

Statistics report

# Renewables Information

Overview

2020

**leda**

# Introduction and highlights

This overview summarises the key messages from the *Renewables Information* data set. It is the result of a yearlong team effort by colleagues in the Energy Data Centre of the International Energy Agency in coordination with representatives in OECD member countries and in other countries worldwide, providing the definitive set of energy data for the world. These data are used not only by IEA analysts but also by energy ministries, businesses, journalists, students and many others.

Some of the main messages from the overview are:

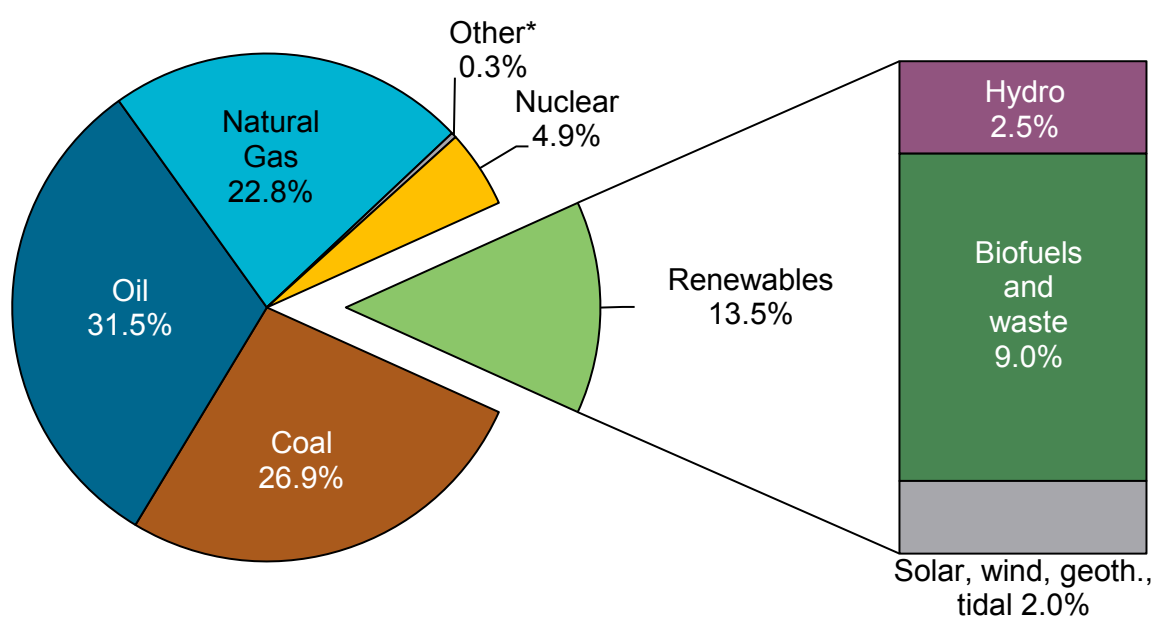
- Renewable energy sources comprised 13.5 percent of the 1 931 Mtoe of Total Energy Supply (TES) in 2018, up from 1 875 Mtoe in 2017. Since 1990, they have grown at an average annual rate of 2.0%, which is slightly higher than the growth rate of world TES, 1.8%.
- Growth has been especially high for solar PV and wind power, which grew at average annual rates of 36.5% and 23.0% respectively.
- Between 1990 and 2018, the average annual growth rate of hydroelectric power in non-OECD countries was 3.9%, considerably higher than in OECD countries (0.7%). Growth was driven by mainly by China, which accounted for 51.7% of the hydro power increase.
- Africa, which accounted for only 5.9% of the world's total TES in 2018, accounted for 33.3% of the world's solid biofuels supply.
- Renewables are the second largest contributor to global electricity production. They accounted for 25.2% of world generation in 2018, after coal (38.2%) and ahead of natural gas (23.1%).
- In the OECD, there has been a diversification of renewables demand, with the most significant trend being the steep growth of biofuels used for transport. In 2018, liquid biofuels and biogases used for transport constituted 10.3% of renewables consumption.
- The 2019 share of renewables in electricity production in the OECD was 27.0%, which was ahead of coal (22.5%) and behind natural gas (29.7%).

Please note that the timeframes for different data sets vary throughout this overview. When discussing the world, only data through 2018 are available. For OECD countries, supply data are available through 2019 while consumption and capacity data are available through 2018.

