

Renewable Energy and Jobs

Annual Review 2022



In collaboration with



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ABOUT IRENA

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future and serves as the principal platform for international co-operation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity.

www.irena.org

ABOUT ILO

The only tripartite U.N. agency, since 1919 the ILO brings together governments, employers and workers of 187 Member States, to set labour standards, develop policies and devise programmes promoting decent work for all women and men.

www.ilo.org

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FOREWORD

With the extreme weather events witnessed across the globe in recent years, the heavy costs of climate change are becoming increasingly visible to all, strengthening the already compelling case for our transition to a low-carbon future powered by renewable energy.

As with the global economy, the renewable energy sector faces lingering supply chain disruptions from the COVID-19 crisis and volatile energy prices stemming from trade disputes and geopolitical rivalries.

Our responses to these immediate and long-term challenges bring to the fore the role of workforce development. This remains an essential component of the energy transition that should be addressed in the context of a broad policy framework comprising industrial policies, education and skills training, labour market policies, enterprise development, diversity and inclusion strategies, regional revitalisation and social protection measures, based on social dialogue.

This ninth edition of IRENA's *Renewable energy and jobs: Annual review* shows that the number of people either directly or indirectly employed in the renewable energy sector has continued to grow, from 12 million in 2020 to 12.7 million in 2021. Solar photovoltaics, with a third of these jobs, remains the most dynamic renewable industry.

Close to two thirds of all renewable energy jobs are based in Asia, with China alone accounting for 42% of the global total. This reflects the region's strengths in installation markets and equipment manufacturing. To secure jobs and other socioeconomic benefits worldwide, more countries across the globe need to pursue policies to boost their domestic capabilities.

As the number of jobs in the renewable energy sector continues to rise, it is essential to ensure that these posts provide decent livelihoods in terms of wages, occupational health and safety and workplace conditions, job security and other rights at work.

A successful and just energy transition must reflect the needs and interests of communities and regions, offer social protection for those most affected, and ensure that poor households and the most vulnerable members of societies are not priced out of the energy market by measures intended to reflect the environmental costs of fossil fuels. Such a perspective can ensure that the move from old to new energy systems is just, both in terms of jobs and other pressing social and economic needs in societies around the world.

Encouraging advances have been made in workforce gender equity – with women accounting for one-third of all renewable energy jobs. Additional progress is essential. As the transition gathers pace our focus must remain on fostering workforce diversity in ways that offer equal opportunities across the board, not only in terms of gender but for youth, minorities and marginalised groups.

This report shines a spotlight on the extended renewables value chain. On the upstream side, growing scrutiny of industry practices in the mining and processing of commodities critical to renewable energy is required. This includes environmental and labour standards as well as impacts on local communities, local content, value added and domestic manufacturing. Meanwhile, at the other end of the value chain, measures are needed to handle decommissioned equipment and materials with greater care and responsibility.

As the transition gains momentum, the multiple benefits of pursuing renewable energy are becoming increasingly clear – ranging from greater climate stability to new economic opportunities and jobs. If we are to lock in these benefits for the long term, we must act with urgency to significantly ramp up the pace of our transition to a sustainable energy future.



