions or removals toward its own NDC.

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7. EU circular economy

Chapter 7 focuses on circular economy in the EU. We cover its definition, evolution, challenges and opportunities, discussing its implementation in different economic sectors (e.g., waste, plastics, textiles). We then move to a brief overview of municipal waste management and of water and sanitation services in the EU. We conclude with an understanding of the sources, implications and issues related to fossil and biogenic methane emissions together with EU policies aiming at mitigating them.316

7.1 Circular economy in the EU

Sofia Nicolai and Nicolò Rossetto

This section analyses the notion of circular economy (CE) and its implementation in the European Union. Firstly, the concept is clarified and linked to the EU Green Deal; secondly, the implementation through the Circular Economy Action Plan (CEAP) and the subsequent legislative proposals is described, with an attempt to provide a comprehensive view of the role played by this concept in the achievement of EU environmental, economic and social targets.

7.1.1 What is a circular economy?

This subsection describes what a circular economy is and which are its benefits and challenges.

When analysing the concept of circular economy, it is certainly helpful to start with its opposite: a linear economy. A linear economy is characterised by the production of goods which follow a precise, straight production-consumption scheme: take-make-use-dispose. Natural resources are extracted from the environment, transformed into a product which is used (often for a limited amount of time) and then disposed of, becoming waste. This type of economy is extremely dependent on a throughput of new materials and products that follow these steps. Most countries and regions around the world have relied on this approach to ensure their economic development so far. However, it is straightforward to note the criticalities of such an approach. Natural resources are not infinite; their availability and accessibility are a major constraint for a linear economy, together with other consequences of their use, such as the accumulation of landfilled waste and biodiversity loss, just to name a few (EC, 2020; Steffen et al., 2015).[317] Continuous global population growth is exacerbating the problems related to resource use and availability (OECD, 2018). Furthermore, the Covid-19 pandemic aggravated an already serious scenario: the circulation of the virus favoured single-use products like masks and gloves, which were often non-recyclable.

To achieve sustainable development, economic growth must be progressively decoupled from resource use and developing a circular economy seems the right approach to achieve this result. In a circular economy, the value of a material which is extracted from the environment, and of the product that is manufactured with it, is not lost in a take-make-use-dispose straight line process; on the contrary, it is kept in the system, by reusing and recycling the product itself or some parts of it, therefore reducing the amount of waste produced and of the new resources employed (see Figure 7.1).[318]

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316 Carbon capture, use and storage can be considered as part of the EU approach to a circular economy. However, this topic is not addressed in this edition of the technical report due to space and time limits.

317 The EU industry is responsible for 20% of the overall EU greenhouse gas (GHG) emissions. Moreover, approximately half of total GHG emissions and almost the entire biodiversity loss and water stress occurring in the EU can be attributed to resource extraction and processing of materials, fuels and food (EC, 2019).

318 Designing products for durability, reparability and recyclability is an important pillar of a circular economy.

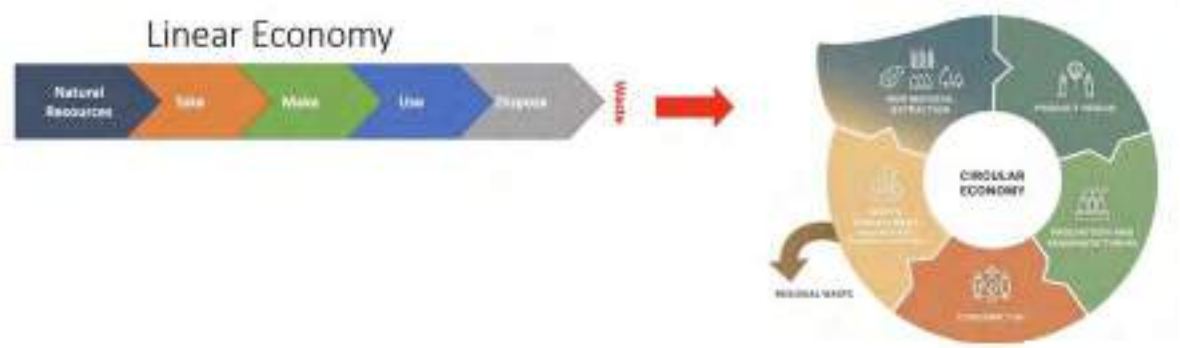

Figure 7.1: From a linear to a circular economy (source: own illustration based on Ecologic Institute, 2023)

Replacing a linear economy with a circular one is crucial to safeguard the essential services that ecosystems provide to society, such as the supply of fresh water, clean air, climate regulation and natural disaster mitigation. Moreover, moving away from a linear to a circular model of economic development presents at least two additional benefits. First, it reduces the dependency of an economy on certain virgin raw materials and products. This can be strategically important for countries with a limited domestic endowment of raw materials. By recycling or re-using the materials already present in their economy, those countries face a reduced need for new imports and become less vulnerable to price volatility in international markets. Second, the implementation of a circular model of economic development can unlock new business opportunities for the industrial sector of a country, allowing it to be at the forefront of international competition and support the transformational changes needed to achieve the green transition.

On the other hand, the implementation of a circular economy must overcome at least four challenges.

1. Avoid regulatory and legislative silos

Circular economy's benefits and opportunities can only be grasped if regulatory and legislative silos are avoided. In a circular economy, the end products or the waste generated by a sector become the raw materials and inputs for another sector. Policymakers and regulators must then define the rules that apply to a sector by considering their implications not only on that sector but also on the others that are impacted.

2. Balance a top-down with a bottom-up approach

The fundamental requirement to enable a successful transformation of a linear economy into a circular one is the ability to balance a governmental top-down approach and a bottom-up collaboration with stakeholders (being them industries or consumers) to allow the challenges of new CE approaches, identified at the bottom, to meet the solutions proposed at the top (Künkel and Ragnarsdottir, 2022).

3. Safeguard jobs and reskilling workers

To ensure that the transition from a linear to a circular economy is fair, it is important to safeguard jobs that may be lost during the re-organisation of production processes and value chains. This means not only replacing jobs lost with new ones, but also reskilling workers to give them the possibility to adapt and catch the new job opportunities that a circular economy can offer.

4. Lack of a silver bullet fostering circularity for all categories of products

The economy comprises very different sectors and products, from textiles to batteries. Each of them has its own specific challenges in the transition from a linear to a circular model. Therefore, it is hard from a policy perspective to provide harmonised, general guidelines fostering circularity in every sector. A more tailor-made approach is equally hard and time-consuming to develop and implement from a policy perspective.

7.1.2 Why is circular economy relevant for the Green Deal?

This subsection describes the role of circular economy in the context of the EU Green Deal and how it is embedded in its policy areas.

The systematic implementation of the circular economy approach is one of the tools to achieve the Green Deal targets, which aim at transforming the European economy and make it fit for an environmentally, economically and socially sustainable future. This is confirmed by the embedding of the circular economy approach in most of the Green Deal policy areas (see Section 1.1).

In particular, buildings renovation is inspired by energy and resource efficiency and by the additional objective of making buildings resilient to extreme weather events induced by climate change. The sector accounts for around 40% of the EU final energy consumption. The renovation wave that Member States will have to deploy, together with a rigorous enforcement of the legislation related to the energy performance of buildings (EP and the Council, 2024a), must ensure their energy efficiency (EP and the Council, 2023b): the better the insulation, the higher the thermal storage potential, which reduces the need for additional energy resources.

For what concerns the mobilisation of the industry, circular production and consumption patterns are promoted. The Circular Economy Action Plan, that will be described more in detail below, specifies the circularity demanded to EU industries in the Green Deal; it prioritises reduction and reuse of materials before recycling and calls for common principles for the circular design of all products placed on the EU market, that will have to respect minimum requirements of environmental safety.

Considering ecosystems and biodiversity, which are crucial for natural disasters' mitigation, the Green Deal foresees, among other things, an effort targeted at forests protection and re-/afforestation, to promote the natural, circular CO_2 absorption/release cycle from and in the atmosphere. Furthermore, the preservation of the blue economy, an important element of the Action Plan, aims at safeguarding the climate change mitigation potential of oceans and their ability to ease the burden on land resources. In fact, through a better use of aquatic and marine resources (e.g., identifying new types of protein sources, such as algae), it is possible to partially relieve the pressure on agricultural land.

The policy area of smart mobility gravitates around the pressing need to drastically reduce transport emissions by 2050 in order to achieve climate neutrality. The EU foresees an increasing number of low-emission vehicles on the road, which will rely on batteries. Batteries can foster circularity thanks to their storage capacity, which enables mechanisms like vehicle-to-grid (i.e., the possibility for the grid to rely on energy injections from batteries in case of insufficient generation). However, the same manufacturing of batteries is addressed by the Action Plan, that foresees a mandatory recycled content. This action tries to alleviate the criticalities related to the virgin raw materials necessary to produce batteries, which are often not sustainable, both socially and environmentally (for more on critical raw materials, see Section 3.5).

In the Farm to Fork Strategy, which aims at making food systems "*fair, healthy and environmentally-friendly*" (EC, 2020a), the circularity dimension clearly emerges from its objectives (see Figure 7.2). Among the actions foreseen, food loss and waste prevention perfectly mirror the basic principle of resource efficiency characterising the circular economy.

Figure 7.2: Objectives of the Farm to Fork Strategy (source: EC, 2020)

For what concerns the energy sector, a ‘circular’ energy system integration, based on energy efficiency, is foreseen by the Green Deal and pursued through a dedicated EU strategy issued in 2020. Such policy document recognises that an organisation in silos of the various energy supply chains, such as gas, electricity and storage systems, is technically and economically inefficient. Energy system integration represents the solution to those inefficiencies. The strategy defines that concept as “[…] *the planning and operating of the energy system “as a whole”, across multiple energy carriers, infrastructures, and consumption sectors, by creating stronger links between them with the objective of delivering low-carbon, reliable and resource-efficient energy services, at the least possible cost for society*” (EC, 2020c).

Energy system integration ensures not only the optimisation of the functioning of a specific energy infrastructure, such as the electricity grid, and of all the resources connected to it, but also supports the interaction between different sectors and energy vectors. One example of that is the possibility to use surplus electricity, generated during the night by wind farms, to produce hydrogen, that can be used either for industrial purposes or to store energy for a later use.

Until today, the energy system has been planned, operated and regulated in a very linear way, with several unidirectional energy flows (secondary energy is produced from primary energy sources, transferred via dedicated infrastructures, and consumed by final customers). Energy system integration encourages bidirectional energy flows, not only from producers to consumers but also from consumers back to the rest of the system. Moreover, it allows the system to build on the synergies that exist between different sectors and vectors, for example, with power to gas processes, that support the conversion of electrical power into a gaseous energy carrier.

A more integrated approach that exploits synergies between sectors and vectors is expected to support the decarbonisation of emission intensive activities, like transport and industry (through electrification and storage), but also to minimise the costs of the energy transition for consumers. Energy and monetary savings could derive from different measures; a non-exhaustive list includes setting up renewable energy communities to foster local energy efficiency and promote consumer engagement; boosting vehicle-to-grid services to support the secure and continuous functioning of the electricity grid; reusing unavoidable waste streams to reduce the need for primary energy. The *fil rouge* of these actions is weaved around a more efficient use of resources, being them primary energy sources or vectors and preventing waste whenever possible.

In this frame, waste-to-energy processes, defined as "*various waste treatment processes generating energy* (e.g., *in the form of electricity/or heat or produce a waste-derived fuel)*" (EC, 2017), shape a new way of dealing with unrecyclable and biological waste. The EU waste legislation gravitates around the waste hierarchy, a pyramidal classification of actions to deal with waste from the environmentally preferable option (waste prevention) to the least preferred (disposal). Waste-to-energy processes can fall into different levels of the waste hierarchy (e.g., recycling, but also other recovery, see Figure 7.3). However, it is likely that in the future the margin for these options will narrow down due to waste prevention measures (see Section 7.3 on municipal waste).

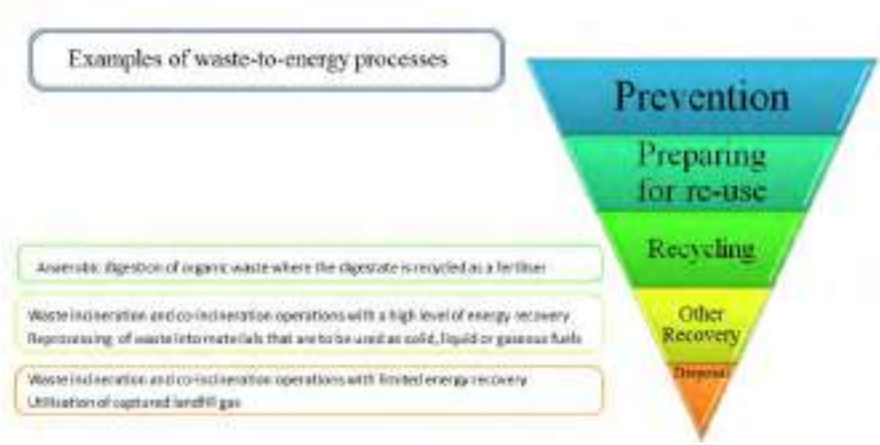

Figure 7.3: The waste hierarchy and three examples of waste-to-energy processes (source: EC, 2017)

7.1.3 What is the EU Circular Economy Action Plan (CEAP)?

This subsection provides an overview of the evolution of the European policy on circular economy and describes the Circular Economy Action Plan adopted by the EC first in 2015 and, in a revised and expanded form, in 2020.

The attention of the EU to circular economy is not new. On the contrary, in the last decade, the spotlight on resource use has driven policy actions towards its decoupling from economic growth. This is, in fact, the core of the 2011 Roadmap for a Resource-Efficient Europe, which was stimulated by volatility in the price of resources, growing dependence on imports of natural resources for a variety of end uses, and increasing attention to their unconstrained availability (EC, 2011). The roadmap aimed at analysing key resources from a life-cycle and value-chain perspective and proposed actions in the housing and mobility sectors, which were considered responsible for the most severe environmental impacts. In 2012, the European Resource Efficiency Platform was established, with the aim of providing policy recommendations to private and public actors, advocating for a transition towards a circular economy (EC, 2012).

In 2014, a Circular Economy Package was built upon the 2011 Roadmap. The publication of the package was followed by a public consultation with stakeholders of the private sector, civil society and national authorities, after which the Directorate General for Environment presented the 2015 Circular Economy Action Plan (CEAP). The Plan encompassed 54 legislative and non-legislative actions, among which a revision of waste legislation and a sustainable buildings initiative. To share best practices, some platforms were set up, like the European Circular Economy Stakeholder Platform and the Circular Economy Finance Support Platform. The adoption and delivery of all the actions foreseen in the Action Plan led the EU to be recognised as a leader in circular economy policies (Ellen MacArthur Foundation, 2020a).

The 2015 Action Plan encouraged at least 14 Member States, eight regions and 11 cities to put forward circular economy strategies and roadmaps (Ellen MacArthur Foundation, 2020b). Some of these roadmaps have a limited duration (e.g., the Finnish roadmap to a circular economy 2016-2025), while others are expected to play a role for the whole green transition (e.g., the French roadmap for the circular economy). They can be local (e.g., the roadmap for a circular city of Porto in 2030), regional (e.g., Promoting the green and circular economy in Catalonia), or national (e.g., the German resource efficient programme II) (European Economic and Social Committee, 2019). Some plans are more ambitious than others, but circular economy clearly emerged as an approach to be implemented at European, national and local level.

However, with the adoption of the Green Deal Communication in 2019 (EC, 2019), it was evident that the EU wanted to move a step further in its decarbonisation targets. As mentioned in Section 1.1, the Green Deal is a comprehensive plan encompassing all sectors of the economy, therefore, an equally overarching strategy was needed to support its implementation, considering that, from 2015 to 2020, some sectors, such as the textile industry, increasingly caught the eye of policymakers for their disruptive environmental impacts.

The 2020 CEAP aspires at speeding up the transformational change put forward by the European Green Deal (EC, 2020b). To achieve its objectives, the plan foresees a series of new directives and regulations and the revision of existing ones. It aims at providing guidelines and obligations for the different sectors of the economy to facilitate and implement the transition. In addition, it contains a horizontal policy, intervening on all the sectors: the sustainable product design framework.

This framework originates from the idea that by intervening in the design phase of a product it is possible to devise specific product’s characteristics to make its manufacturing and consumption (more) sustainable. In fact, the new Ecodesign for Sustainable Products Regulation aims at setting eco-design requirements for specific product groups to significantly improve their circularity, energy performance and other environmental sustainability aspects (EP and the Council, 2024b). In the context of product design, the Commission will also intervene on the EU ecolabel criteria, which are high environmental standards to be met by a product during its entire life (starting, therefore, from the design phase) if the producer wants the product to be awarded the ecolabel (EC, 2022b). In particular, durability, recyclability and recycled content requirements will be included more systematically in the criteria, allowing consumers to make more conscious and informed choices. Moreover, the recently adopted Directive on common rules promoting the repair of goods aims at ensuring that more products are repaired within the legal guarantee (EP and the Council, 2024c). In March 2023, a proposal for a directive on substantiation and communication of explicit environmental claims ('Green Claims Directive') was published, to establish minimum requirements on the substantiation and communication of voluntary environmental claims and environmental labelling in business-to-consumer commercial practices.[319] Negotiations on this proposal are expected to begin in the new legislative cycle.

Arriving to the sector-specific measures, the 2020 CEAP identifies seven sectors which deserve specific attention due to their disruptive environmental impacts: electronics and ICT, batteries and vehicles, packaging, plastics, textiles, construction and buildings, and, lastly, food, water and nutrients. This list of high-impact sectors is built upon the one included in the 2015 CEAP, which dedicated particular attention to plastics, food waste, critical raw materials (present in electronic devices), construction and demolition, and biomass and bio-based products. It is evident how, in the years between the two plans, electronics, batteries and vehicles, packaging and textiles drawn increasing policy attention due to the negative and difficult to manage environmental consequences originating from their production, consumption and disposal, and are now at the heart of the new CEAP.

To intervene in the seven high-impact sectors, the 2020 CEAP foresees a series of new or revised directives and regulations. This regulatory *modus operandi* is accentuated compared to the 2015 CEAP, which identified priority areas, but regulations and directives were envisaged to a lesser extent (most of the actions included in the 2015 CEAP referred to the adoption of guidelines, good practices, and other complementary tools, such as cooperation platforms).