# Renewables and waste worldwide

In 2018, world total energy supply (TES) was 14 282 Mtoe, of which 13.5% was produced from renewable energy sources, which includes hydro, biofuels, renewable municipal waste, solar PV, solar thermal, wind, geothermal and tidal. Renewable energy sources comprised 1 931 Mtoe of TES, up from 1 875 Mtoe in 2017.

## 2018 fuel shares in world total energy supply



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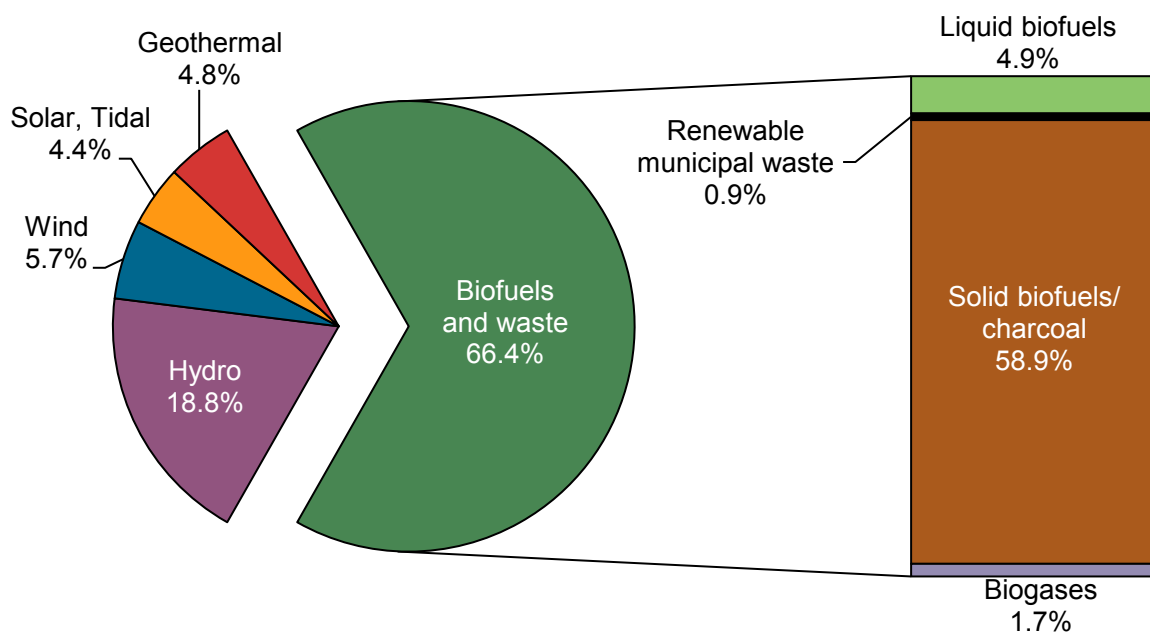
\* Other includes non-renewable wastes and other sources not included elsewhere such as fuel cells.

Note: Totals in graphs might not add up due to rounding.

Source: IEA/OECD *World Energy Balances*.

Due to its widespread use in developing countries for heating and cooking, solid biofuels/charcoal is by far the largest renewable energy source, and the second largest source is hydro. Liquid biofuels, wind, geothermal, solar, biogases, renewable municipal waste and tidal make up the rest of the renewables energy supply.

## 2018 product shares in world renewable energy supply



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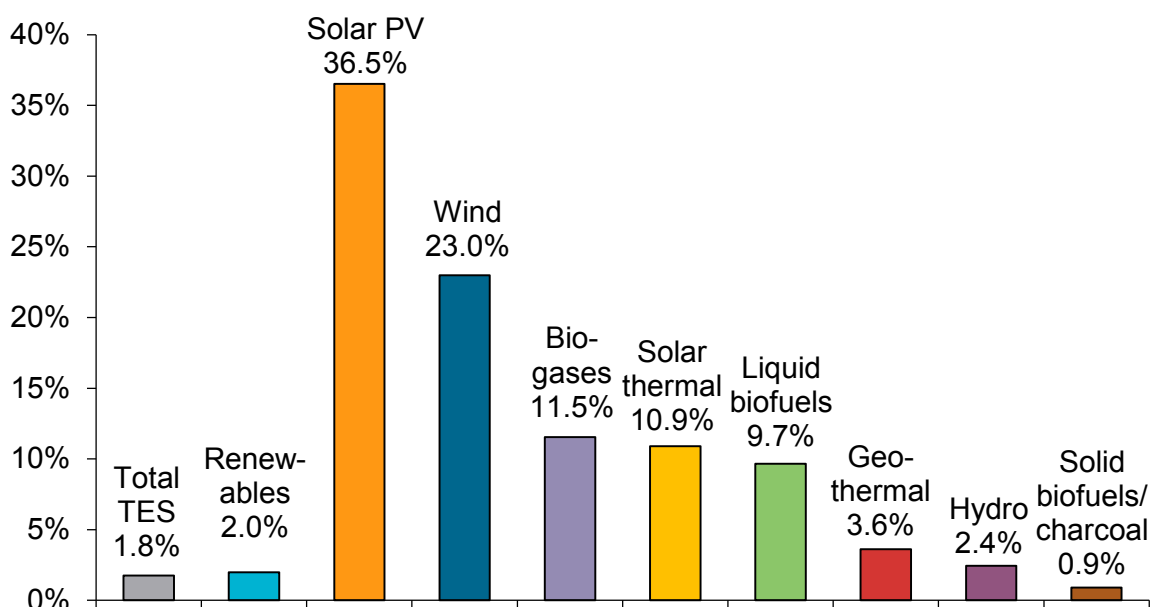
Note: Totals in graphs might not add up due to rounding.