Francesco La Camera
Director-General
International Renewable Energy Agency



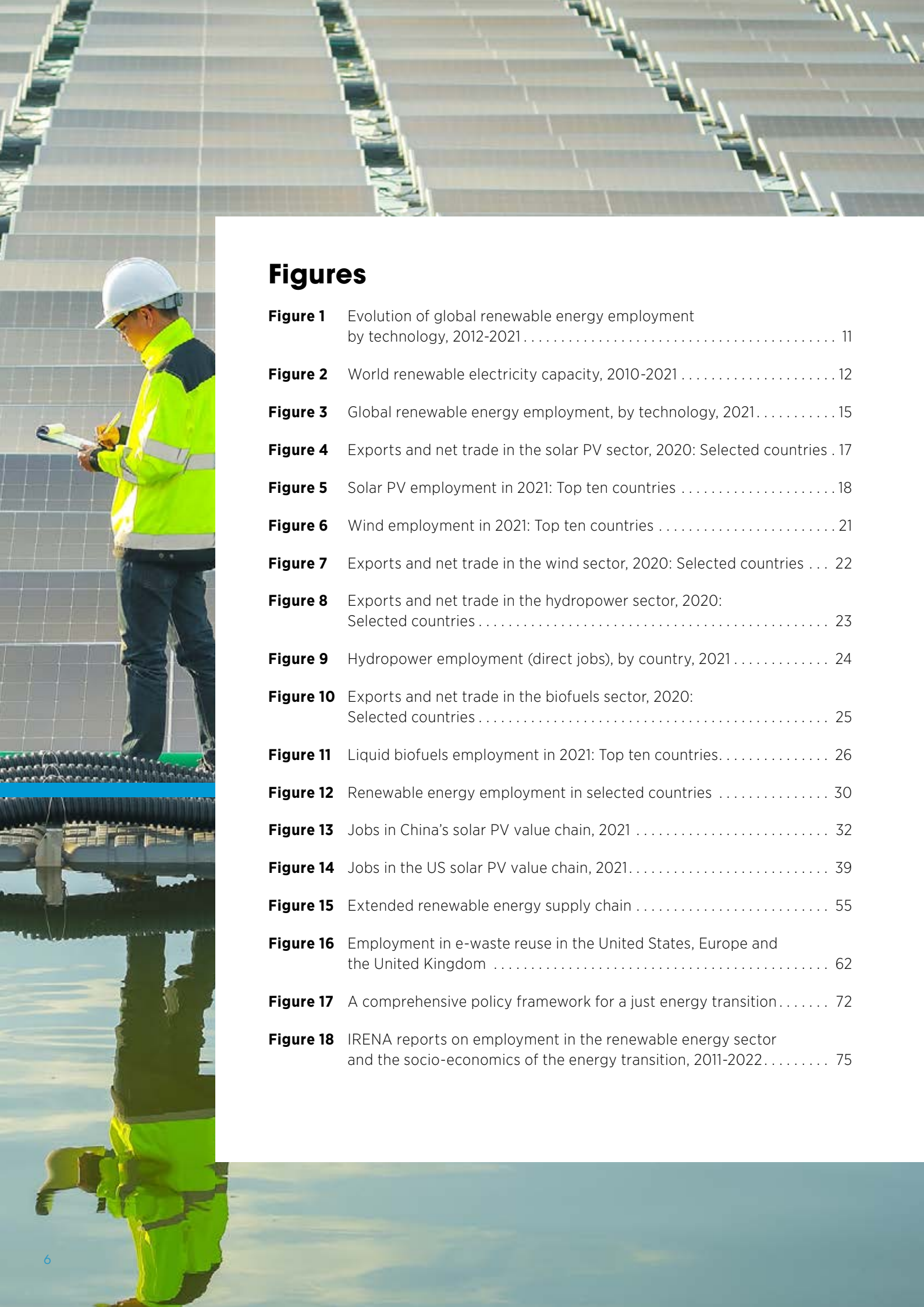
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Abbreviations

ASM	artisanal and small-scale mining
CdTe	cadmium telluride
CSP	concentrated solar power
DRE	decentralised renewable energy
EOL	end-of-life
EU	European Union
EU-27	27 Member States of the European Union
GW	gigawatt
IEA	International Energy Agency
ILO	International Labour Organization
IREC	Interstate Renewable Energy Council
MW	megawatt
O&M	operations and maintenance
PV	photovoltaic
R&D	research and development
SGRE	Siemens Gamesa Renewable Energy
USDA-FAS	US Department of Agriculture Foreign Agricultural Service
US DOE	US Department of Energy

KEY FACTS

12.7 million ➤ **Worldwide employment** in renewable energy in 2021, up from 12 million in 2020. Close to two-thirds of all jobs are in Asia, and China alone accounts for 42% of the global total. It is followed by the European Union and Brazil with 10% each, and the United States and India with 7% each.

4.3 million ➤ **Jobs in solar photovoltaic (PV)** in 2021, the fastest-growing sector, accounting for more than a third of the total renewable energy workforce.

1.3 million ➤ **Jobs in wind power** in 2021. Countries are building the industrial base and infrastructure needed to support growing offshore installations.

2.4 million ➤ **Direct jobs in hydropower** in 2021. Two-thirds of these jobs were in manufacturing, 30% related to construction and installation and about 6% to operation and maintenance.

2.4 million ➤ **Jobs in biofuels** in 2021, with the vast majority in feedstock operations. Biodiesel output and employment are rising while ethanol is ebbing.