In what follows, we provide an overview of the sector-specific actions foreseen by the 2020 CEAP in the seven high-impact sectors.

7.1.3.1 Electronics and ICT

Electronical products sales are expected to continue increasing due to the twin processes of digitalisation and decarbonisation. The Commission wants to intervene in this sector to promote longer product lifetimes with a Circular Electronics Initiative to boost durability, reparability, upgradability, maintenance, reuse and recycling. Regulatory measures include the introduction of a common charger and efforts to decouple the purchase of chargers from the purchase of new devices made by Directive (EU) 2022/2380. Furthermore, to ensure a sustainable end-of-life phase of electronic devices, the collection and treatment of this type of waste will be tackled, exploring opportunities for EU-wide take back schemes to return or sell old devices.

7.1.3.2 Batteries and vehicles

Batteries are at the heart of the electrification of the transport sector, as key components of electric vehicles, but their manufacturing and disposal pose serious environmental and social issues. The Action Plan foresees a new regulatory framework to ensure the sustainability of the battery value chain (e.g., imposing minimum recycled content, performance and durability criteria), and its competitiveness. It will enhance the sustainability and transparency requirements for batteries manufacturing, considering their carbon footprint and the ethical sourcing of raw materials. Reusing, repurposing and recycling will be facilitated, together with the recovery of valuable materials through guidance for consumers. Non-rechargeable batteries will be addressed with the purpose of reducing their usage when alternatives exist. To achieve these objectives, a regulation concerning batteries and waste batteries has been adopted in 2023, which sets minimum levels of recovered cobalt, lead, lithium and nickel from

319 Proposal for a directive of the European Parliament and of the Council on substantiation and communication of explicit environmental claims (Green Claims Directive) COM/2023/166 final available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2023%3A0166%3AFIN.

manufacturing and gradually increasing collection targets, differentiated per type of battery (EP and the Council, 2023a).

The Commission also wants to revise the rules on end-of-life vehicles. Linking the design phase of a product to its end-of-life treatment, it is possible to enhance circularity, with mandatory recycled content for certain materials, for instance. The Comprehensive European Strategy on Sustainable and Smart Mobility will boost even more the circularity of the sector: approaching mobility as a service rather than as a product will allow infrastructure and vehicle use optimisation (EC, 2020e).

7.1.3.3 Packaging

To tackle the massive amount of materials used for packaging, the Action Plan proposes a revision of EU rules on packaging and packaging waste. In March 2024, the Council and the European Parliament reached a provisional political agreement on a proposal for a regulation on packaging and packaging waste. It sets requirements to ensure that packaging is safe and sustainable, by requiring that the presence of substances of concern is minimised and all packaging is recyclable. Other measures will focus on reducing the complexity of packaging materials and considering no-packaging options when feasible. Through a rigorous monitoring of the implementation of the Drinking Water Directive, which aims at making drinkable tap water widely accessible, the Commission wants to reduce the dependence on bottled water, thus preventing packaging waste.

7.1.3.4 Plastics

Plastics consumption is and will continue to be a serious environmental concern. The Commission will take targeted measures to cope with the sustainability challenges deriving from this ubiquitous material. Mandatory requirements for recycled content and waste reduction measures for selected products, like vehicles and packaging, will be imposed. Moreover, the Commission has already adopted the communication for an EU policy framework on biobased, biodegradable and compostable plastics in November 2022, a non-binding document which clarifies the concepts of biobased, biodegradable and compostable plastics, identifying also the conditions to promote an overall positive environmental impact of their production, consumption and disposal (EC, 2022a). It represents an attempt to fill the existing gap of a comprehensive plan tackling this type of materials.

The Commission will ensure the timely implementation of the 2019 Directive on Single Use Plastic Products, to prevent the disposal of plastics products after a single use, promoting their reusability. Microplastics are also at the heart of the Action Plan: their intentional and unintentional release into the environment will be regulated and measures will be taken to improve the capture of microplastics during the most relevant phases of a product lifecycle. In particular, the proposal for a regulation on preventing plastic pellet losses to reduce microplastic pollution was published in October 2023 and negotiations will be pursued by the newly elected European Parliament.

7.1.3.5 Textiles

Textiles production requires a substantial amount of virgin raw materials and water, with a very low recycling rate, which puts a significant pressure on natural resources. The Action Plan proposes a comprehensive EU Strategy for Textiles to reinforce industrial competitiveness and innovation when creating a market for sustainable and circular textiles and for textile reuse. Measures will include the application to textiles of the new sustainable product framework, described above. This will imply the need to consider the design phase of products as crucial for ensuring their circularity (e.g., imposing a mandatory recycled content). A proposal for the mandatory performance requirements for the environmental sustainability of textile products is expected in 2024. Mandatory minimums for the inclusion of recycled fibres in textiles are on the horizon, to ease the negative environmental impact of this sector, whose production almost doubled between 2000 and 2015 and whose consumption is expected to continue increasing until, at least, 2030 (EC, 2022d).

At the same time, the EU Strategy for Textiles aims at empowering producers and consumers to select sustainable textiles and access re-use and repair options. These actors will be provided with guidance to meet high levels of separate collection of this type of waste.

7.1.3.6 Construction and buildings

The built environment requires a variety of resources, among which extracted materials; it is responsible for vast amounts of waste and greenhouse gas emissions from the extraction of resources, manufacturing and construction works. For these reasons, the Action Plan foresees a comprehensive Strategy for a Sustainable Built Environment to foster material efficiency. The strategy enhances circularity in the design, construction, maintenance and demolition of buildings, intervening on the sustainability performance of construction products and improving durability and adaptability of assets. It will consider mandatory recycled content in construction products and a revision of material recovery targets for the resulting waste. This strategy is increasingly important in light of the Renovation Wave promoted by the Green Deal to improve energy efficiency in EU buildings.

7.1.3.7 Food, water and nutrients

Approximately 20% of the total food produced is lost or wasted in the EU. Therefore, through the revision of the Waste Framework Directive, currently under negotiations, a target on food waste reduction is proposed, in line with the UN Sustainable Development Goals. The target comprises two sub targets to be achieved by 2030: a) −10% in food processing and manufacturing; b) −30% per capita in retail, restaurants, food services and households (EC, 2023). According to the Action Plan, specific measures will be adopted to put sustainability at the heart of the food distribution value chain. For instance, water reuse in agriculture has been encouraged through the Water Reuse Regulation in force since June 2023 and the Commission will deploy an Integrated Nutrient Management Plan, in order to encourage a more sustainable application of nutrients and to promote markets for recovered nutrients.

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7.2 Water and sanitation services in the EU

Maria Salvetti

Water and sanitation services (WSS) are essential services.[320] They support the sustainable development of our societies and are key to achieve the ambition of the EU Green Deal and the UN Sustainable Development Goals. In this section, we provide an overview of WSS governance and management in the European Union (EU). We then describe the regulatory arrangements for WSS in Europe as well as aspects of tariff setting. We briefly recap the WSS-related EU legislation and the expenditure needs associated with compliance. Finally, we connect WSS and the Green Deal ambition.

7.2.1 Overview of WSS governance and management across the EU

This subsection provides an overview of governance and management of water and sanitation services in the EU.

Water services are defined in Article 2(38) of the Water Framework Directive (WFD)[321] as "*all services which provide for households, public institutions or any economic activity: (a) abstraction, impoundment, storage, treatment and distribution of surface water or groundwater, (b) waste-water collection and treatment facilities which subsequently discharge into surface water*" (EP and the Council, 2000).

However, the governance and management of water and sanitation services are subject to subsidiarity (Protocol 26 to the Treaty on the Functioning of the European Union), and it is a competence of Member States. EU institutions remain neutral in this regard. Thus, a great diversity of governance and management arrangements can be observed among EU Member States (MSs).

7.2.1.1 Governance of water and sanitation services

In the EU, the responsibility and competence for WSS provision are decentralised at local or sub-national levels. This generates, in some countries, an important fragmentation of the WSS market (France, Spain, Austria) while others conducted specific reforms to concentrate the WSS market by aggregating utilities at inter-municipal or regional level (Scotland, Portugal, Hungary) (see Figure 7.4).

320 The importance of lifeline services such as water and energy is the focus of many resolutions and declarations at the highest institutional level, including the current Sustainable Development Goals (with SDG 6 dedicated to water). In 2010, the United Nations General Assembly explicitly recognized "the right to safe and clean drinking water and sanitation as a human right that is essential for the full enjoyment of life and all human rights" (United Nations General Assembly, 2010). In 2016, a High-Level Panel on Water convened by the United Nations and the World Bank recognised in its first headline recommendation "access to safe drinking water and sanitation services as a fundamental human right" (United Nations and World Bank, 2018).

321 The Water Framework Directive 2000/60/EC is an EU directive which commits European Union Member States to achieve good qualitative and quantitative status of all water bodies. It establishes a common framework for an overall EU water-related policy.

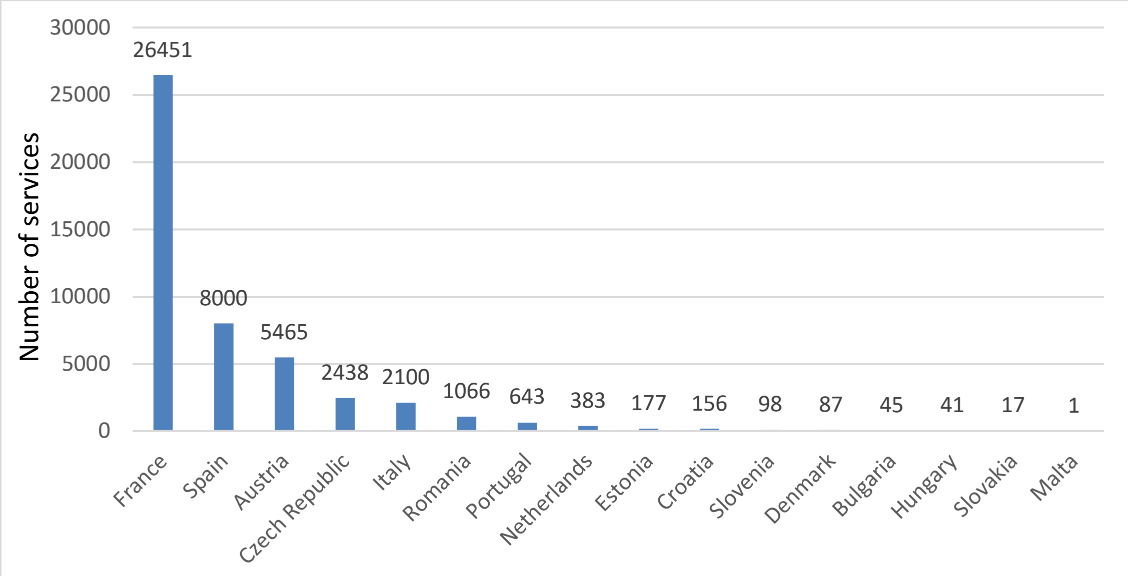

Figure 7.4: Number of WSS operators in some EU Member States (source: own illustration, 2024)

7.2.1.2 Management of water and sanitation services

As stated by the EurEau, as a way of simplification, four management models can be distinguished across Europe (Table 7.1).

Management Model	Description
Direct public management	The responsible public authority is entirely in charge of service provision and management.
Delegated public management	A public operator is appointed by the responsible public authority to execute the management tasks. Public operators may sometimes include a minor private shareholding.
Delegated private management	The responsible public authority appoints a private operator to manage the service on the basis of a time-bound lease or concession contract. The ownership of WSS infrastructure remains in the hands of public authorities.
Direct private management	All management tasks, responsibilities and ownership of WSS assets are placed in the hands of private operators, while public entities limit their activities to control and regulation. This system is in place in England, Wales, and the Czech Republic to some extent.

Table 7.1: WSS management models (source: EurEau, 2020)

In a large majority of European countries, the first three above-mentioned management models co-exist, while the ownership of WSS infrastructure remains public.

7.2.2 Economic regulation models and tariff setting for WSS in the EU

This subsection describes the regulatory arrangements for WSS in Europe as well as aspects of tariff setting.

7.2.2.1 WSS regulation models

Water and sanitation are essential local public services and as such, they are subject to economic, environmental and health regulations. In most countries health regulation falls under the prerogatives of the Health Ministry or Agency, while environmental standards are generally defined by the Environment Ministry or Agency.

Regarding economic regulation, a variety of regulatory arrangements can be observed across European countries. While some countries have established national or subnational regulatory authorities (either multi-sector or WSS sector only), others resort to contractual regulation and/or self-regulation (Table 7.2).

Country	Regulatory Model
Austria	Self-regulation
Bulgaria	Regulatory agency
Croatia	Regulatory agency
Czech Republic	Self-regulation; Contractual regulation
Denmark	Self-regulation
France	Self-regulation; Contractual regulation
Hungary	Regulatory agency
Germany	Self-regulation; Contractual regulation
Italy	Regulatory agency; Self-regulation
Ireland	Regulatory agency
Malta	Regulatory agency
Netherlands	Self-regulation
Portugal	Regulatory agency
Romania	Regulatory agency; Self-regulation
Slovakia	Regulatory agency
Slovenia	Self-regulation; Contractual regulation
Spain	Self-regulation; Contractual regulation

Table 7.2: WSS regulatory models in some EU Member States (source: own illustration, 2023)

7.2.2.2 Tariff regulation

When they exist, regulatory agencies resort to different tariff setting methodologies. Cost plus and rate of return are more commonly used by WSS regulators across EU Member States than price and revenue cap tariff setting methods (WAREG, 2019) (Table 7.3).

	Cost Plus	Rate of Return	Price Cap	Revenue Cap	Other
EU Member States	4	4	4	2	3

Table 7.3: Tariff setting methodologies used by WSS regulators in the EU (source: WAREG, 2019)

However, regardless of the economic regulation arrangement in place in EU Member States, WSS tariffs across the EU must comply with the cost recovery principle as well as the polluter-pays principle as stated in Article 9 of the WFD:

"Member States shall take account of the principle of recovery of the costs of water services, including environmental and resource costs […], and in accordance in particular with the polluter pays principle.

Member States shall ensure by 2010

- *that water-pricing policies provide adequate incentives for users to use water resources efficiently, and thereby contribute to the environmental objectives of this Directive,*

- *an adequate contribution of the different water uses, disaggregated into at least industry, households and agriculture, to the recovery of the costs of water services […] and taking account of the polluter pays principle."*

Tariffs should thus target full cost recovery, including resource and environmental costs (see Figure 7.5). Environmental costs are defined as the market and non-market value of damage inflicted by the different water uses on the environment and ecosystems, and indirectly on those using them. Resource costs are defined as the value of the opportunity lost because one use of available water resources was preferred over another, in cases where the resource is limited. This is the difference in benefit value between the option producing the highest benefit value and the selected option (Salvetti, 2013).

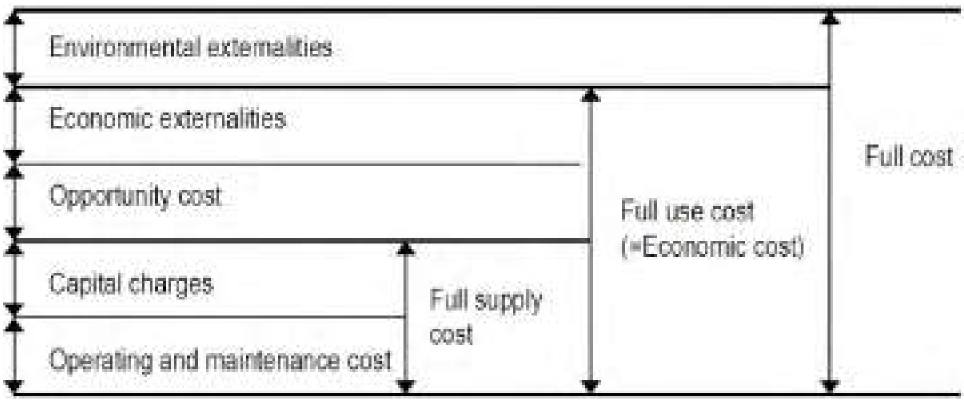

Figure 7.5: Definition of full cost (source: Salvetti, 2013)

Note: in the figure, resource costs and environmental costs are both included into environmental externalities.

7.2.3 Water-related legislation in the EU

This subsection briefly recaps the water-related EU legislation and the expenditure needs associated with compliance.

There are several pieces of water-related legislation in place in the EU, with the Water Framework Directive (WFD) being the overarching and most important piece. Its main objective is to protect and improve the quality of Europe's freshwater resources, including rivers, lakes, groundwater and transitional waters (e.g. estuaries and coastal waters). The WFD was adopted in 2000 and has been in force since 2003. It requires that EU Member States reach ambitious environmental objectives for all water bodies in all the major river basins (river-basin districts as per the WFD).

The directive set four essential objectives:

- no further deterioration of water resources;
- reaching good status or good potential of water bodies by 2015;
- reducing or eliminating pollution by priority substances;
- complete compliance with all standards in protected zones by 2015.

To reach these objectives in each river basin district, it is necessary to characterise the pressures and impacts affecting water resources, to conduct economic analysis of water uses (Article 5), to draft a river basin management plan (Article 13) and set up a programme of measures (Article 11). In addition, participation of the public is mandatory (Article 14) (see Figure 7.6).

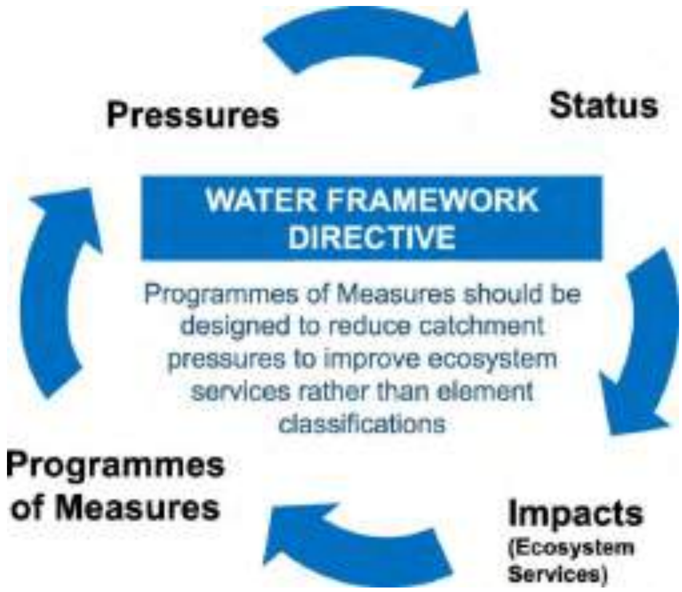

Figure 7.6: The WFD cycle (source: Giakoumis and Voulvoulis, 2019)

The WFD introduces a river basin management approach for water management, as water management decisions are made at the river basin level rather than on a local or national level. River basin management plans are developed for each river basin district, which cover all aspects of water management, including water quality, quantity and ecology. To achieve good ecological status, water bodies meet specific biological, physical and chemical criteria. The biological criteria include the presence and abundance of aquatic flora and fauna, such as macroinvertebrates and fish, as well as the diversity of these species. The physical criteria refer to the structure and function of the aquatic ecosystem, including the condition of the riverbanks, the flow regime, and the connectivity of different habitats. The chemical criteria refer to the level of pollutants in the water, such as nutrients, organic matter and hazardous substances.