Source: IEA/OECD *World Energy Balances*.

Since 1990, renewable energy sources have grown at an average annual rate of 2.0%, which is slightly higher than the growth rate of world TES, 1.8%.

Growth has been especially high for solar PV and wind power, which grew at average annual rates of 36.5% and 23.0% respectively. Biogases had the third highest growth rate at 11.5%, followed by solar thermal (10.9%) and liquid biofuels (9.7%).

## Average annual growth rates of world renewables supply from 1990 to 2018



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Source: IEA/OECD World Energy Balances.

Between 1990 and 2018, the average annual growth rate of hydroelectric power in non-OECD countries was 3.9%, larger than in OECD countries, at 0.7%. Growth in the world in this period was driven by China, which accounted for 51.7% of the hydro power increase, with an average annual growth rate of 8.4%. Brazil, Canada and India made the next three biggest contributions to the world increases, with 8.8%, 4.3% and 3.8% of the hydro power increase. The highest average annual growth rates were seen in Equatorial Guinea (22.5%), Mozambique (14.9%) and Belarus (10.5%).

The average annual growth rate for renewables from 2010 to 2018, 2.5%, was higher than the period from 1990 to 2018, 2.0%. This was strongly influenced by the increased growth rate for solar PV which was 42.8%. The second highest growth rate was in wind (17.9%), followed by solar thermal (11.0%), tide (8.8%), biogases (6.0%), liquid biofuels (5.8%), geothermal (5.1%), hydro (2.5%), renewable municipal waste (2.2%) and solid biofuels (0.7%). The growth in new renewables (solar PV, wind, tide, biogases, solar thermal, liquid biofuels and renewable municipal waste) for TES was 14.4%.

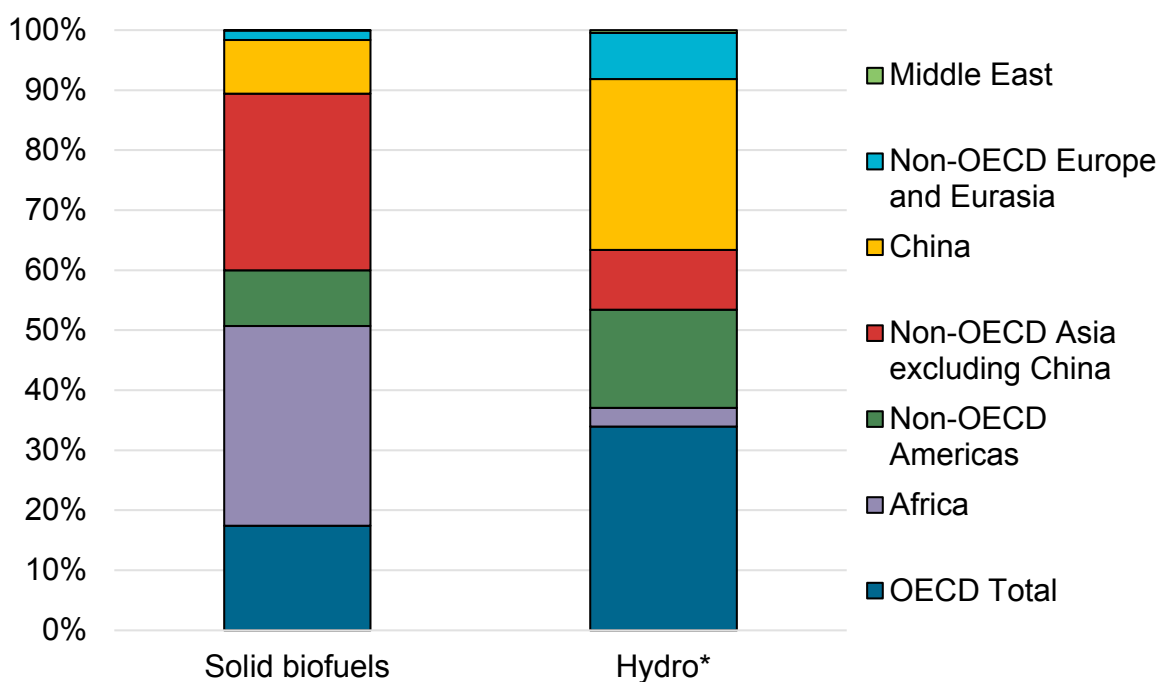
From 2010 to 2018, the average annual growth rate for the TES of renewables in the OECD was 3.4% whilst the growth rate in the rest of the world was 2.2%. Although growth in the OECD for total renewables was higher than non-OECD, when it comes to new renewables, the growth rate in non-OECD countries, 15.6% was faster than in the OECD, 9.0%. The top two fastest energy sources were the same in both regions.