38.2 million ➤ **Worldwide employment in renewable energy in 2030** under an ambitious energy transition scenario with front-loaded investments. The number of jobs in the energy sector could rise to 139 million, including more than 74 million in energy efficiency, electric vehicles, power systems/flexibility and hydrogen.



KEY OBSERVATIONS

- › **MANUFACTURING HUBS:** At present, a handful of countries dominate the renewable energy landscape, reflecting their strengths in manufacturing, engineering and related services, reaping the majority of jobs. But some component production is shifting to other countries.
- › **DOMESTIC JOB CREATION:** The lingering impact of the COVID-19 crisis has put a spotlight on the viability of far-flung supply chains. Rising concerns in the context of additional supply chain disruptions, trade disputes and geopolitical rivalries are reinforcing interest in localisation of supply chains, to enhance resilience, domestic value and job creation.
- › **DECENT JOBS:** Jobs that pay good wages, adhere to occupational health and safety standards, and provide job security are essential for a just energy transition. Workers' rights are key to collective bargaining and effective social dialogue.
- › **COMMODITIES:** Observance of labour and environmental standards is critical along the renewable energy supply chain. This includes the mining and processing of metals and other raw materials critical to renewable energy equipment. Industry practices vis-à-vis workers and local communities are receiving greater scrutiny.
- › **CIRCULAR ECONOMY:** Once solar panels and wind turbines reach the end of their life, recycling, remanufacturing and reuse of embedded materials limit waste flows, reduce the extraction of virgin raw materials and offer greater employment opportunities than landfilling or incineration.
- › **POLICY FRAMEWORK:** The continued expansion of decent renewable energy jobs requires a comprehensive approach comprising policies on deployment, integration and enablement, as well as industrial policies, education and skills training, labour market measures, diversity and inclusion strategies, and regional revitalisation and social protection measures.

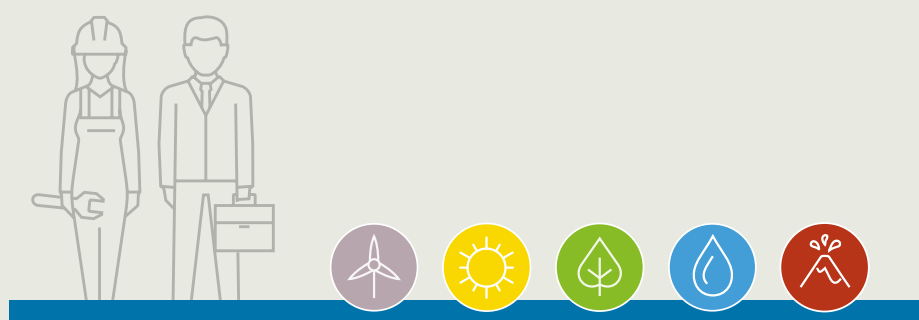
RENEWABLE ENERGY JOBS

Introduction

This ninth edition of IRENA's *Renewable energy and jobs: Annual review* series provides the latest estimates of renewable energy employment globally. In addition to IRENA's own calculations, the report is based on a wide range of studies and reports by government agencies, industry associations, non-governmental organisations and academic experts.