Economic analysis plays a major role in WFD implementation. It serves as a decision-aid tool throughout the planning process because it can be used to:

- assess and contrast the economic value of water uses and the related issues;
- estimate the degree of cost recovery and the incentive value of price levels;
- determine the most cost-effective combinations of measures to achieve WFD environmental objectives;
- justify exemptions for deadlines and/or objectives on the basis of disproportionate cost.

The WFD is supported by more targeted directives, i.e. the Groundwater Directive, the Drinking Water Directive (DWD), the Bathing Water Directive, the Nitrates Directive, the Urban Waste Water Treatment Directive (UWWTD), the Environmental Quality Standards Directive, the Marine Strategy Framework Directive (MSFD) and the Floods Directive (Water protection and management, 2023) (see Figure 7.7). All these key water-related EU laws were adopted before the EU Green Deal.

Figure 7.7: Water-related EU legislation (source: Water protection and management, 2023)

The Groundwater Directive aims at protecting groundwater quality and preventing its deterioration to ensure that the quality of groundwater is suitable for human consumption, and for the protection of ecosystems and associated surface waters.

The DWD sets out minimum standards for the quality of drinking water in the EU. It requires Member States to regularly monitor the quality of their drinking water and take action to ensure that it meets the required standards.

The UWWTD sets out rules for the collection, treatment, and discharge of urban wastewater. It aims to protect water resources and human health by ensuring that wastewater is treated before it is discharged into the environment.

The Nitrates Directive aims to protect water quality by reducing the pollution of surface and groundwater from agricultural sources. It sets out rules for the application of fertilizers and the management of livestock manure.

The Bathing Water Directive aims to protect the health of people who swim in natural bathing waters such as lakes, rivers and the sea. To meet the requirements of the directive, Member States must carry out regular monitoring of bathing waters during the bathing season. If water quality falls below the minimum standards, Member States must take action to identify and address the sources of pollution. This may involve improving sewage treatment or reducing pollution from agricultural or industrial activities.

The Floods Directive aims to reduce the risks and consequences of floods by improving flood risk management across the EU. It requires Member States to carry out flood risk assessments and develop flood risk management plans.

The MSFD sets out a framework for the protection and sustainable use of Europe's marine waters. It aims to achieve ‘good environmental status’ of marine waters by 2020 and sets out measures for achieving this goal.

Although financial requirements for water supply and sanitation services to comply with water-related EU legislation can vary considerably across EU Member States depending on specific contexts, significant investments in water infrastructure, technology and human resources are needed.

In a study, the OECD assessed the financial needs to achieve compliance with DWD and UWWTD, to improve efficiency and reduce leakage rate while implementing business as usual (BAU) total expenditure for water (WS) and wastewater (WW) (see Figure 7.8). The aggregated figure for EU 28 shows a financial need of €289 billion over a decade. Sanitation requirements represent the most important of expenditure needs. This is particularly true for Italy, Spain and Romania, and to a lesser extent for Bulgaria, Croatia, Portugal and Slovakia.

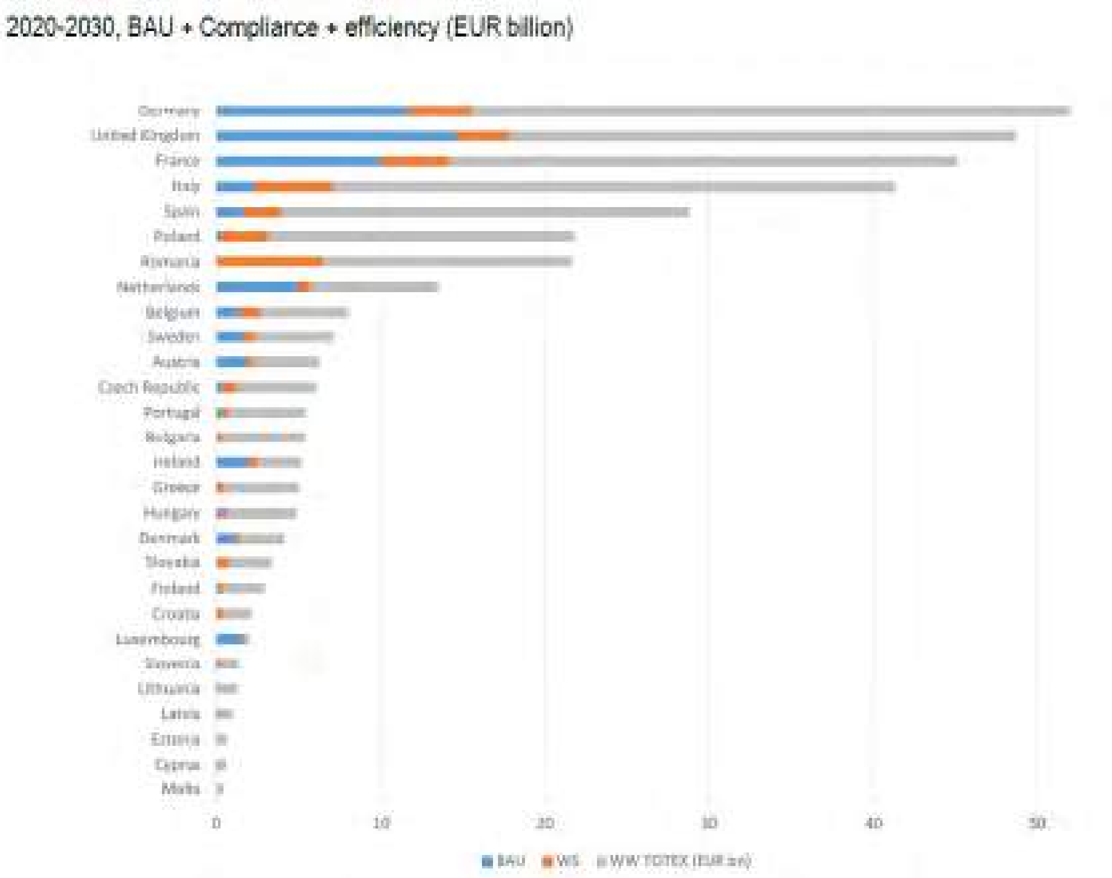

Figure 7.8: Total cumulative additional expenditures by 2030 for water supply and sanitation (source: OECD, 2020)

Another way to look at the required efforts for compliance is to compare the additional expenditure with the current spending in each EU Member State. According to the OECD, all countries (but Germany) will need to increase annual expenditures for water supply and sanitation by more than 25% (see Figure 7.9). At the higher end, Romania and Bulgaria need to double (or more) the current level of expenditures. Finland is projected to increase expenditures by 85% (however this significant increase may reflect the fact that the current level of expenditures in Finland is probably underestimated as stated by the OECD study). At the lower end of the spectrum, Cyprus, the Czech Republic, France, Germany, the Netherlands and Slovenia are projected to face comparatively minor needs for increase (by less than 1/3). This is likely to reflect different situations, including high levels of expenditures and good anticipation of future needs, significant catch up in recent decades (Czech Republic), or underestimation of future needs, possibly driven by overreliance on sanitation or other appropriate systems (Slovenia).

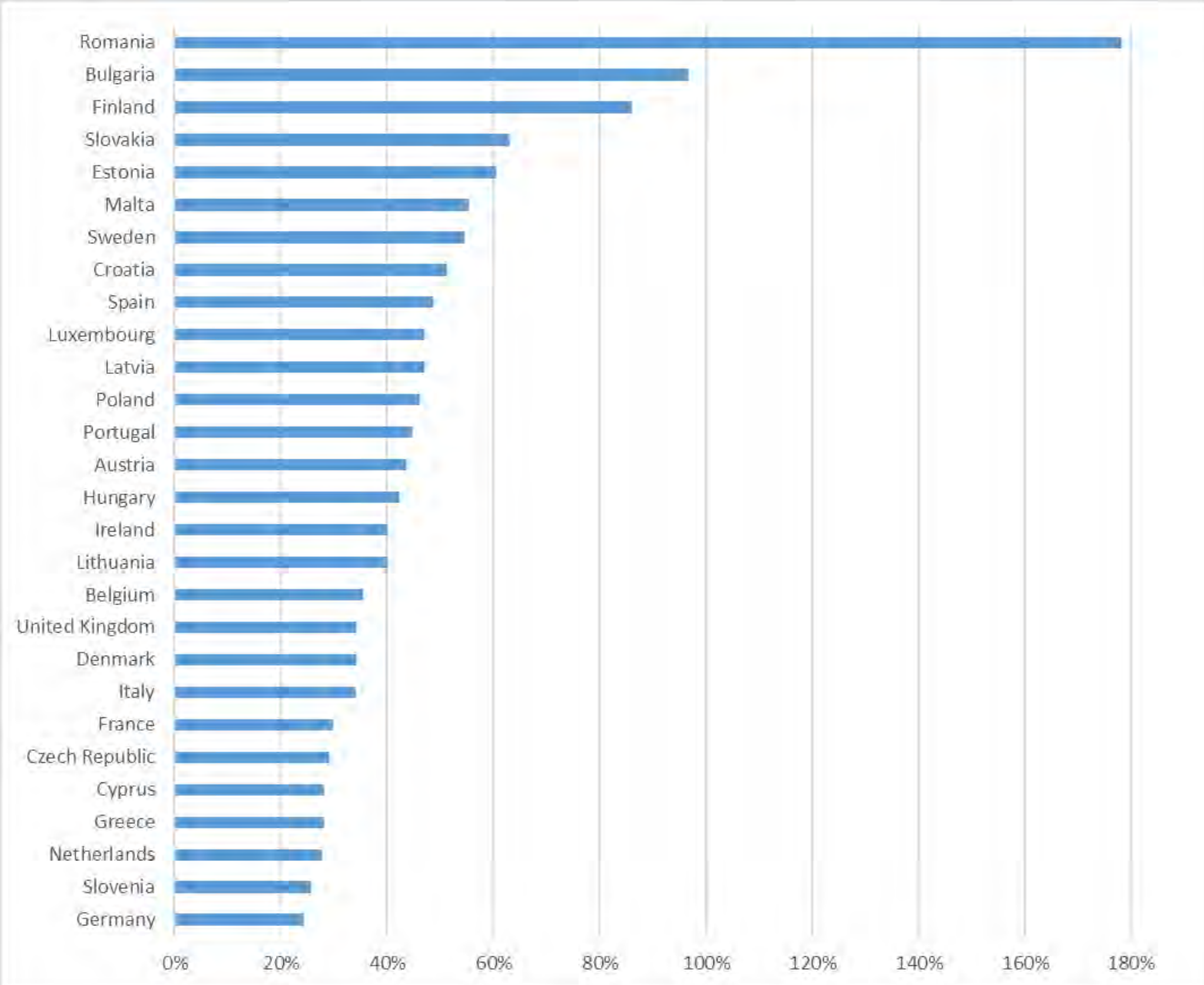

Figure 7.9: Per annum additional expenditures by 2030 for water supply and sanitation (source: OECD, 2020)

7.2.4 WSS and the Green Deal

This subsection connects WSS with the Green Deal ambition.

As stated by the OECD, "*water security in many regions will continue to deteriorate due to increasing water demand, water stress and water pollution*" (OECD, 2013). Indeed, water supply and sanitation utilities in many countries are already and increasingly faced with pressing water risks which include the risk of "*water shortages (including droughts), water excess (including floods), inadequate water quality, as well as the risk of undermining the resilience of freshwater systems (rivers, lakes, aquifers)*" (OECD, 2013). These risks are exacerbated by climate change which increases the magnitude and frequency of extreme events. These developments, as well as the financial constraints on the services (limited capacity to increase the price of water in an inflationary context and strong constraints on post-covid public finances) are all elements that encourage operators to rejuvenate their economic and operating model in order to ensure the sustainability and resilience of the services in an environment now marked by threatened water security.

This rejuvenated model, aligned with the EU Green Deal, targets carbon neutrality and resource efficiency while aiming to generate additional revenues decorrelated from water volumes sold, and to foster improved operational efficiency to ensure sustainability of service quality and asset management.

This rejuvenated model is currently articulated around three main axes (see Figure 7.10):

- Prosumption of renewable and decarbonised energy;
- Promotion of green investment and ecosystem services over grey investment whenever possible;
- Implementation of circular economy practices in the water supply and sanitation sector.

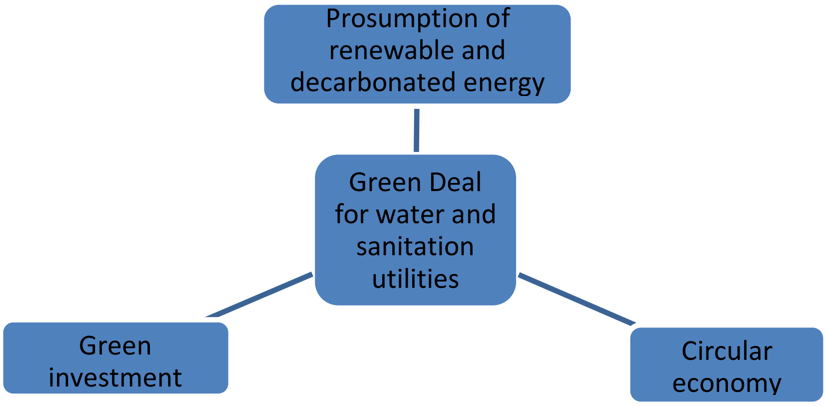

Figure 7.10: Green Deal model for WSS utilities (source: own illustration, 2024)

Prosumption[322] of renewable and decarbonised energy relates to entities (natural or legal persons, public or private) that consume and produce these renewable energies and/or offer energy services to the centralized system, such as flexibility or storage. Prosumption can both generate new revenues for the prosumers and/or help reduce the purchase of energy from external suppliers. The adoption of prosumption activities will help achieving carbon neutrality while promoting clean, affordable and secure energy supply, as required by the EU Green Deal. Concrete examples of prosumption application to water and sanitation utilities include, for instance, heat recovery from wastewater, electricity generation by turbines using the energy of a dissipation valve, and solar/wind power generation.

Green investments are designed and managed to deliver a wide range of ecosystem services including, for instance, water purification. For example, after a pilot project relying on the self-purification capacities of a wetland located along the Ingol river, Anglian Water has decided to build 29 other sites of the same type.[323] In most cases, green investments are more cost-effective solutions than conventional 'grey' investments and require less CAPEX and OPEX. The development of green investments will help achieving the EU Green Deal objective of ecosystems and biodiversity preservation and restoration.

Many types of circular economy practices can be developed by WSS utilities to generate new sources of revenues and/or increase operational economic efficiency. These practices include, for instance, treated wastewater reuse, or biogas and/or biomethane production, as indicated in the provisional agreement on the UWWTD revision, reached by the Council and the

322 To know more: https://www.eea.europa.eu/publications/the-role-of-prosumers-of, European Environment Agency, 2022.

323 To know more: https://www.anglianwater.co.uk/environment/river-health/river-biodiversity/wetlands/.

European Parliament (the latter adopted it in April 2024 (EP, 2024), while formal adoption by the Council is pending). The adoption of such practices will help achieving the EU Green Deal objectives of clean and circular economy, clean, affordable and secure energy supply, and climate neutrality.

This rejuvenated Green Deal model for service delivery seeks to reach financial sustainability through a mix including the traditional 3Ts[324] (OECD, 2009), and additional revenue sources decorrelated from volumes sold, as described above. Further complementary funding instruments are also explored. They include the willingness to pay from specific user categories, i.e., high-income households or companies/industries connected to the public network (as currently tested in Denmark); or the extended producer responsibility implementation to fund micropollutant treatment investment (as prescribed by the UWWTD revision orientations).[325]

324 The OECD defines the ultimate financial sources of investment as the 3 Ts: tariffs, taxes and transfers.

325 If you want to know more about water and sanitation utilities and the Green Deal, read the Technical Report “A Green Deal for water and sanitation utilities to rejuvenate the service delivery and financing model”, available at https://fsr.eui.eu/publications/?handle=1814/75439; you can also read ‘Economic Regulators’ Role in Supporting the Ecological Transition of Water and Sanitation Service Operators’, available at https://fsr.eui.eu/publications/?handle=1814/75106.

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7.3 Municipal waste management in the EU

Maria Salvetti

Municipal waste management is a significant issue in the European Union (EU) due to the quantities and the diverse composition of waste generated by households, commercial activities and public services. In this section, we provide a definition of municipal waste as well as an overview of the key targets deriving from EU waste legislation. We then describe the EU municipal waste governance, market structure and funding sources. We briefly recap the current levels of municipal waste generation and treatment in EU27. Finally, we look into the asset and financing needs required to meet the ambitious municipal waste management targets set by the EU.

7.3.1 Municipal waste management definition and legal context

In this subsection, we provide a definition of municipal waste as well as an overview of the EU legislative framework concerning waste.

Defined as waste from households and "*from other sources, such as retail, administration, education, health services, accommodation and food services, and other services and activities, which is similar in nature and composition*" (EP and the Council, 2018a), municipal solid waste (MSW) only represents about 10% of the total waste generated in the EU (Eurostat, 2020). Nevertheless, it is a highly political topic as local authorities are in charge of its collection and management, either directly or through an operator (public or private), and a financial sensitive issue as it requires large public investments. It is also a complex matter due to its dispersed generation (60% to 90% of total MSW comes from households, and the rest from commercial activities), to its diverse composition (which includes organic, plastic, metal, paper, glass, bulky items, batteries, exhaust oils/lubricants, light bulbs, etc.), and to the link it has with consumption behaviours and trends (coupling of economic growth and waste generation). MSW management is also crucial due to its potential adverse effects on the environment and human health.