In the OECD, solar PV grew at a rate of 33.2% but it grew much faster in the rest of the world, 92.3%. There was a similar pattern with wind, with a 13.5% growth rate in the OECD and 28.2% growth rate in non-OECD countries.

In 2018, non-OECD countries accounted for 66.0% of total hydro power and any further increase is likely to be from these countries, as most of the remaining hydro potential resides in these countries.

Non-OECD countries account for most of the production of solid biofuels and its importance in these regions has not seen major fluctuations since 1990. Thus, the average annual growth rate for these countries, 0.9%, is slower compared to the OECD, 1.4%, since 1990.

### 2018 regional shares in renewables supply



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\* Excludes pump storage generation.

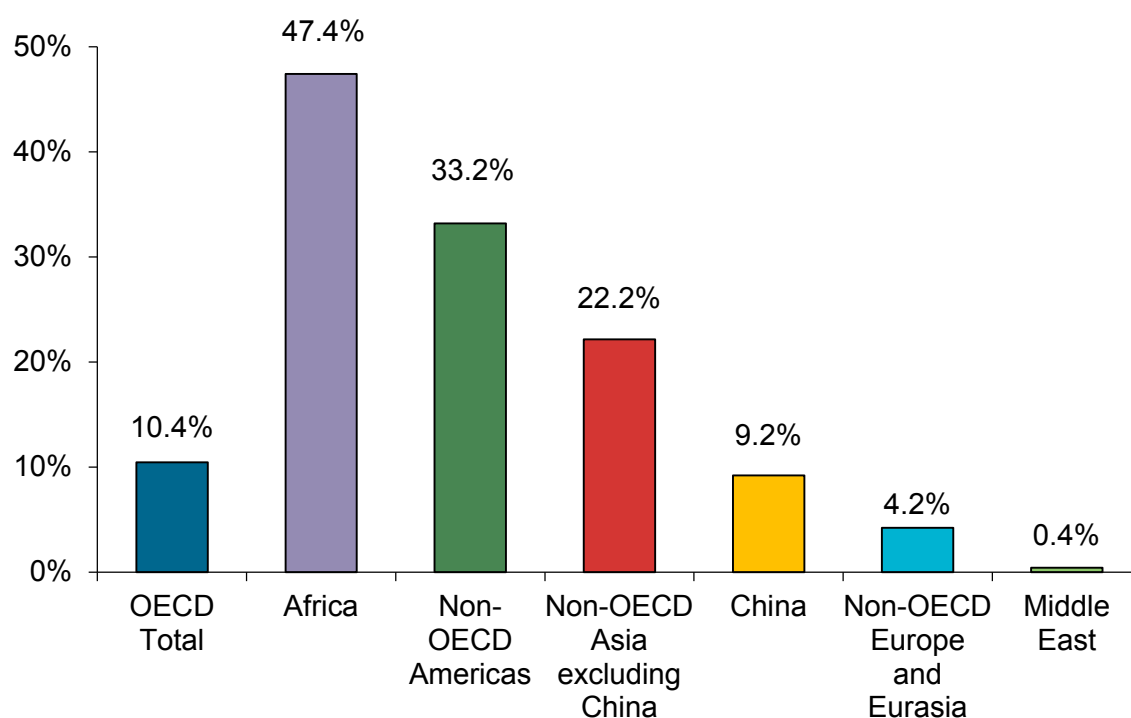
Note: Totals in graphs might not add up due to rounding.