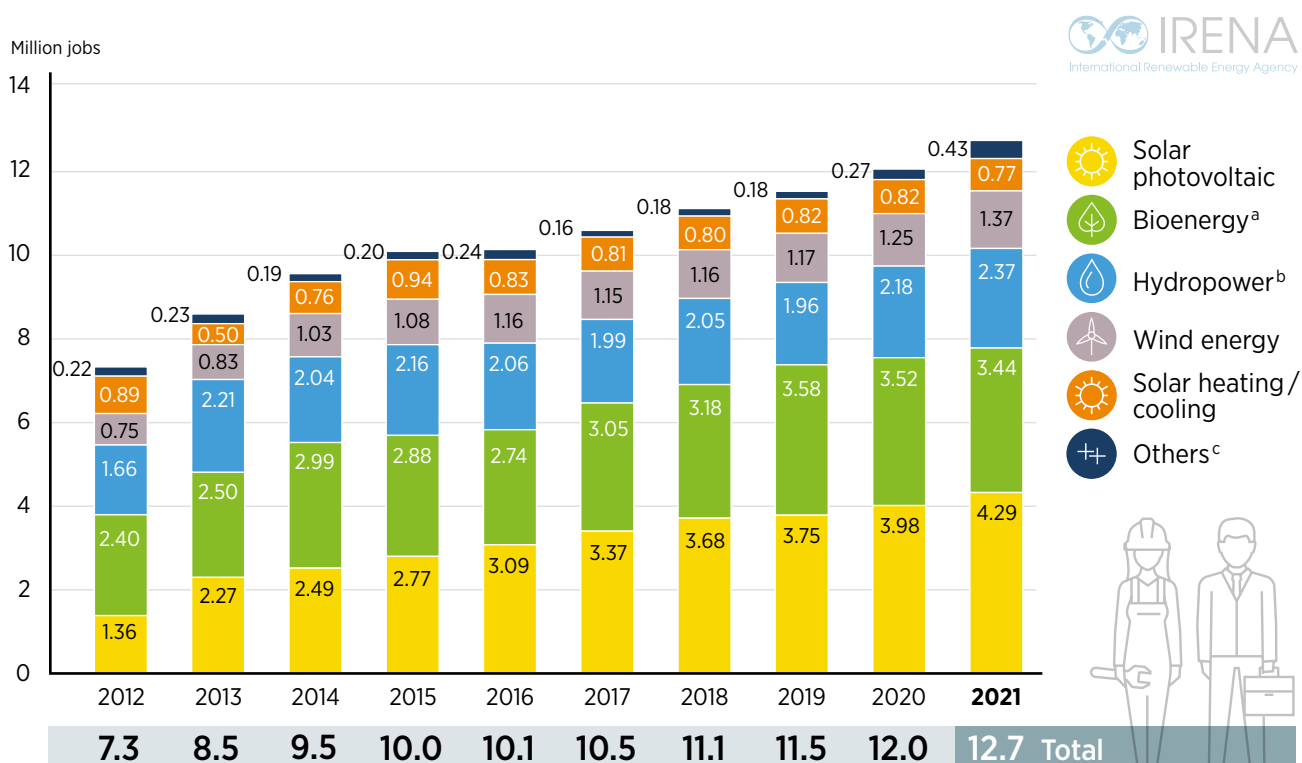
The report first surveys the global renewable energy employment landscape as of 2021. It then discusses employment results for selected countries with respect to deployment trends, policy contexts and pandemic impacts, with an eye to job quality as well as job numbers. It explores job quality and related issues in the upstream and downstream segments of the renewable energy supply chain. Throughout the report, particular attention is given to the regional distribution of employment within countries, to the gender dimension, and to trade.

The renewable energy sector employed 12.7 million people, directly and indirectly, in 2021.¹ The number continued to grow worldwide over the past decade, with most jobs in the solar photovoltaic (PV), bioenergy, hydropower and wind power industries. Figure 1 shows IRENA's renewable energy employment estimates since 2012.²



¹ Data are principally for 2021, with some dates for 2020 and a few instances in which only earlier information is available. The data for hydropower include direct employment only and for other technologies include both direct and indirect employment wherever possible.

² The job numbers shown in Figure 1 reflect the figures reported in earlier editions of this series. IRENA does not revise estimates from previous years in light of information that may become available after publication of a particular edition.

Figure 1 Evolution of global renewable energy employment by technology, 2012-2021

a Includes liquid biofuels, solid biomass and biogas.

b Direct jobs only.

c "Others" includes geothermal energy, concentrated solar power, heat pumps (ground based), municipal and industrial waste, and ocean energy.