Within this context, the EU has adopted a set of laws, over the past two decades, aiming at reducing waste generation impacts by shifting MSW management from waste disposal to waste preparing for re-use and recycling, thus moving MSW management up in the 'waste hierarchy' (see Figure 7.11).[326]

Figure 7.11: Waste hierarchy (source: based on DG Environment, 2024)

Within this set of laws, four directives define specific and challenging targets for MSW collection and management. The Landfill Directive (LD), dated 1999, which aims at preventing

326 Article 4 of the Waste Framework Directive, or Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain directives (EP and the Council, 2008).

or reducing as far as possible negative effects of waste landfilling on the environment and human health, forbids landfilling of separately collected waste by 2020 and limits to 10% the MSW generated that can be landfilled from 2035 onwards. The revised 2008 version of the Waste Framework Directive (WFD) "*lays down measures to protect the environment and human health by preventing or reducing the generation of waste*"[327] and its adverse impacts. For instance, it prescribes the separate collection of specific waste materials and sets ambitious targets for municipal waste recycling in an effort to boost the transition towards a circular economy. More recently, in 2019, the Single-Use Plastics Directive (SUP), which originates from the European Commission's Plastics Strategy and intends to reduce marine litter, sets separate collection targets for plastics. The previous year, the amended Packaging and Packaging Waste Directive (PPWD), which aims to prevent the generation of packaging waste and its environmental impact, promoted further recycling through recycling targets which vary depending on the packaging material. Still in 2018, the European Parliament and Council adopted the Circular Economy Package which was first proposed by the European Commission (EC) in 2015 (see also Section 7.1). The package consisted of various legislative measures and initiatives, and intended to accelerate and continue the transition towards a circular economy; thus, seeking to maximize the value of waste materials, to minimize materials and resources consumption, and prevent waste generation.

The targets for MSW management deriving from these various pieces of EU legislation are described in Table 7.4.

Targets	2020	2025	2030	2035	Legislation
Municipal waste recycling	50%	55%	60%	65%	WFD
Municipal waste landfilling	No landfilling of separately collected waste			Max. 10% of total waste generated	LD
Hazardous waste		Set up separate collection schemes*			WFD
Biowaste collection		Set up separate collection schemes**			WFD
Textile collection		Set up separate collection schemes			WFD
Plastic bottles collection		77%	90%***		SUP
All packaging recycling		65%	70%		PPWD

327 Article 1 of the Waste Framework Directive.

Plastic packaging recycling		50%	55%		PPWD
Wood packaging recycling		25%	30%		PPWD
Ferrous metals packaging recycling		70%	80%		PPWD
Aluminium packaging recycling		50%	60%		PPWD
Glass packaging recycling		70%	75%		PPWD
Paper and cardboard packaging recycling		75%	85%		PPWD

Table 7.4: MSW-related targets deriving from EU waste legislation (source: own illustration, 2023)

* Deadline is 2022; ** Deadline is 2023, *** Deadline is 2029.

In March 2020, the EC adopted the new circular economy action plan (CEAP) which is one of the main building blocks of the EU Green Deal, as the transition to a circular economy will reduce pressure on natural resources, will create sustainable growth and jobs, and represents a prerequisite to achieve the EU's 2050 climate neutrality target and to halt biodiversity loss (EC, 2020). The new CEAP focuses on the entire life cycle of products, and targets how products are designed, promotes circular economy processes, encourages sustainable consumption, and aims to ensure that waste is prevented (see also Section 7.1).

The new CEAP targets the following core objectives:

- Make sustainable products the norm in the EU;
- Empower consumers and public buyers;
- Focus on key product value chains (electronics, batteries and vehicles, packaging, plastics, textiles, water and nutrients; etc);
- Ensure less waste;
- Make circularity work for people, regions and cities;
- Lead global efforts on circular economy.

On 30 November 2022, the EC published the Circular Economy Package II. The main objective of the proposal is to ensure reusable packaging options for consumers and get rid of unnecessary packaging, and to provide clear labels to support correct recycling.

The new CEAP and the recent revisions of waste-related directives have laid down ambitious targets for MSW collection and recycling that will require massive investments in MSW management infrastructure, technologies, capacities and processes. An increase in both complexity and costs for consumers and local authorities is thus expected, at least in the medium term, during the transitional period from a linear to a circular economy. This scenario may induce important structural changes in the organization and governance of MSW management to face higher investment and operation costs while providing high level quality services. Taking stock of this context, the following subsections seek to provide some key information on the municipal waste sector in terms of institutional setting, market characteristics, funding arrangements and current situation against MSW EU targets, highlighting recent waste generation and treatment trends. It then looks at the future capital and operational expenditure required to reach MSW EU targets and the associated financing options.

7.3.2 Municipal waste collection and treatment state of play

In this subsection, we describe the EU municipal waste governance, market structure and funding sources. We briefly recap the current levels of municipal waste generation and treatment in EU27.

The waste sector in Europe, although very different from one country to another, tends to share common features in terms of market fragmentation and low level of cost recovery. This situation raises concerns, especially in view of the current status of EU countries with regard to MSW targets.

7.3.2.1 Three or four-tiered governance systems in the municipal waste sector

Despite a wide diversity of institutional settings across Europe, most countries tend to have a three-tiered or four-tiered governance system in their waste sector. Indeed, although municipal waste services are local public services, the sector involves many multi-level stakeholders. At supra-national level, the EU adopts directives and strategies which set binding legal objectives for Member States. It also provides grants for investments through a variety of funding schemes. Several European financial institutions (e.g. European Investment Bank, European Bank for Reconstruction and Development) also provide some funding for municipal waste projects in EU Member States. At national level, a line ministry[328] and/or a national agency or board is in charge of policy planning, enforcement and sometimes financing. This line entity consults with other relevant national institutions, i.e. ministries of economy, health, agriculture, environment, etc. In federal countries, regional level administration is often in charge of those functions, either through a regional line ministry or a regional agency. It should however be noted that even in unitarian systems, regional authorities also tend to have an important role in waste management policy, planning and financing. At local level, municipalities or inter-municipal bodies are responsible for service provision to users either (a) through municipal departments, (b) through municipally owned waste management companies or (c) by outsourcing to (usually private) providers through procurement. In some countries, regulatory agencies have been set up to oversee waste services tariffs and quality (see Figure 7.12).

328 The term ‘line ministry’ designates a ministry which exercises delegated, sectoral powers (OECD, Public Governance Terms).

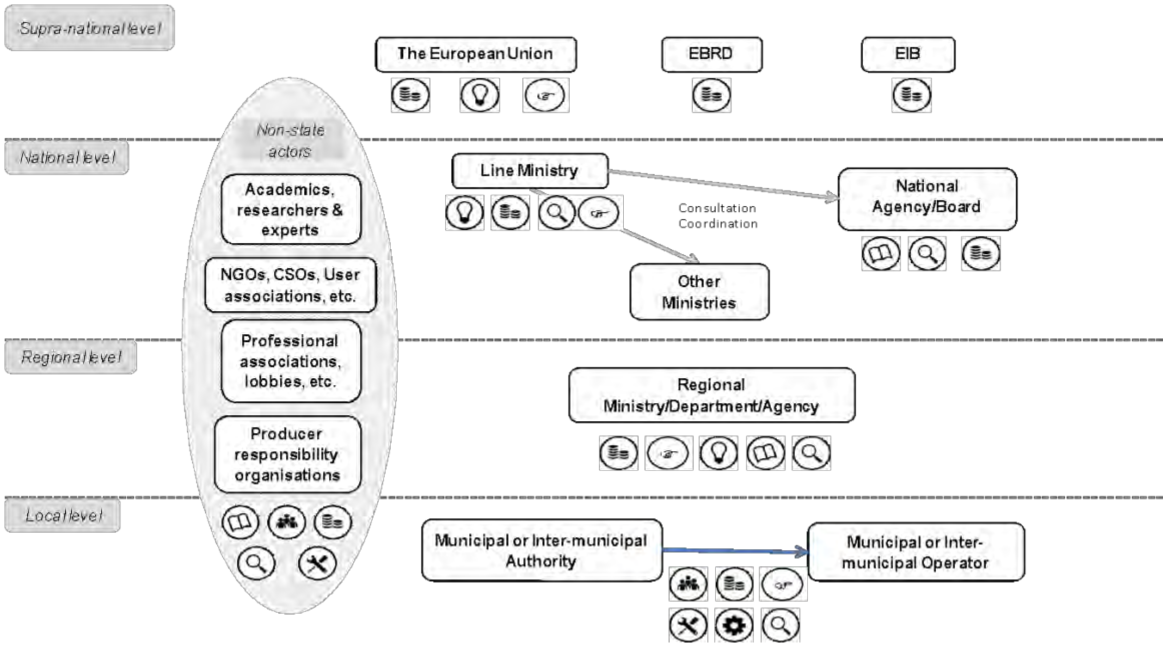

Figure 7.12: Generic mapping of institutional setting for municipal solid waste in Europe (source: based on the analytical framework developed by the OECD Water Governance Programme, OECD, 2015)

7.3.2.2 A fragmented, dynamic and small-sized market with a few big players

According to Eurostat data (2020), there are about 47,200 waste operators (public and private) in EU27, representing an annual turnover of €178 billion with waste collection accounting for 39% of this turnover, materials recovery 34%, and waste treatment and disposal 24% (see Figure 7.13). As such, the municipal waste market appears almost twice as much fragmented as the water and wastewater sector, which counts 26,800 operators across Europe (Eurostat, 2020).

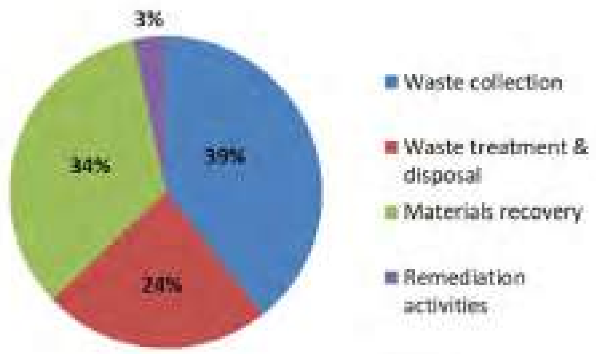

Figure 7.13: Composition of waste operators' turnover (source: Eurostat, 2019)

The municipal waste sector proves quite dynamic with a turnover increase of 16% from 2011 to 2020 compared to a 10% increase in the water and wastewater market over the same period (Eurostat, 2020). In the meantime, the number of municipal waste staff grew by 23% to reach approximately 1,000,000 employees in 2020 (see Figure 7.14), while the number of water and wastewater employees only increased by 15% to reach 498,000 staff (Eurostat, 2020). Waste collection appears as the most labour-intensive phase of waste management with 56% of total staff of the sector. Nevertheless, employment in the recycling phase is expected to grow steadily with the progressive shift to a circular economy.

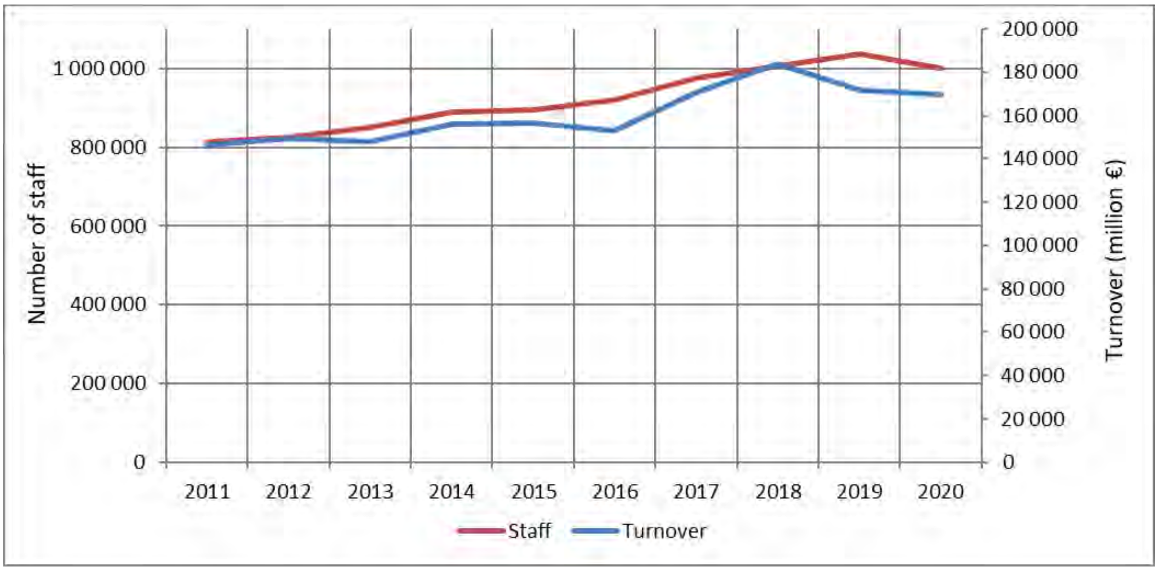

Figure 7.14: Evolution of staff and turnover of waste operators (2011-2019), (source: Eurostat, 2022)

Although the market structure varies from one country to another, thus reflecting different approaches at national, regional and local levels, the fragmentation of the waste market is more pronounced in the most populated European countries, where a higher number of operators is observed, with the exception of the Czech Republic (see Figure 7.15).

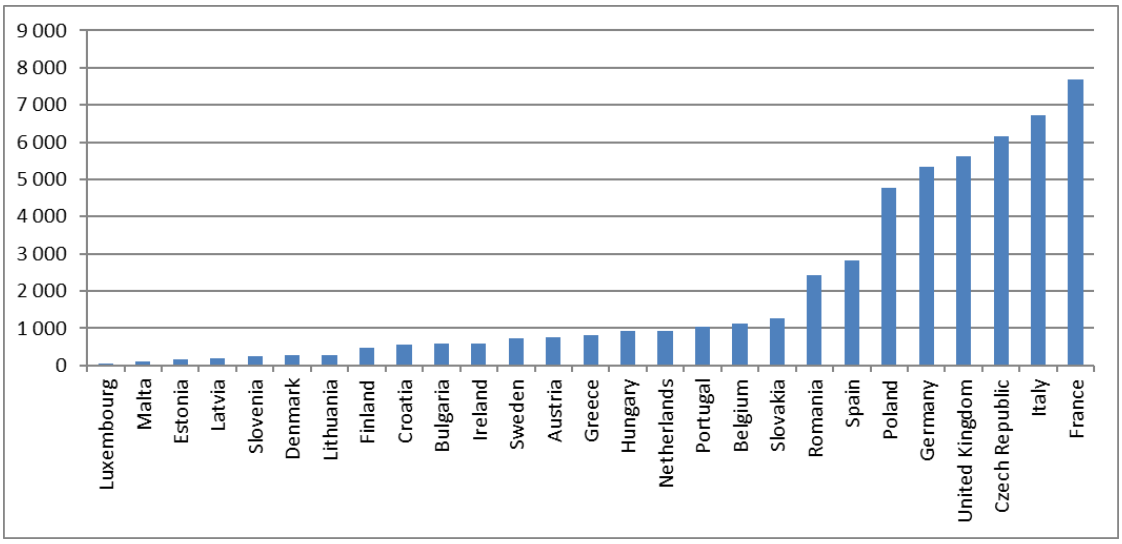

Figure 7.15: Number of waste operators per country (2019), (source: Eurostat, 2020)

Approximately three quarters of the waste operators are micro companies and 99.7% of them are Small and Medium Enterprises (SMEs)[329] (Dri et al., 2018), with the average number of staff per operator ranging from 6 in the Czech Republic to 65 in Germany. Nevertheless, in this

329 Micro-companies have less than 10 staff and SMEs have less than 250 employees.

small-sized market, a few large operators play a considerable role as the 16 biggest private companies account for 40% of the total revenue of the sector. Among them, five companies are international key players (Veolia, Suez, Remondis, FCC, Alba) (Dri et al., 2018).

7.3.2.3 Funding sources and cost recovery concerns

The graph below (see Figure 7.16) describes the various financing sources for MSW management. Funding can originate from charges paid by the users; from public funds (taxes) from national, regional and/or local budgets; from grants provided by the EU or European financial institutions. In addition, some funding can also derive from producers as part of an extended producer responsibility (EPR) scheme.[330]

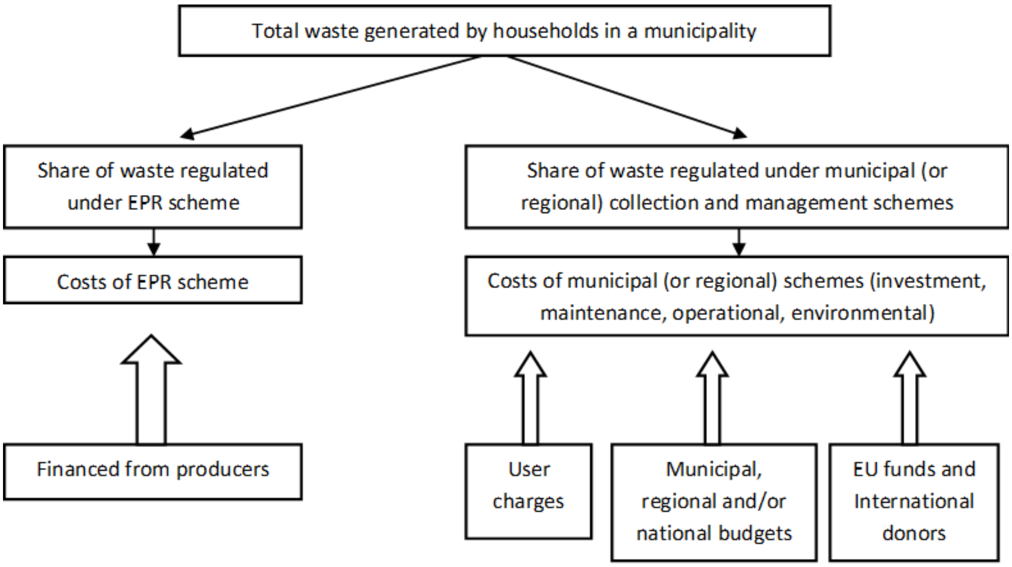

Figure 7.16: Financing sources for MSW management (source: EC, Eunomia, Cowi, 2019)

7.3.2.4 User Charge

Seventeen EU Member States have embedded into their legal framework the cost components that should be recovered through waste user charge (Table 7.5). While these costs always include maintenance costs (except for Latvia), only four countries have set up by law full cost recovery charge that include maintenance, operational, environmental and investment costs. Moreover, only five countries consider environmental costs as part of user charges, and four countries tend to finance investments through user charges. As a result, the cost recovery level through tariff varies widely from one country to another and so does the associated financial viability of waste services.