Source: IEA/OECD *World Energy Balances*.

In 2018, 82.6% of solid biofuels were produced in non-OECD countries, where developing countries, situated mainly in Asia and Africa, use biomass for residential cooking and heating. Africa, which accounted for only 5.9% of the world's total TES in 2018, accounted for 33.3% of the world's solid biofuels supply. Although in the past the shares in non-OECD Asia excluding China and Africa were almost equal, in 2018, the share in non-OECD Asia excluding China was lower, 29.4%.

Non-OECD countries supply 71.0% of the world's renewable energy which accounts for 9.4% of world TES. While OECD countries supply 29.0% of world renewables, these renewables constitute only 3.9% of world TES. Consequently, in OECD countries, the share of renewables in total energy supply is 10.4% compared to 47.4% in Africa, 33.1% in non-OECD Americas, 23.9% in non-OECD Asia excluding China, and 9.2% in China. However, OECD countries play a major role in "new" renewables, a loosely defined term comprising solar, wind, tidal, renewable municipal waste, biogases and liquid biofuels. In 2018, OECD countries accounted for 59.1% of "new" renewables.

### 2018 shares of renewables in regional total energy supply

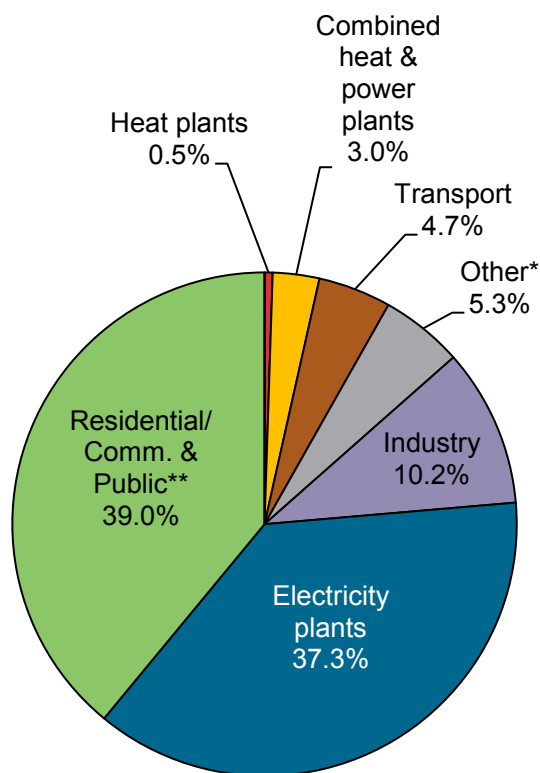


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Source: IEA/OECD *World Energy Balances*.

About half of the renewable primary energy supply in OECD countries is used in the transformation sector to generate electricity and heat. However, on a global level, the majority of renewables are consumed in the residential, commercial and public services sectors. This is a consequence of widespread use of solid biofuels in the residential sector of developing countries. 40.5% of renewables are used for electricity and heat production worldwide, while 39.6% are used in the residential, commercial and public sectors.

**2018 world sectoral consumption of renewables**



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\* Other transformation, energy industry own use, losses.

\*\* Includes the Agriculture/ forestry, fishing and non-specified industries.