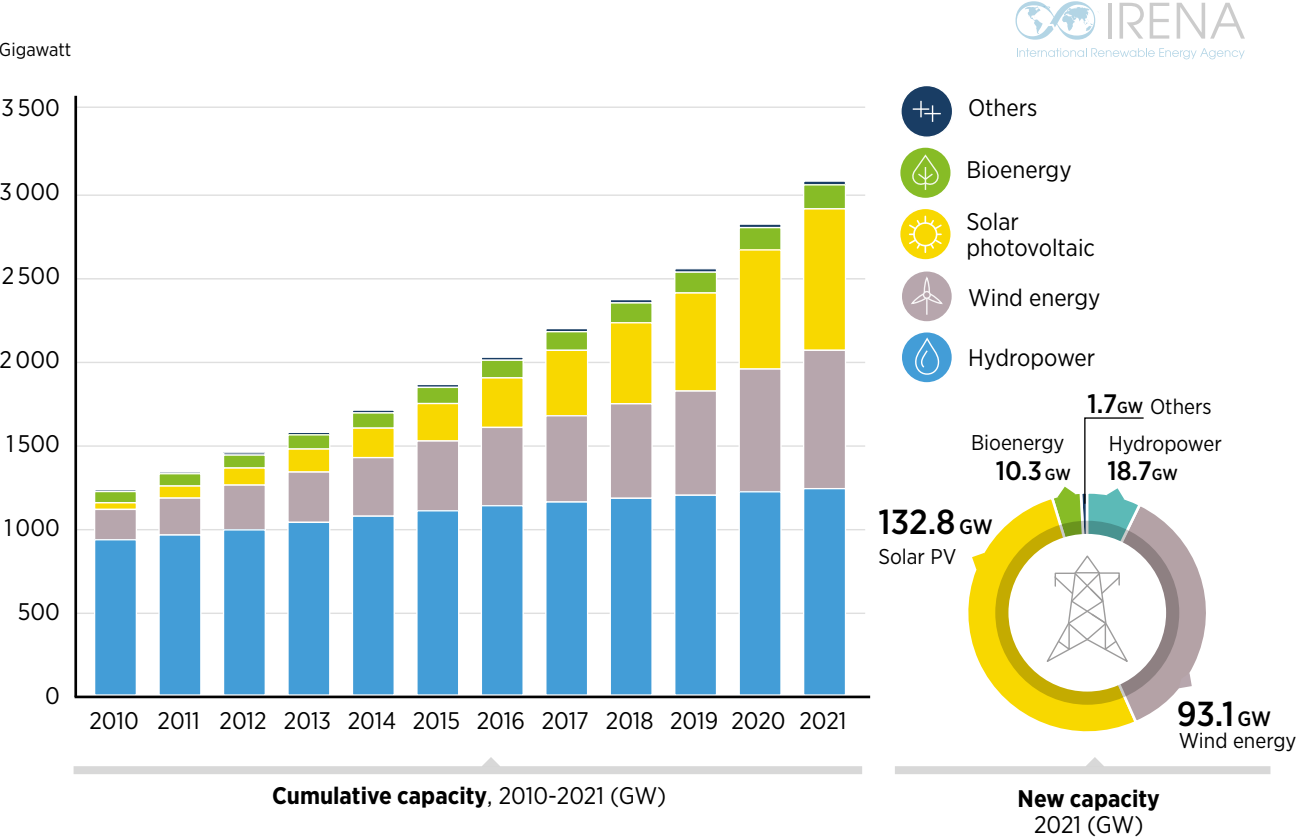
Source: IRENA jobs database.

These employment trends are shaped by a multitude of factors, including costs, investments, and new and cumulative capacities, and by a broad array of policy measures to enable renewable energy deployment, generate viable supply chains and create a skilled workforce. The COVID-19 pandemic continued to affect the global economy during 2021, altering both the volume and structure of energy demand.

Domestic market size is a major factor that affects employment generation in construction, installation, and operations and maintenance (O&M). Building or maintaining a strong equipment manufacturing industrial base also needs sufficiently large and steady domestic demand. Only a few countries have become significant equipment producers. Trade restrictions may be required to protect a fledgling local industry, but policy makers need to strike a careful balance between such efforts and minimising costs for renewable energy projects.

Worldwide, some 257 gigawatts (GW) of renewable electricity were installed in 2021, expanding cumulative capacity by 9% to a total of 3 068 GW (Figure 2). Solar and wind power together accounted for 88% of this expansion, at 133 GW and 93 GW, respectively. By contrast, hydropower grew by just 25 GW in 2021, the same pace as in 2020, and bioenergy power capacity expanded by 10 GW in each of the last two years (IRENA, 2022a). Solar thermal capacity grew by 31 million square metres or 21 gigawatt-thermal, continuing an upswing after several years of declining installations (Weiss and Spörk-Dür, 2022). Global biofuel output of about 160 billion litres matched the level reached in 2019, before the COVID-19 crisis (REN21, 2022).

Figure 2 World renewable electricity capacity, 2010-2021



Note: GW = gigawatt; PV = photovoltaic.
Source: IRENA, 2022a.