330 EPR is a policy tool seeking to internalize end-of-life costs into the products' price, thus incentivizing producers to lower the environmental adverse effects of their products.

Countries	Does legislation specify which cost should be included in user charges?	Which cost are to be considered?
Austria	Yes	Investment, Operational, Maintenance
Belgium (Flanders)	No	
Bulgaria	Yes	Operational, Maintenance
Cyprus	No	
Czech Republic	Yes	Operational, Maintenance
Denmark	Yes	Investment, Operational, Maintenance
Germany	No	
Estonia	Yes	Investment, Operational, Maintenance, Environmental
Spain	No	
Finland	Yes	Investment, Operational, Maintenance
France	Yes	Investment, Operational, Maintenance
Greece	Yes	Investment, Operational, Maintenance, Environmental
Hungary	Yes	Investment, Operational, Maintenance, Environmental
Croatia	Yes	Investment, Operational, Maintenance
Ireland	No	
Italy	Yes	Investment, Operational, Maintenance
Latvia	Yes	Operational, Maintenance, Environmental
Lithuania	Yes	Investment, Operational, Maintenance
Luxembourg	Yes	Investment, Operational, Maintenance
Malta	No	
Netherlands	N/A	N/A
Poland	No	
Romania	Yes	Investment, Operational, Maintenance
Slovenia	Yes	Investment, Operational, Maintenance, Environmental
Slovakia	No	
Sweden	Yes	Investment, Operational, Maintenance

Table 7.5: Cost components to be included in user charges according to national legislation (source: EC, Eunomia, Cowi, 2019)

Furthermore, there is a great variety of tariff-setting methods among Member States which illustrates the heterogeneity and complexity of systems used at regional and/or municipal levels throughout the EU. A large number of countries are computing user charges based on the weight of waste collected, on the size of the waste bin and/or on the frequency of collection (Table 7.6), thus trying to provide incentives to households to reduce their waste.

	Basis on which charges are formed:								
COUNTRIES	**weight of collected**	**waste size of bin**	**frequency of collection**	**per household**	**household size**	**(household) income**	**water or other utility bills**	**size of the property**	**property value**
Austria	X	X	X	X	X				
Belgium	X	X	X	X	X				
Bulgaria	X	X	X					X	X
Cyprus				X					
Czech Republic	X	X	X	X	X				
Denmark	X	X	X	X					
Germany	X	X	X	X	X		X		
Estonia	X	X	X	X	X				
Spain	X			X	X			X	
Finland		X	X	X	X				
France	X	X	X						X
Greece								X	
Hungary		X		X	X				
Croatia	X	X	X						
Ireland	X		X	X					
Italy	X	X			X			X	
Latvia		X	X	X	X				
Lithuania	X	X	X		X			X	
Luxembourg	X	X	X						
Malta						X			
Netherlands	X	X	X	X					
Poland					X		X	X	
Portugal							X		
Romania	X	X		X					
Slovenia	X	X	X						
Slovakia	X	X	X		X				
Sweden	X	X	X						
United Kingdom				X		X			X
	19	20	18	15	13	2	3	6	3

Table 7.6: Overview of user charge systems in EU Member States (source: EC, Eunomia, Cowi, 2019)

7.3.3 Public and European funding

There are currently no data available at EU and Member States level to quantify public funding that finances the municipal waste sector. Further research to document those financial flows should be conducted to provide policymakers with accurate information, evaluation and monitoring and strengthen the knowledge regarding the financial viability of the MSW sector. This would prove crucial especially in view of the upcoming investments required to reach EU MSW targets.

With regard to European funding, the EU has allocated €6.4 billion to MSW investments, from 2014 to 2018, through the EU Cohesion Fund (75.7%), European Funds for Strategic Investments (17.1%), Horizon 2020 (4.7%) and Life programme (2.5%) (EC, Eunomia, Cowi, 2019). This represents an annualized contribution of approximately €1.3 billion.

7.3.4 EPR Schemes

Extended producer responsibility (EPR) schemes are "*an environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle*" (OECD, 2016). An EPR scheme is characterized by an upward shift in responsibility (administratively, financially or physically) from governments or municipalities to producers as well as an encouragement of producers to take environmental considerations into account during the design and manufacture phases of product development. EPR seeks to achieve a reduction in the environmental impact of products, throughout their lifespan, from production through end-of-life.

In the EU, there are several mandatory EPR schemes that have been established to ensure that producers are responsible for the collection and disposal of their products. The Packaging and Packaging Waste Directive requires EU Member States to establish a mandatory EPR scheme for packaging waste. The Waste Electrical and Electronic Equipment (WEEE) Directive requires EU Member States to establish a mandatory EPR scheme for the collection and treatment of waste electrical and electronic equipment. The Batteries Directive requires EU Member States to establish a mandatory EPR scheme for the collection and recycling of batteries and accumulators. The End-of-Life Vehicles Directive requires EU Member States to establish a mandatory EPR scheme for the treatment and disposal of end-of-life vehicles. The EU Tyre Labelling Regulation requires that EU Member States establish an EPR scheme for the management of end-of-life tyres. Additional waste streams for which producer responsibility organisations have been most commonly identified within the EU include waste oil, paper and card, and construction and demolition waste. However, a much broader range of waste streams are subject to obligatory or voluntary producer responsibility systems in some EU Member States, including medicines and medical waste, photo-chemicals and chemicals, newspapers, refrigerants, pesticides and herbicides, lamps and light bulbs.

The level of cost recovery of EPR schemes varies a lot across schemes and across countries. At most, they recover all the net costs related to the management of separately collected waste. These net costs include the costs for collection and treatment, minus the revenues from the sales of recovered materials, and the administrative, reporting and communication costs related to the operation of collective schemes (EC, DG ENV, 2014). However, they hardly recover all the components of the full cost of the waste stream management, which includes:

- "*Collection, transport and treatment costs for non-separately collected waste (waste covered by EPR but not entering the separate collection channel, e.g. waste collected together with mixed municipal waste);*

- *Costs for public information and awareness raising (in addition to the Producer Responsibility Organisation's own communication initiatives), to ensure participation of consumers in the scheme (i.e. through separate collection);*

- *Costs related to waste prevention actions;*

- *Costs for litter prevention and management;*

- *Costs related to the enforcement and surveillance of the EPR system (including auditing, measures against free riders, etc.)*" (EC, DG ENV, 2014).

Thus, the cost recovery of EPR schemes will need to improve in order to (1) ensure that producers are responsible for the end-of-life stage of their products (which constitutes an implementation of the polluter-pays principle), and (2) reduce the amount of cross-subsidies needed from consumers to fill any gap (as costs not borne by producers are ultimately covered by users).

7.3.5 Municipal waste generation and treatment

According to Eurostat data, 513 kg of waste were generated on average by EU citizens in 2022, which represents a total amount of 229.5 million tons. Compared to 2004, this represents a 2.6% increase for the average waste generated by EU citizens and a 5.9% increase for the total amount of MSW. From 2004 to 2022, 12 EU countries managed to reduce their MSW per capita ratio, thus succeeding in decoupling economic growth and MSW production, while 15 others witnessed an increase and two remained stable (see Figure 7.17). The observed differences between countries mainly reflect different consumption patterns and economic wealth as wealthier countries tend to generate more MSW per person, while tourism contributes to high generation rates in Cyprus and Malta (European Environment Agency, 2016). Nevertheless, these data should be looked at with caution due to important discrepancies in definitions of municipal waste data collection methods across countries.

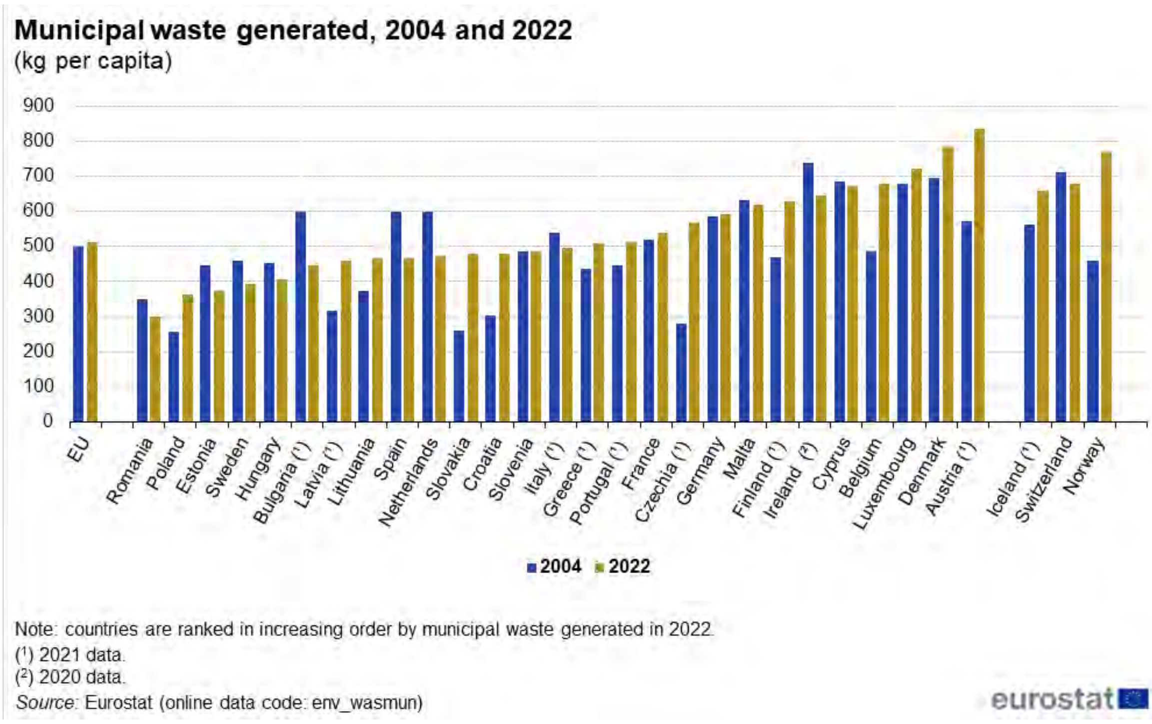

Figure 7.17: Municipal waste generated, 2004 and 2022 (kg per capita), (source: Eurostat, 2024)

In 2022, 30% of the MSW was recycled, 26% incinerated, 23% landfilled and 19% composted.[331] Although landfilling has steadily declined since 1995, dropping from 61% to 23%, it is still above the 2035 target of 10% in 19 EU Member States. Recycling and composting remain below 50% (MSW target for 2020) in 20 countries despite a continuous increase since 1995 from 19% to 49% (see Figure 7.18 and Figure 7.19). This situation shows that important efforts to comply with EU legislation still lie ahead for a large majority of Member States.

331 The remaining 2% are declared as “Other” in Eurostat and correspond to the difference between the amount of waste generated and the amount of waste treated. This difference arises in countries that have to estimate waste generation in areas not covered by a municipal waste collection scheme and thus report more waste generated than treated. In addition, the “Other” category reflects the effects of import and export, weight losses, double counting of secondary waste (e.g. landfilling and recycling of residues from incineration), differences due to time lags, temporary storage and, increasingly, the use of pre-treatment, such as mechanical biological treatment (MBT).

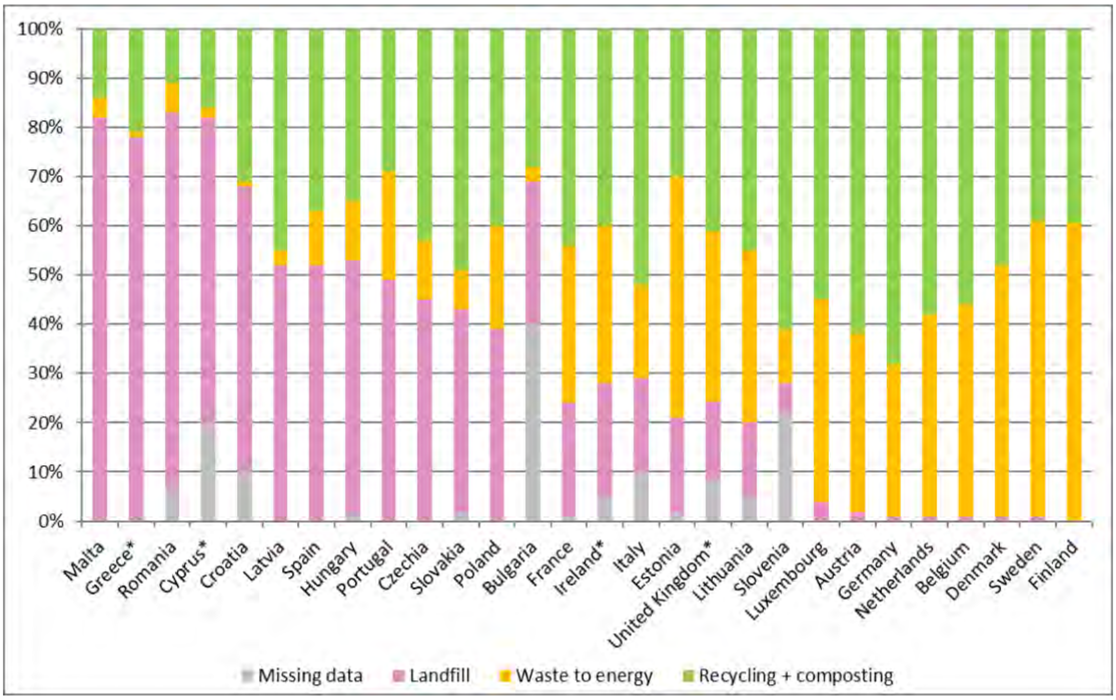

Figure 7.18: Municipal waste treatment in EU countries (2022), (source: Eurostat, 2024)

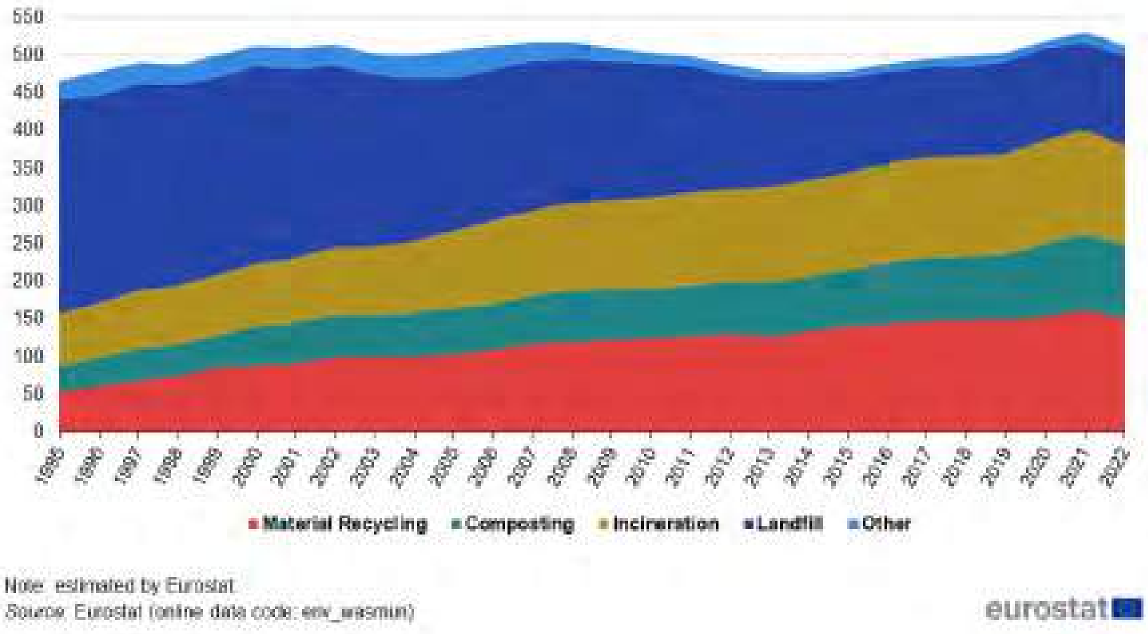

Figure 7.19: Evolution of municipal waste treatment from 1995 to 2022 in EU countries (source: Eurostat, 2024)

7.3.6 Asset and financial needs to meet EU requirements: bridging the gaps

This subsection looks into the asset and financing needs required to meet the ambitious municipal waste management targets set by the EU.

Important investments will be required to achieve the various MSW collection and recycling targets as described in Figure 7.20. In order to assess these efforts, the EC commissioned a study which uses a financial model to appraise the magnitude and nature of the upcoming capital and operational expenditure (CAPEX and OPEX) necessary to reach full compliance with EU requirements by 2035 (EC, Eunomia, Cowi, 2019).

7.3.6.1 Capital Expenditure

The financial model focuses on the required changes in waste management between 2020 and 2035 by assessing the investment needs for each EU Member State to reach the recycling target of 55% for 2025, 60% for 2030 and 65% for 2035. The model includes a limitation of 10% of municipal waste being landfilled by 2035. Requirements on separate collection for hazardous household waste (by 2022), biowaste (by 2023) and textiles (by 2025) are accounted for, and all packaging targets are considered met on time. The model assumes that all MSW targets for 2020 are met.

As a result of the modelling, it is estimated that the total investment costs from 2020 to 2035 to reach full compliance amount to €26.6 billion (€60/capita for EU 27), which represents an annual average capital expenditure of €1.8 billion. The major financial effort would be directed towards waste collection, representing 35% of the overall investment needs, followed by recycling and re-processors (34%), and biowaste (24%) (see Figure 7.20). Nevertheless, there is a wide diversity of situations among EU Member States, with France facing a maximum investment need of €5 billion representing €75/capita, while it would be 100 times lower in Malta in absolute terms but representing €107/capita (see Figure 7.21).