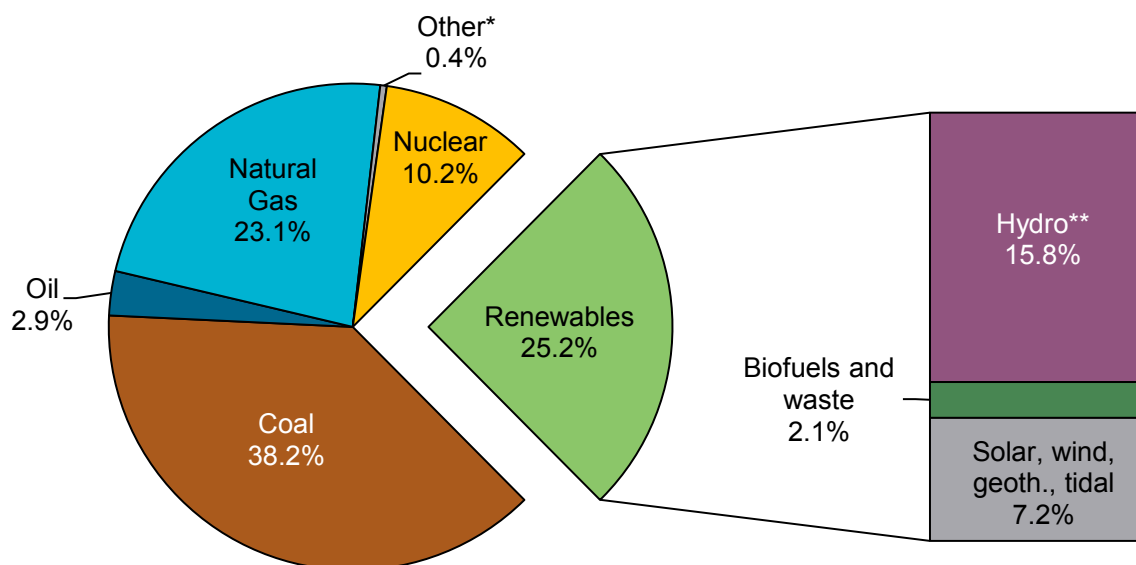
Note: Totals in graphs might not add up due to rounding.

Source: IEA/OECD *World Energy Balances*.

Renewables are the second largest contributor to global electricity production. They accounted for 25.2% of world generation in 2018, after coal and ahead of gas, nuclear and oil. Historically, the relative positions of renewables and natural gas have been influenced by various factors, including weather conditions. Policies that favour renewables over fossil fuels have also contributed to the increasing importance of renewables in world electricity production.



## 2018 fuel shares of world electricity production



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\* Other includes electricity from non-renewable wastes and other sources not included elsewhere such as fuel cells and chemical heat, etc.

\*\* Excludes pump storage generation.

Note: Totals in graphs might not add up due to rounding.

Source: IEA/OECD *World Energy Balances*.

Hydroelectricity supplies the vast majority of renewable electricity, generating 15.8% of world electricity, and 62.9% of total renewable electricity. Although growing rapidly, geothermal, solar, wind and tidal energies accounted for 7.2% of world electricity production, which is 28.8% of total renewable electricity in 2018. Biofuels and waste, including solid biofuels, play a minor role in electricity generation, supplying 2.1% of world electricity.

Since 1990, renewable electricity generation worldwide grew on average by 3.9% per annum, which is greater than the average growth rate of total electricity generation, 2.9%. Whilst 19.4% of global electricity in 1990 was produced from renewable sources, this share increased to 25.2% by 2018. Over this period, hydroelectric power saw its share of total world electricity production falling from 18.1% in 1990 to 15.8% in 2018. The share of the remaining renewable sources used to produce electricity grew from 1.3% in 1990 to 9.3% in 2018.

The worldwide average annual growth rate for renewable electricity generation from 2010 to 2018 was 6.0%. This was strongly influenced by high growth rates in solar PV

(42.8%), solar thermal (27.3%) and wind (17.9%). The remaining growth rates were tide (8.8%), biogases (8.4%), solid biofuels (8.1%), liquid biofuels (6.6%), geothermal (3.4%), hydro (2.5%), renewable municipal waste (2.0%). The growth in new renewables electricity production was 20.0%.