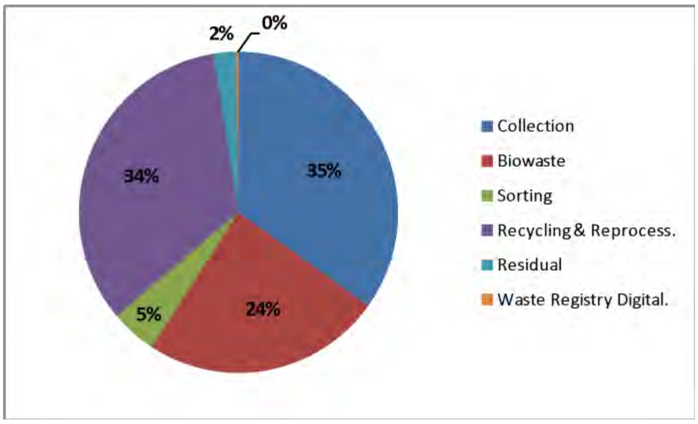

Figure 7.20: Composition of investment needs to reach MSW targets by 2035, (source: EC, Eunomia, Cowi, 2019)

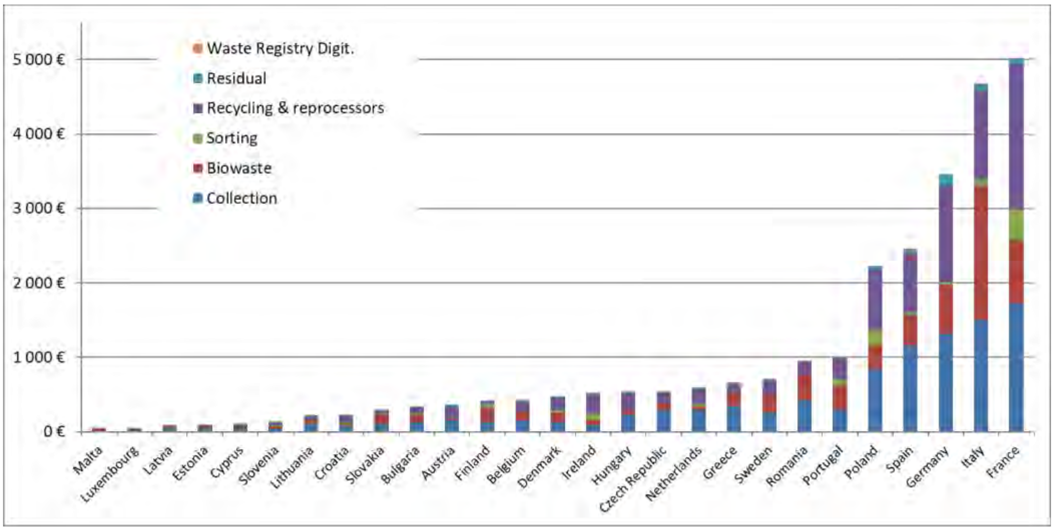

Figure 7.21: Investment needs per Member State to reach MSW EU targets by 2035 (million €), (source: EC, Eunomia, Cowi, 2019)

7.3.6.2 Operational Expenditure

In addition to the investment needs, the financial model was also used to quantify the projected OPEX associated with the new infrastructure. The operational costs accounted for include waste collection, sorting of dry recyclables, recycling revenues, biowaste treatment, and disposal. The graph below presents the expected evolution of MSW OPEX from 2014 to 2035 following the achievement of MSW EU targets (see Figure 7.22). The OPEX are expected to vary from -20% for Latvia to +270% for Malta, and are likely to trigger tariff increases in 19 countries at least to avoid further deterioration of the cost-recovery level and financial viability of waste services.

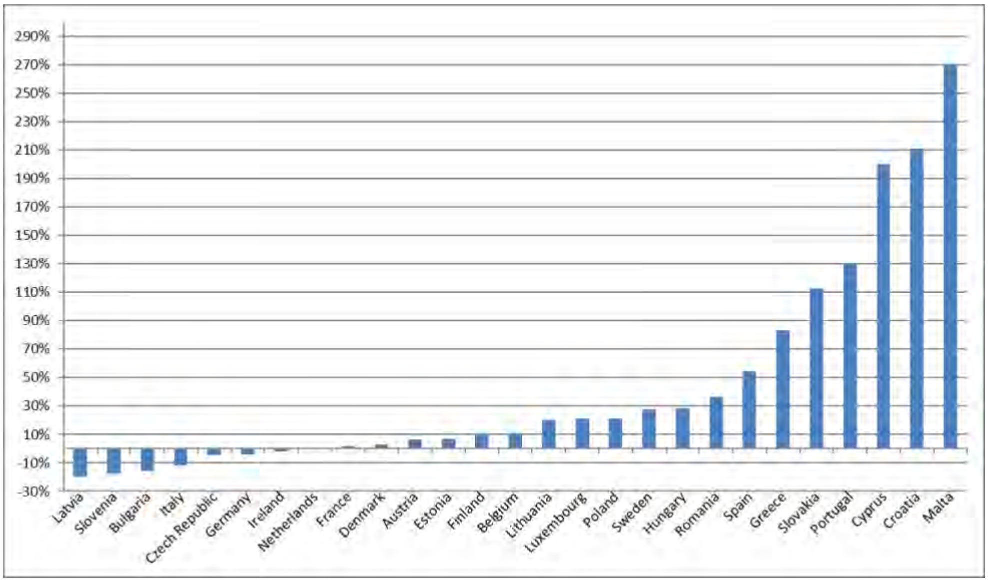

Figure 7.22: Evolution of MSW OPEX due to full EU requirements compliance (from 2014 to 2035), (source: EC, Eunomia, Cowi, 2019)

7.3.6.3 Financial options to bridge the gaps

Based on the legal provisions with regard to cost reflectivity in EU Member States, as previously described, the above-mentioned investment needs will most likely be funded through public funds for a large majority of European countries. When compared to the national GDP of each EU27 country, annual MSW CAPEX needs represent from 0.01% to 0.04%. When compared to annual public investments, annual MSW CAPEX needs account for 0.15% to 1.78% (see Figure 7.23).

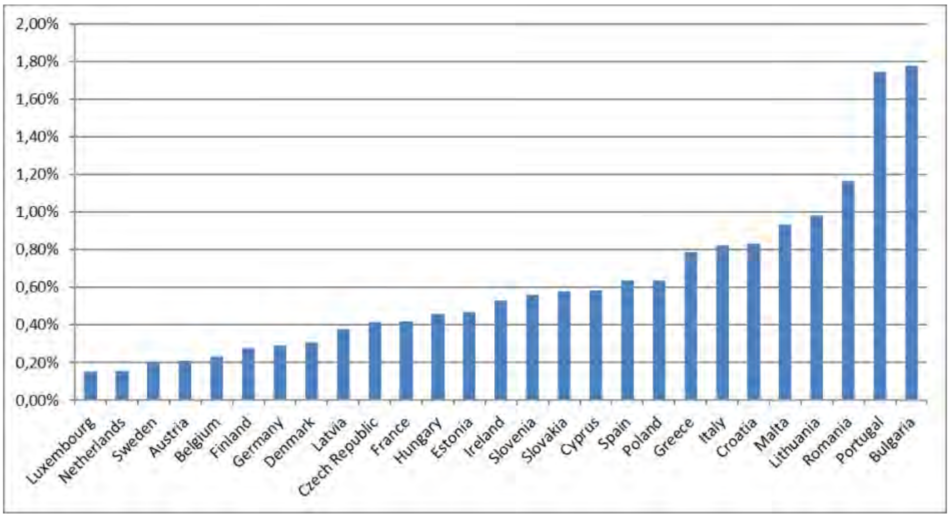

Figure 7.23: MSW annual CAPEX needs as share of annual public investments per Member State (2018), (source: Eurostat, 2019)

Although these proportions may not seem too burdensome (despite the likely underestimation of investment needs), the financial consequences of the covid-19 pandemic have strongly affected the fiscal capacity of European Member States for the coming years. Whereas EU countries had managed to recover from the 2008 financial crisis a decade later, they were forced to increase again their public spending to support and rescue their respective economies. As revenues have already increased by 56% over the last two decades, there may not be much room to increase further public revenues (see Figure 7.24). As a result, alternative financing options will have to be explored to reduce the MSW investment burden on public funding through a better cost-reflective tariff or a more stringent implementation of the polluter-pays principle, for instance. In addition, a more robust assessment of the financial effort required to reach full compliance with EU MSW targets will have to be conducted by comparing future investment needs with current trends. As data are currently sparse and patchy, this could be an interesting research area to explore in the future.

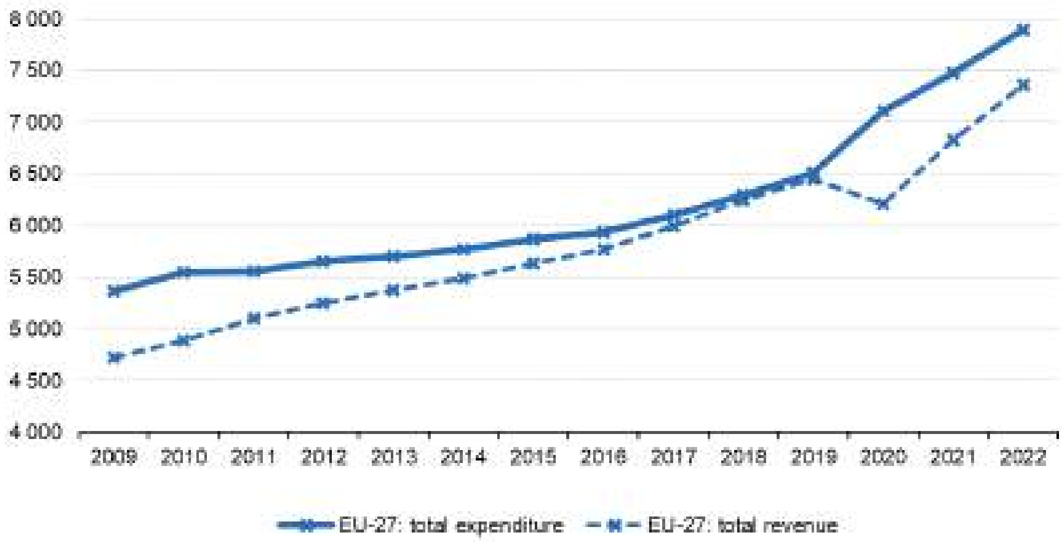

Figure 7.24: Evolution of total public expenditure and revenue, 2009–2022 (billion €), (source: Eurostat, 2023)

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7.4 Methane emissions in the energy sector: fossil methane

Maria Olczak and Andris Piebalgs

Methane is a short-lived but potent greenhouse gas (GHG) which causes ~25% of the anthropogenic warming experienced today; yet compared to carbon dioxide (CO_2) it has received relatively little attention. To meet the Paris Agreement objective of holding global temperature increases to 2-1.5°C by mid-century, methane emissions need to be reduced by 40-45% by 2030, with the major reductions expected in the energy sector, in particular with regard to the emissions associated with the extraction and use of fossil fuels – coal, oil and gas (UNEP and CCAC, 2021). In the EU context, reducing methane emissions will contribute to meeting both the 2030 GHG reduction target of 55% compared to 1990 levels and the European Green Deal objective to reach climate neutrality by 2050.

In this reading material, we explain what methane emissions are, why they matter and how they can be reduced. This part focuses on methane emissions associated with fossil fuels (fossil methane), while the next section will discuss methane emissions produced from biological sources, e.g. plant and animal, in agriculture and in the waste sector (biogenic methane). The biological origin of a significant part of methane emissions originated by human activities justifies the inclusion of this topic under the broad issue of circular economy that we address in this chapter.

This section is structured as follows. First, we provide the basic information on methane as a GHG and on major methane emission sources. We then discuss the mitigation potential and ongoing initiatives focusing on the reduction of emissions in the oil and gas industry. Finally, we assess initiatives to reduce methane emissions: globally (the Global Methane Pledge), in the EU (the EU Methane Regulation) and in other jurisdictions (US, Canada, Mexico, Norway and Russia).

7.4.1 What are methane emissions and why do they matter?

In this subsection and the next one, we provide the basic information on methane as a GHG and on the major methane emissions sources.

Methane is the second most important GHG after CO_2. Compared to CO_2, methane remains in the atmosphere for a shorter time (around 10-12 years), but it is a much more potent GHG, as it attracts more heat per unit of mass than CO_2.

One way to compare the environmental impacts of the two gases is to use their global warming potential (GWP) to measure the heat absorbed by 1 tonne of methane over a given period of time compared to 1 tonne of CO_2. Therefore, the GWP of CO_2 is always 1, while the GWP of methane is calculated as 82.5-80.8 in a 20-year perspective and 29.8-27.2 in a 100-year perspective (IPCC, 2022). Seeing the high heat-trapping potential of the gas, abatement of methane emissions would have an immediate effect on climate. Hence, reducing methane emissions now is important to keep the Paris Agreement 1.5°C target within reach, complementing other mitigation measures. An emissions decrease would also benefit air quality, as methane contributes to the formation of ground-level ozone, an air pollutant (CCAC, 2023).

The Global Methane Budget (see Figure 7.25) provides an estimate of atmospheric sources and sinks of methane in the period 2008-2017 (Saunois et al., 2020). While the net change is well understood (13 Mt), there is more uncertainty regarding individual sources, e.g. the oil and gas sector, and sinks.

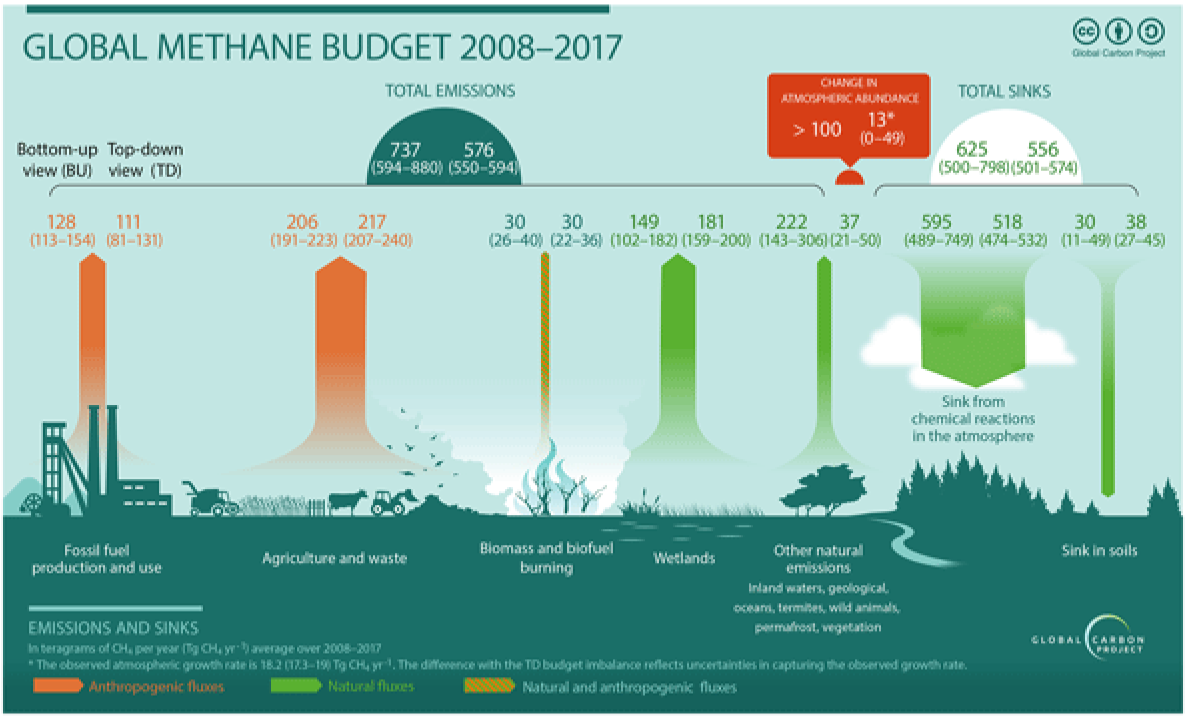

Figure 7.25: Global Methane Budget (source: Saunois et al., 2020)

The concentration of methane in the atmosphere is increasing and is approximately 2.6 times higher than pre-industrial levels (1750). It surpassed 1900 parts per billion (ppb) (~2 parts per million, ppm) in 2021 (see Figure 7.26), reaching 1933.46 ppb in 2023. The increase is most likely driven by emissions from agriculture and fossil fuel use.

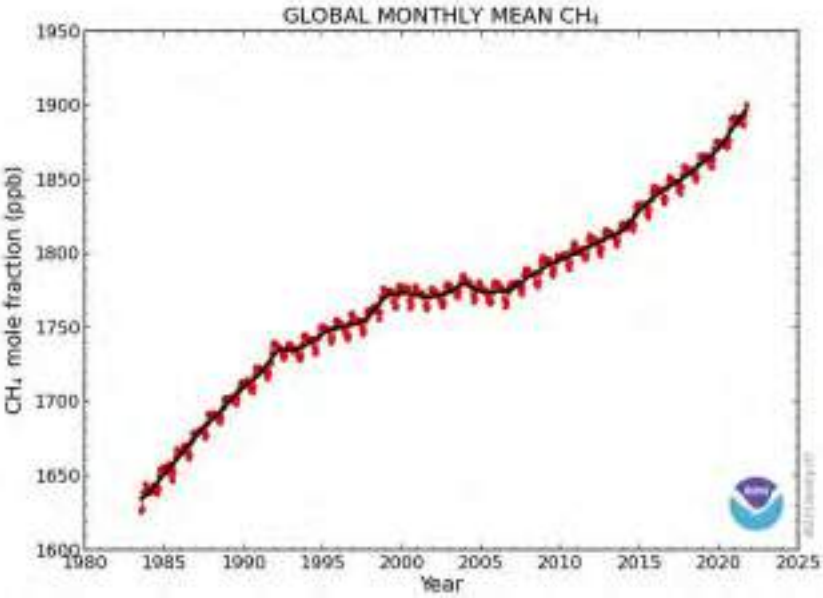

Figure 7.26: Trends in atmospheric methane (source: Ed Dlugokencky, NOAA/GML, 2024)

7.4.2 What are the main sources of methane emissions?

The Global Methane Budget shows that annual global methane emissions are around 737-576 million tonnes (Mt), the majority of which (nearly 60%) is the result of human activity (Saunois et al, 2020). These emissions originate mostly in the agriculture (40%), energy (35%) and waste sectors (20%) (UNEP and CCAC, 2021).