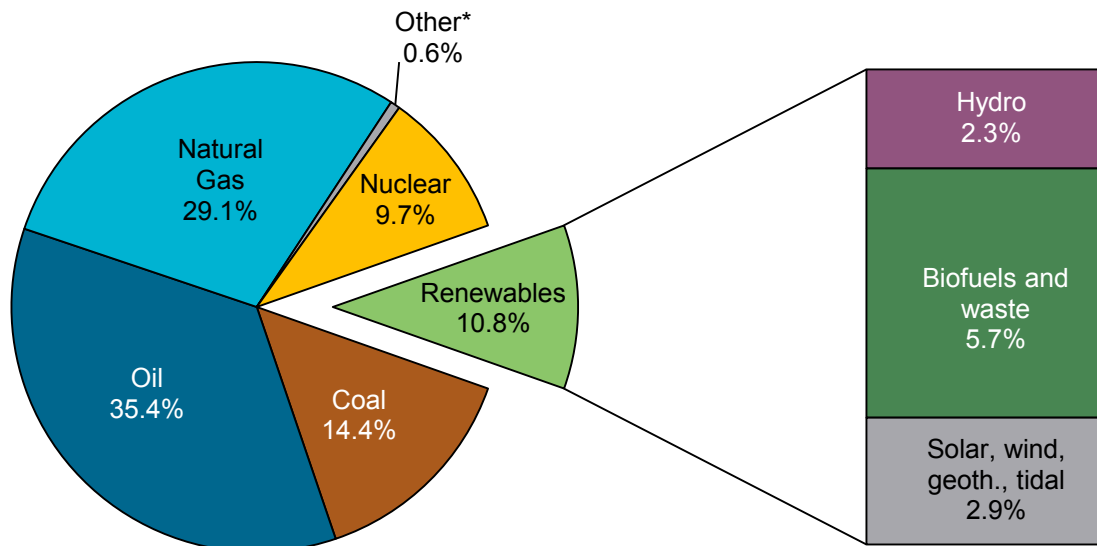
From 2010 to 2018, the average annual growth rate for renewable electricity production in the OECD was 5.1% whilst the growth rate in the rest of the world was 6.8%. These growth rates exceeded the growth rates in total electricity for both regions. Although growth in the OECD for total renewables was higher than non-OECD, when it comes to new renewables, the growth rate in non-OECD countries, 33.6% was faster than in the OECD, 15.1%. The fastest growing electricity source in non-OECD countries was solar thermal (144%) which grew from 2 GWh to 2 511.2 GWh. Next was solar PV (92.3%), followed by liquid biofuels (86.8%), wind (28.2%), biogases (19.8%), solid biofuels (13.3%), tide (5.4%), renewable municipal waste (4.7%), geothermal (4.1%) and hydro (3.6%).

# Renewables and wastes in OECD countries

In 2019, the share of renewables in total OECD primary energy supply reached a new high of 10.8%.

Each OECD region also showed increases in the share of renewables in 2019 reaching 16.0% in OECD Europe, 9.2% in OECD Americas and 5.9% in OECD Asia/Oceania.

## 2019 fuel shares in OECD total energy supply



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\* Other includes non-renewable wastes and other sources not included elsewhere such as fuel cells.

Note: Totals in graphs might not add up due to rounding.

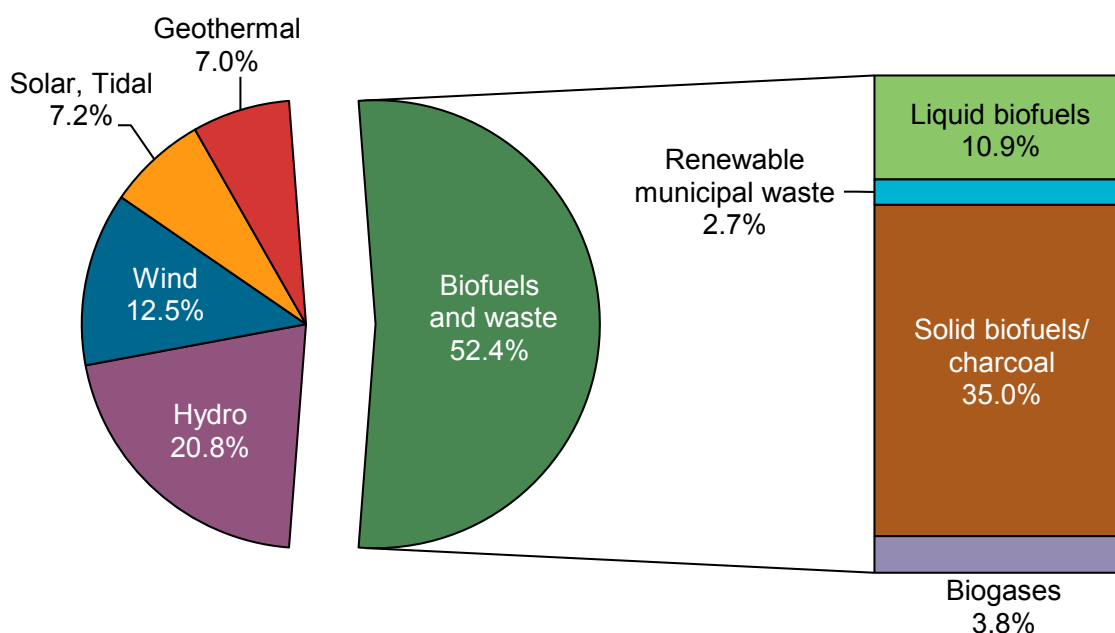
Source: IEA/OECD *World Energy Balances*.