Agriculture is responsible for the largest amount of human activity-related emissions, both globally and at the EU level. Farm-related emissions primarily come from enteric fermentation (fermentation within the digestive systems of animals), manure management, rice cultivation and biomass burning. The energy sector follows closely. Methane is mainly emitted during the extraction, transport, distribution and use of fossil fuels (coal, oil, gas). Finally, in the waste sector, landfills (organic waste, landfill gas) and, to a lesser degree, wastewater treatment are the major sources of emissions.

Although a significant part of man-made methane emissions can be reduced with already existing technologies, Figure 7.27 below suggests that further technological innovation and other measures, e.g. dietary changes, will be necessary, e.g. to reduce emissions associated with enteric fermentation.

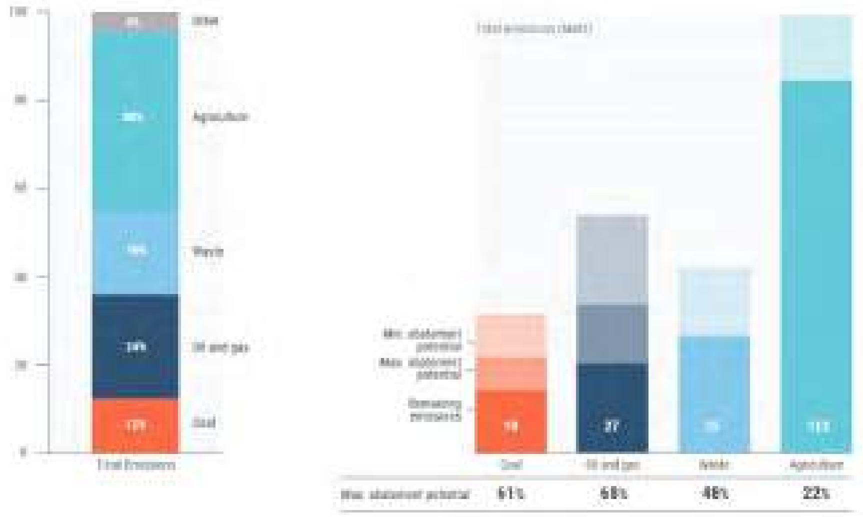

Figure 7.27: Anthropogenic methane emissions sources and reduction potential (source: IMEO Report, 2021)

7.4.3 What is the role of methane emissions in the oil and gas sector?

In this subsection and the next one, we discuss the mitigation potential and the ongoing initiatives focusing on the reduction of emissions in the oil and gas industry.

As mentioned above, energy-related methane emissions – although lower than those from agriculture – are considerable in size. The IEA estimated that methane emissions from the global energy sector increased to nearly 135 Mt in 2022, with the coal, oil and gas responsible for ca 40 Mt of emissions each and 5 Mt of leaks from end-use equipment, while roughly 10 Mt of emissions come from the incomplete combustion of bioenergy, largely from the traditional use of biomass (IEA, 2023).

There are three types of methane emissions from the oil and gas sector – fugitive, venting and flaring emissions – which pose different challenges in terms of measurement and abatement. Fugitive emissions are unintentional releases of methane, e.g. resulting from wear and tear in instruments. Since it is difficult to predict when and where they can happen, operators carry out regular inspections at their facilities to detect and fix leaks. Venting is an intentional release of methane, e.g. for safety reasons. In principle, we know when, where and how much is emitted but in some cases the equipment vents more than it is supposed to. In order to reduce venting emissions, operators can replace high-bleeding pneumatic devices with low-bleed pneumatic devices, install new devices such as vapour recovery units or flare the excess methane instead. In some cases (e.g. lack of offtake infrastructure) methane is combusted in flares and transformed into CO_2. But in many cases not all methane is burnt and some of it is released in a methane slip as unburnt gas.

The size of the phenomenon begs the question of what we can do about it. For one thing, a large part of fossil fuel emissions can be reduced cost-effectively with the use of existing abatement technologies (IEA, 2023). Moreover, unlike CO_2, methane has a commercial value in itself as it is the main component of natural gas so efforts to capture methane can be often monetised as is shown in Figure 7.28 (IEA, 2023).[332] In the decades to come – and even in strong decarbonisation scenarios, such as the IEA's Sustainable Development Scenario –

332 Globally, 78% of emissions is technically possible to abate, including 39% of emissions which could be avoided at no net cost: their deployment results in overall savings (IEA, 2023).

natural gas is expected to continue to play a significant role in the energy system as a 'transition fuel', especially in developing economies. This role that gas will play in the transition to a carbon-neutral energy system is heavily dependent on the industry's ability to reduce methane emissions.

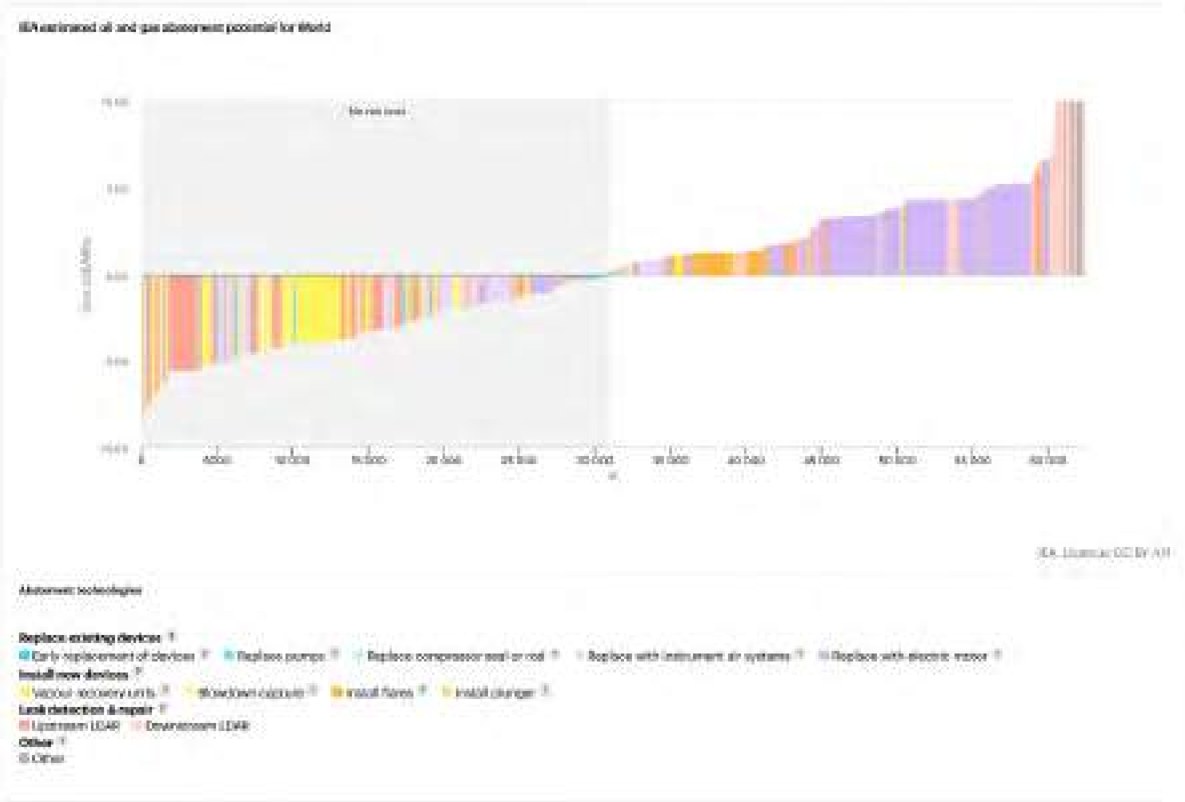

Figure 7.28: Marginal abatement cost curve for global oil- and gas-related methane emissions (source: IEA, 2023)

In fact, unabated methane emissions have the potential to question the environmental benefits of switching from oil and coal to natural gas, blue hydrogen or biomethane (Ocko et al., 2021).

7.4.4 What measures is the EU oil and gas sector taking to reduce methane emissions?

Currently, most actions to reduce methane emissions in the EU oil and gas sectors are voluntary. Here we cover four important industry initiatives.

First, a group of companies led by Gas Infrastructure Europe (GIE) and Marcogaz have compiled a report investigating potential ways in which the industry can contribute to reducing methane emissions (GIE and Marcogaz, 2019). This publication, constituting a first-of-a-kind summary of industry initiatives to tackle methane emissions, was presented and discussed at the Madrid Gas Regulatory Forum in 2019 (Madrid Gas Regulatory Forum, 2019).

Second, a group of companies are developing an Oil and Gas Methane Partnership (OGMP) 2.0 Reporting Framework (UNEP et al., 2020). The companies participating in this initiative will voluntarily annually report emissions from their facilities using a standardised methodology focused on emissions measurement. The aggregated data is made publicly available as a part of an International Methane Emissions Observatory (IMEO) Annual Report.

Third, the Methane Guiding Principles initiative is organising training to raise awareness on the issue of methane emissions among oil and gas companies, and is sharing best practices and advocating policies and regulations to address methane emissions (Methane Guiding Principles, 2023).

Fourth, there is the Oil and Gas Climate Initiative (OGCI) – the initiative led by the CEOs of the oil and gas major companies focusing on three areas: methane emissions mitigation, carbon intensity reduction and Carbon Capture Use and Storage (CCUS). The OGCI has set an upstream methane intensity target of 0.20% by 2025 compared to 2017 levels, which has become a benchmark of what is possible in terms of methane emissions reduction (OGCI, 2023).

7.4.5 What is the Global Methane Pledge?

In this subsection and the following two, we assess the initiatives to reduce methane emissions: globally (the Global Methane Pledge), in the EU (the EU Methane Regulation).

The Global Methane Pledge is a joint EU-US initiative with a collective aim to reduce man-made methane emissions by at least 30% compared to 2020 levels by 2030. The Pledge was launched at the COP26 climate negotiations in Glasgow in 2021. Over one hundred fifty countries supporting this initiative also committed to improve the methane quantification methodologies used in their inventories, especially from high emission sources. Together these countries account for over half of anthropogenic methane emissions world-wide.

Although the Pledge was important in focusing the political attention to the issue of methane emissions, its effectiveness is undermined by (1) the collective character of the pledge (no country-specific targets), (2) the absence of some of the major methane producing countries (China, India and Russia) and of a formal mechanism to track progress towards meeting the objective.

7.4.6 How is the EU going to reduce domestic emissions?

The 2020 EU methane strategy and the 2024 EU Methane Regulation are currently the most important elements in the EU policy framework on methane emissions. On 14 October 2020, i.e. 24 years after the publication of the first EU Methane strategy in 1996, the European Commission (2020b) presented an EU strategy to reduce methane emissions. The 1996 strategy helped to reduce methane emissions in the EU but fell short of meeting the methane reduction targets and improving methane monitoring and reporting (Olczak and Piebalgs, 2019a).

The 2020 strategy covers all sources of emissions – agriculture, waste and energy (including emissions related to biogas and biomethane production and use) – and sets an objective to reduce EU methane emissions by 35-37% compared to 2005 levels by 2030. The strategy combines cross-sector and sector-specific actions and sets a clear priority – robust methane emissions measurement and reporting – with roles for corporate reporting (based on voluntary initiatives such as the OGMP2.0), satellite observations (Copernicus Programme) and the establishment of an International Methane Emissions Observatory.

The strategy specifies actions targeting emissions from the agriculture and waste sectors, which currently account for 53% and 26% of all man-made methane emissions in the EU. The actions include: 1) better emissions measurement and quantification (i.e. analysis of life-cycle methane emissions metrics in agriculture and enhanced measurement, reporting and verification (MRV) in the waste sector), 2) mitigation (e.g. by providing Member States with assistance to tackle unlawful practices and technical assistance to address substandard landfills[333] and biodegradable waste treatment, and by reviewing the Landfill Directive in 2024); 3) research activities financed through the Horizon Europe 2021-2024 programme.

Another important factor is the external dimension of the strategy. As it is one of the major natural gas importers in the world, the EU has both responsibility and leverage to advocate for reducing energy-related methane emissions globally. According to some estimates, methane emissions from imported natural gas are 3-8 times higher than those within the EU borders (Carbon Limits, 2020). The strategy suggests the following actions: 1) creating an IMEO tasked with developing a Methane Supply Index (an index demonstrating the methane footprint of imported gas); 2) satellite data sharing on super-emitters (Olczak et al., 2020); 3) cooperation with energy buyers and suppliers (North America, China, South Korea, Japan); and 4) cooperation through multilateral fora and institutions such as the World Bank, the United Nations Environment Programme (UNEP), the International Energy Agency (IEA) and the Climate and Clean Air Coalition (CCAC).

On 15 December 2021 the European Commission presented a proposal for a regulation on methane emissions reduction in the energy sector as part of the hydrogen and gas decarbonisation package (EC, 2021). The final version of the regulation entered into force on 4 August 2024 (EC, 2024). The regulation covers emissions associated with the exploration, extraction, and transport of fossil fuels – oil, gas and coal – including LNG regasification terminals, storage, transmission and distribution, but excluding LNG shipping. As of the 1st of January 2026 these emissions (CO_2, methane and nitrous oxide) will be covered under the EU ETS system (Olczak et al. 2023). The regulation applies also to emissions from inactive wells and closed and abandoned coal mines and emissions associated with fossil fuels' imports.

The regulation introduces new requirements in terms of monitoring and mitigation of emissions (Olczak et al. 2024). First, it sets a measurement, reporting and verification (MRV) of emissions framework requiring direct emission measurements at source and site level in line with the existing OGMP2.0. It provides for abatement measures including regular leak detection and repair (LDAR) programmes. It also puts a ban on routine venting and flaring, except for specific situations (e.g. safety or malfunctioning).

Each Member State is required to nominate at least one Competent Authority (CA), which will be the main institutions responsible for the implementation of the regulation. CAs gather, assess and report to the Commission the reports submitted by the importers (art. 5 of the regulation), they can perform routine and non-routine inspections (art. 6), review complaints concerning the potential infringement of the regulation by an operator (art. 7) and impose financial penalties (or competent national courts at the request of the competent authorities) for incompliance with the regulation (art. 33).

7.4.6.1 How is the EU going to reduce imported emissions?

The regulation introduces three new obligations for EU importers (Articles 27-29), which will be phased in gradually from 2025 to 2030. The 'importer' is defined as: "*a natural or legal person who, in the course of a commercial activity, places crude oil, natural gas or coal originating from a third country on the Union market, including any natural or legal person established in the Union appointed to carry out acts and formalities required under Chapter 5*" (art. 2(59)). The first obligation, effective May 5, 2025 (Figure 7.29), requires EU importers to report specific information outlined in Annex IX to the CAs of the Member State where they are based. Annex IX primarily mandates qualitative data, much of which is already publicly

333 A substandard landfill is a landfill that does not meet the minimum requirements, for instance in terms of location, water control, leachate management, protection of soil and water, and landfill gas control.

accessible. This includes the exporter/producer's name and address, a list of countries/regions through which fossil fuels transit before reaching the EU market, current MRV and mitigation practices employed by the producer/exporter, and details about any independent third-party verification, if applicable. Notably, the information required under Annex IX is not fixed and can be expanded by the European Commission through delegated acts. Member States, through their CAs, will then relay the collected information to the European Commission, which will publish it via the methane transparency database by February 5, 2026. If importers fail to provide this information, they must supply a 'sound justification' and describe efforts taken to obtain the required data.

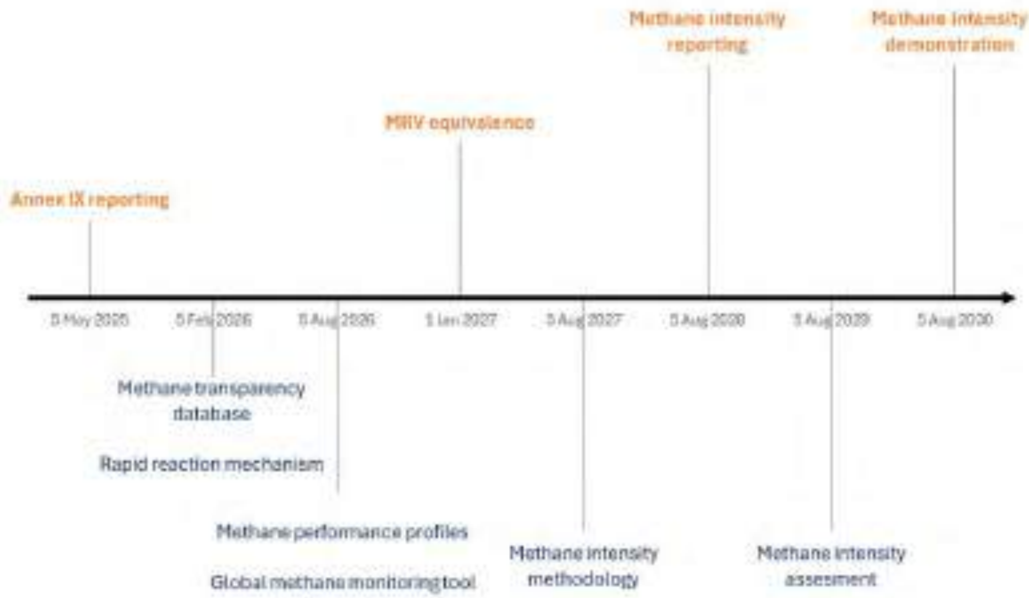

Figure 7.29: Timeline with obligations for EU importers (orange) and European Commission (navy) (source: own illustration based on the EU Methane Regulation, 2024)

From January 1, 2027, importers must demonstrate to the CA that imported crude oil, natural gas, or coal was produced under MRV standards equivalent to those in the regulation. This equivalence can be met by either following Article 12 of the regulation or achieving OGMP2.0 level 5 reporting with third-party verification. This requirement is mandatory for new contracts signed or renewed after the regulation's entry into force of August 4, 2024. For existing contracts, importers must make 'reasonable efforts' (such as contract amendments) to meet this standard, report their efforts to the CA, and provide justification if they are unsuccessful. Equivalence may be achieved at either a company or country level, with the latter option established through negotiations between the third country and the European Commission. The exact process and criteria for determining equivalence will be set by an implementing act from the EU.

Further, importers will need to report the methane intensity of crude oil, natural gas, and coal production for products they place on the EU market. By August 5, 2030, they must demonstrate to the CA that these imports meet maximum methane intensity values, which will be defined by the European Commission through delegated acts, along with the methodology for calculating methane intensity. The CA will relay collected information to the European

Commission, with methane intensity values specified separately for crude oil, gas, and coal. In determining these values, the Commission will balance supply security, non-discrimination, and EU competitiveness, while supporting global methane reduction efforts.

Access to the EU market does not hinge on compliance with these obligations, but importers who fail to provide required information (under Article 27(1) and Annex IX, Articles 28(1) and (2), and Articles 29(1) and (2)) or do not meet the methane intensity thresholds will face financial and reputational penalties set by the CAs (Article 33(5m-p)). Penalty revenues will be collected by individual Member States and directed into their national budgets.

The Commission will make importer data publicly available via a methane transparency database, enabling EU buyers to make informed decisions and encouraging a global reduction in methane emissions (Recital 71). The database will include methane performance profiles for Member States, EU importers, third-country producers/exporters, and third countries. These profiles will detail methane emissions linked to crude oil, natural gas, and coal on the EU market, assess data quality for reported emissions, document mitigation efforts, and provide analysis of ‘super-emitting events’ (sites emitting over 100 kg CH_4/hour, consistent with US EPA standards). For confidentiality, certain data may need to be modified or aggregated before publication.

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7.5 *Biogenic methane emissions*

Maria Olczak and Andris Piebalgs

In this section, we explore biogenic methane emissions resulting from human activity. We start by describing what the main sources of biogenic methane emissions are. We then look at the mitigation strategies that are available, the challenges posed by those emissions, and the type of policies that can be put in place to address them. Later, we focus on policy developments in the EU, especially the role of biomethane in achieving the REPowerEU objectives.

7.5.1 What are the main sources of biogenic methane emissions?

Plants and animals are the source of biogenic methane emissions, which can originate from natural sources (e.g. wetlands, termites) and as a result of human activities (e.g. livestock, landfills). We focus on the latter group in this section. While biogenic and fossil methane are chemically identical, they have a different warming impact. Fossil fuels production and use add new emissions into the atmosphere, while biogenic methane begins as CO_2 that is already in the atmosphere, e.g. plants absorb CO_2 during the photosynthesis process to produce carbohydrates such as cellulose, which is a key feed ingredient for cattle and other ruminants. This process is known as biogenic carbon cycle (UC Davis, 2020). Given that methane from biogenic and fossil sources impact the climate in a different way, the updated Global Warming Potential (GWP) values are: 82.5 (GWP20, i.e. on a 20-year time interval) and 29.8 (GWP100, i.e. on a 100-year time interval) for fossil methane and 80.8 (GWP20) and 27.2 (GWP100) for biogenic methane (IPCC, 2021).

Biogenic methane emissions account for over half (~60%, 197 million tons, Mt) of all man-made methane emissions. Livestock emissions (enteric fermentation and manure) are the single largest source of methane emissions (~30%, 100 Mt), followed by landfills and waste (21%, 67 Mt) and rice cultivation (~9%, 30 Mt). However, significant differences exist among various regions in the world (see Figure 7.29).

Figure 7.30: Estimated annual methane emissions by sector and region, excluding Oceania, in 2017 (source: IMEO, 2022 and Saunois et al., 2020)

The main sources of man-made biogenic methane emissions originate in two sectors: agriculture and waste. Agriculture is the largest source of anthropogenic methane emissions, accounting for roughly 40% of emissions. There are four sources of methane emissions associated with agricultural activities: enteric fermentation, concentrated animal wastes, rice production, and biomass and biofuel burning.

Enteric fermentation: Livestock, such as cattle, sheep and goats, produce methane during the digestion process, which is released into the atmosphere through belching (~87%) and flatulence (~13%) (Saunois et al., 2020). The total number of livestock is growing steadily and already surpassed 1.5 billion. Livestock numbers are assumed to be linearly related to CH_4 emissions in inventories using the simplest estimation approaches (IPCC Tier 1), but this relationship is not always linear, as the amount of methane released depends on other factors including: total weight of the animals, their diet and living conditions.

Manure management: Livestock production brings about animal waste. Manure can be handled in liquid (e.g. liquid/slurry treated in lagoons, ponds, tanks or pits) and in a solid form, e.g. in stacks or dry lots, which decompose on the pasture, resulting in limited methane emissions, but may produce nitrous oxide (N_2O), which is another greenhouse gas (GHG) with a larger warming impact than methane. The amount of methane produced depends on several factors: ambient temperature, moisture, energy content of the feed, manure composition, manure storage and residency time.

Rice cultivation: Rice paddies are another significant source of biogenic methane emissions due to the anaerobic (i.e. without oxygen) conditions that occur in the flooded fields. These emissions show temporal (they peak in the summer months in the extra-tropics) and spatial variation, with Asia accounting for 30-50% of global emissions (Saunois et al., 2020). Rice paddy emissions are influenced not only by the extent of rice field area, but also by changes in the productivity of plants.

Biomass and biofuels burning: Methane is also released during the incomplete combustion of biomass and biofuels (i.e. when oxygen availability is insufficient for complete combustion) in forests, savannahs, grasslands, peats, agricultural residues and the burning of biofuels in the residential sector (e.g. stoves) (Saunois et al., 2020). The intentional burning of agricultural residues, e.g. rice paddies, releases methane emissions and also contributes to the deterioration of air quality in neighbouring areas.

Waste sector: This is another important source of methane emissions. It includes emissions from managed and non-managed landfills (solid waste disposal on land), and wastewater handling. There are several factors affecting methane release from waste: the amount of organic waste, the pH, the moisture and temperature of the material. Methane emissions are released from solid waste through the decomposition of organic waste that occurs in landfills and liquid waste, where wastewater from domestic and industrial sources is treated in municipal sewage treatment facilities and private effluent treatment plants.

7.5.2 How can we mitigate biogenic methane emissions?

To mitigate biogenic methane emissions, there are several strategies that can be employed:

- **Livestock management:** Livestock management practices can be altered to reduce the amount of methane produced by animals. This can be done, e.g. by adjusting feed composition or using supplements that reduce the production of methane (Arndt et al., 2022).
- **Rice paddy management:** Rice paddy management practices can be altered to reduce biogenic methane emissions by using alternative irrigation techniques or changing the timing of the flooding of fields.

- **Landfill management:** Landfill management practices can be altered to reduce biogenic methane emissions by capturing and utilizing the methane produced in these environments (landfill gas) or by reducing the amount of organic waste that is disposed on landfills.
- **Anaerobic digestion:** Organic waste can be used to produce biogas and biomethane in anaerobic digestion plants.

Overall, the mitigation of biogenic methane emissions can be achieved through a combination of management strategies that reduce or eliminate methane emissions from the sources (e.g. food waste reduction) or that reduce the methane intensity of these sources (e.g. landfill gas management).

Ocko et al. estimated that the full deployment of already existing technologies and mitigation strategies would halve global methane emissions from human activities by 2030 with a quarter of methane emission cuts achievable at no net cost (Ocko et al. 2021). There are significant differences among the sectors as to what is technically and economically achievable in terms of methane emissions reduction (see Figure 7.30). For example, the management of emissions from the agriculture and waste sectors is more costly than the management of fossil methane. The effective reduction of methane emissions from the livestock sector requires radical policy proposals, e.g. behavioural changes.

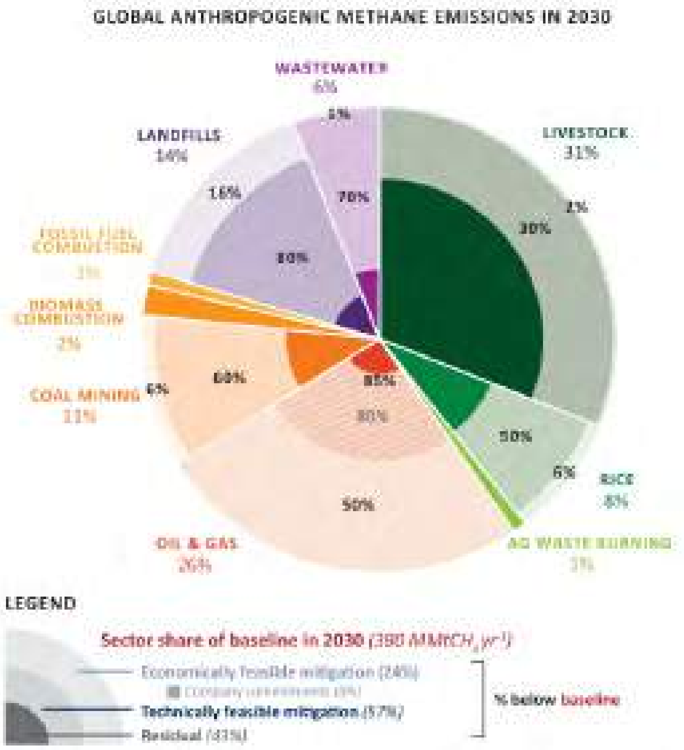

Figure 7.31: Global annual anthropogenic methane emissions abatement potentials in 2030 relative to baseline (source: Ocko et al., 2021)

7.5.3 What are the main challenges of managing biogenic methane emissions?

There are several main challenges to biogenic methane emissions mitigation, including:

- **Lack of data or incomplete data:** Accurately measuring and monitoring methane emissions from different sources can be difficult, particularly in developing countries, where the data collection and reporting infrastructure may be limited. Particular challenges exist as to the source identification and quantification, especially if different sources are located nearby.

- **Uncertainty:** The extent and impact of biogenic methane emissions on climate change is still not fully understood, and there is uncertainty around the effectiveness of mitigation measures and their potential unintended consequences.
- **Technological limitations:** Developing and implementing technologies to effectively prevent, capture and utilize methane emissions can be challenging and costly, particularly in industries with complex and dispersed sources of emissions, e.g. agriculture.
- **Economic factors:** Implementing methane mitigation measures can be expensive, particularly for small-scale farmers and other stakeholders who may lack the resources to make the necessary changes.
- **Political challenges:** Mitigating methane emissions may require changes to existing policies, which can be politically challenging and require buy-in from stakeholders at all levels.
- **Cultural factors:** In some cultures, certain agricultural practices that produce methane emissions are deeply ingrained and difficult to change, making mitigation efforts more challenging.

Addressing these challenges will require collaboration between stakeholders at all levels, including governments, private sector actors, and civil society organizations. A concerted effort is needed to develop and implement effective mitigation strategies that balance economic, social, and environmental considerations.

7.5.4 What type of policies target biogenic methane emissions?

Policies that target biogenic methane emissions include:

- **Agriculture and livestock management policies:** These policies aim to reduce methane emissions from livestock, manure management and rice cultivation. They often include incentives for farmers to adopt practices such as manure management techniques that reduce methane emissions and changes to livestock diets to reduce the amount of methane produced during digestion. Regulations can also play a role in promoting new technologies and changing farming practices, e.g. the Vietnamese System of Rice Intensification, or the regulations of the Indian government, aiming at minimizing agricultural residues burning and encouraging the use of agricultural waste to produce biogas.
- **Biogas/biomethane policies:** These policies promote the use of biogas/biomethane deriving from anaerobic digestion of organic waste, e.g. manure and food waste. This can reduce the demand for fossil fuels, which are a significant source of methane emissions, while reducing methane emissions from agriculture and waste systems.
- **Waste management policies:** These policies promote the reduction, reuse, and recycling of waste, which can reduce the amount of organic waste that ends up in landfills, thus limiting methane emissions. Taxes are widely used in the waste sector, mostly to reduce the amount of landfilled waste, e.g. 23 out of 27 EU Member States introduced a landfill tax with a tax rate ranging from 5 to 100 EUR/tonne (CEWEP, 2021).
- **Emission regulations:** These regulations set standards for emissions from different sources. In the waste sector, regulations focus primarily on landfills and landfill gas

management (e.g. EU, Washington, British Columbia), introducing new monitoring and mitigation requirements for both active and closed landfills (e.g. Oregon). There is a growing number of food waste regulations aiming at tackling methane emissions, especially in Europe (e.g. France, Italy) and parts of Asia Pacific, e.g. South Korea introduced a ban on direct landfilling of food waste. In the agricultural sector, regulations mandate better management and higher rates of animal waste (manure) utilization (South Korea, China) or incentivize biogas/biomethane production (e.g. Denmark, Germany, France, Italy, China).

- **Carbon pricing policies:** These policies put a price on GHG emissions (e.g. tax, cap-and-trade system), including methane, and provide incentives for companies to reduce their emissions. Methane emissions are covered under seven domestic ETSs, including four operating at subnational level: California (US), Chongqing province (China), Quebec (Canada), Nova Scotia (Canada), and three at the national level: New Zealand, South Korea, Switzerland. Most systems include methane from energy and industrial processes, while South Korea and New Zealand also include emissions from the waste sector. Some ETSs are combined with offset schemes, which allow to generate transferrable instruments (credits) representing a reduction of emissions by a given quantity, e.g. one metric tonne, and are certified by a government or an independent certification body (e.g. in California's and Quebec's cap-and-trade system).

7.5.5 Biogenic methane emissions in the EU: key sources and trends

Between 1990 and 2019, methane emissions in the EU have decreased by 39% (from 729 to 443 Mt CO_2 equivalent (Mt CO_2-eq)), mostly driven by reductions in emissions from coal mining, anaerobic waste and enteric fermentation due to a decrease in cattle population (-27.9% between 1990 and 2019) (EEA, 2021). However, the rate of reduction of methane emissions has been much slower in recent years. Currently, methane emissions account for 11% of EU GHG emissions and they originate mostly in three areas: agriculture (53%), waste (26%) and energy (19%). Methane constitutes a significant part of total GHG emissions in agriculture and waste, accounting for 54% and 88% respectively.

There are two major sources of farm-related methane emissions: enteric fermentation and manure management. Despite a significant decrease in the last three decades (of 21% or 50.2 Mt CO_2-eq), enteric fermentation remains the largest source of CH_4 emissions and is the key source of GHG in agriculture. Since 2010, emissions from this category remained stable, decreasing by only 0.8% between 2018 and 2019. Manure management accounts for 8.5% (40.6 Mt CO_2-eq) of total EU methane emissions. Between 1990 and 2019 these emissions decreased by 18% or 9.2 Mt CO_2-eq but they have remained stable since 2010.

Methane emissions occur from the solid and liquid waste streams. The amount of these emissions relates to the amount of biodegradable waste and the volume of landfill gas recovered and flared. The former decreased by 40% in 1990-2019 and the latter increased by 35% in the same period. The EU GHG inventory does not include information on the combustion efficiency of flares used at landfills. On average, 39% of methane from solid waste disposal is recovered or flared, with significant differences between EU Member States (MSs). Methane emissions from wastewater treatment and discharge decreased by 43.7% between 1990 and 2019. While emissions from domestic wastewater continue to decrease (-1.6% between 2018 and 2019), industrial wastewater emissions have been largely stable since 2009, with yearly fluctuations depending on the economic situation in individual countries.

The quality of national GHG inventories is a serious concern. The Intergovernmental Panel on Climate Change (IPCC) Guidelines specify methods for estimating emissions in the inventories. These are divided in three tiers that categorise emission factors (EFs) and activity data used in calculations. Tier 1 (T1) involves the use of IPCC default values, Tier 2 (T2) is similar but includes country-specific EFs and activity data, and Tier 3 (T3) requires the development of site-specific EFs based on direct emission measurements. T3 is more accurate but also the most complex method for estimating emissions.

The majority of EU MSs uses a combination of T1 and T2 methods to report emissions from enteric fermentation (21 out of 27) and manure management (20). Only two countries – France and Spain – use a combination of T2 and T3 methods. Five countries (Croatia, Finland, France, Germany and Portugal) use T2 methods. The majority of EU MSs (25) report methane emissions from managed waste disposal on land using the T2 reporting method. Only Czechia and Luxembourg use T1 methods. These estimates are important because they inform policymaking.

7.5.6 What is the role of biomethane in achieving the REPowerEU Plan objectives?

Following the Russian invasion of Ukraine, the European Commission (EC) unveiled its REPowerEU Plan to drastically reduce EU dependence on Russian gas supply (EC, 2022). The list of measures suggested includes doubling the Fit for 55 biomethane production target to 35 billion cubic meters (bcm) a year by 2030. It means a ten-fold increase from the current ~3.5bcm of biomethane produced in the EU annually. To achieve this objective, the EC recommended, in addition to some legislative changes, (1) the allocation of additional funding for biomethane production under the Common Agricultural Policy (CAP) strategic plan, and (2) the launch of the Biomethane Industrial Partnership (EC, 2023).

The Biomethane Industrial Partnership (BIP) was launched on 28 September 2022. Its objective is to support the achievement of the EU target of 35 bcm annual production and use of sustainable biomethane by 2030 and to create the preconditions for a further ramp-up of additional potential of biomethane in light of 2050.

7.5.6.1 Ensuring responsible operation of biogas plants

The biogas industry uses anaerobic digestion to reduce methane emissions from waste and agricultural residues. While anaerobic digestion helps to avoid methane emissions, methane emissions are still possible during the process and should be avoided. A recent methane quantification study found that fugitive losses related to biogas production can be as high as 9% (Bakkaloglu et al., 2021). However, the potentially leaking components and ways to prevent and reduce such leaks are well known (Olczak and Piebalgs, 2022).

Emissions in the first stages of biogas production (feedstock receiving and storage) can be avoided with tight covering of open tanks and controlling the temperature and pH value. Diffusion through gas holder membranes can be considerably reduced by performing regular maintenance of foils. Gas holders should not be filled above 50% to avoid emissions from safety valves. The residual biogas should be kept in gas-tight covered digestate storage tanks that are connected to the gas system. During biogas utilization in a plant, methane emissions can occur. In case of malfunctioning of a Combined Heat and Power (CHP) plant, the excess gas must be burned in flares so that the methane is converted into carbon dioxide and water. Plant operators should carry out regular leak detection and repair programmes (LDAR) to identify and fix leaks. These efforts could be combined with emission quantification at the source/site level and transparency obligations. The existing voluntary initiatives could serve as a blueprint, but further research is needed, e.g. to understand the factors influencing the variability of methane emissions across different sources and facilities and available cost-effective mitigation options.

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Research Project Report
December 2024

doi:10.2870/1445509
ISBN:978-92-9466-636-9
QM-01-24-182-EN-N

Publications Office
of the European Union

Co-funded by
the European Union