## Primary energy supply

In OECD countries, total energy supply from renewable sources increased from 272 Mtoe to 575 Mtoe between 1990 and 2019, an average annual growth of 2.6%. By comparison, the growth of TES for non-renewable energy sources (including oil, gas, coal, and nuclear) is 0.3%. Over this time period, renewables contribution to total OECD primary energy supply grew from 6.0% to 10.8%.

The largest proportion of renewable primary energy supply in the OECD comes from biofuels and waste, which accounts for 52.4% of the renewable supply. Of this category, solid biofuels, including wood, wood wastes, other solid wastes and charcoal, constitutes the largest share, 35.0%, of the supply. The second largest renewable energy source is hydroelectric power, providing 20.8% of renewable primary energy supply. These two renewable energy sources constituted 55.8% of the total OECD primary renewable energy supply in 2019.

### 2019 product shares in OECD renewable energy supply



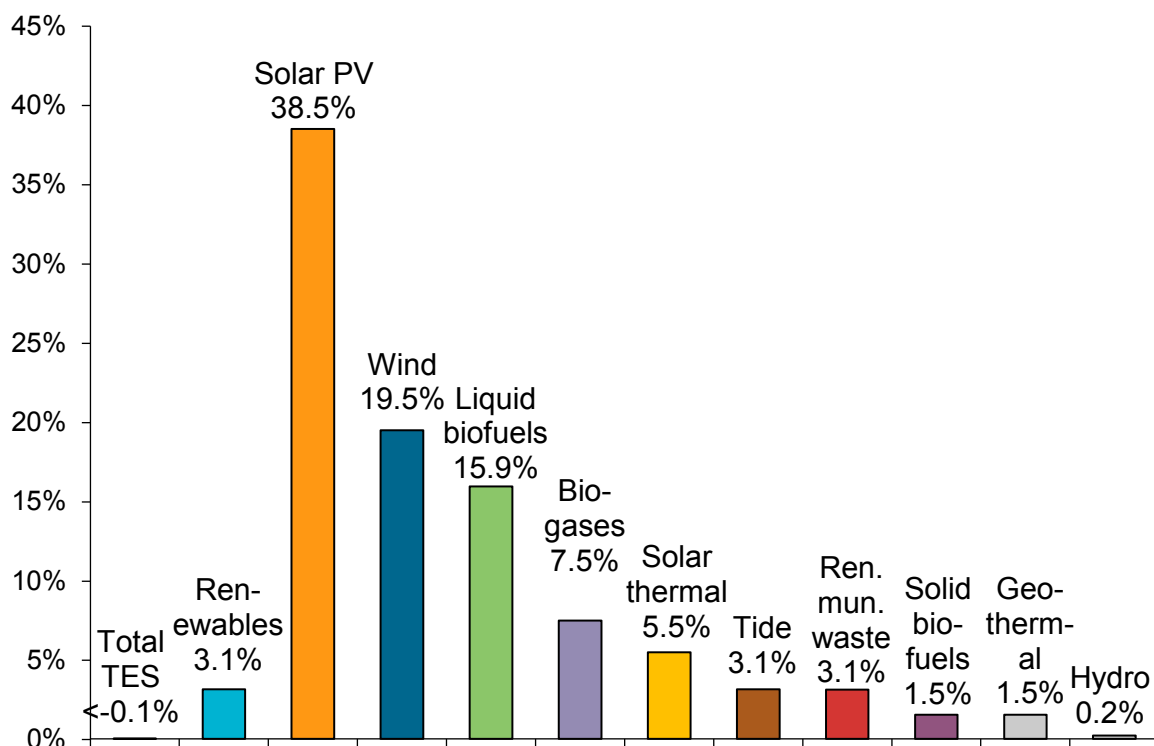
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Note: Totals in graphs might not add up due to rounding.

Source: IEA/OECD *World Energy Balances*.

Renewables showed a larger increase in average annual growth from 2000 to 2019 at 3.1% than from 1990 to 2000 at 0.9%. The growth of renewables has been accelerating recently with 3.0% in the period from 2000 to 2010 and 3.3% in 2010 to 2019. By contrast, the average annual growth rates in modern renewables, such as solar, wind, liquid biofuels, biogases, renewable municipal wastes and tidal, seem to be slowing down for the same time periods. In the period 2000 to 2010, the growth rate was 15.2% while for 2010 to 2019 it was 8.8%. The drop in growth rate in the latter period was influenced by reduced growth in liquid biofuels, biogases and renewable municipal wastes.

## Average annual growth rates of renewable supply from 2000 to 2019 in OECD total



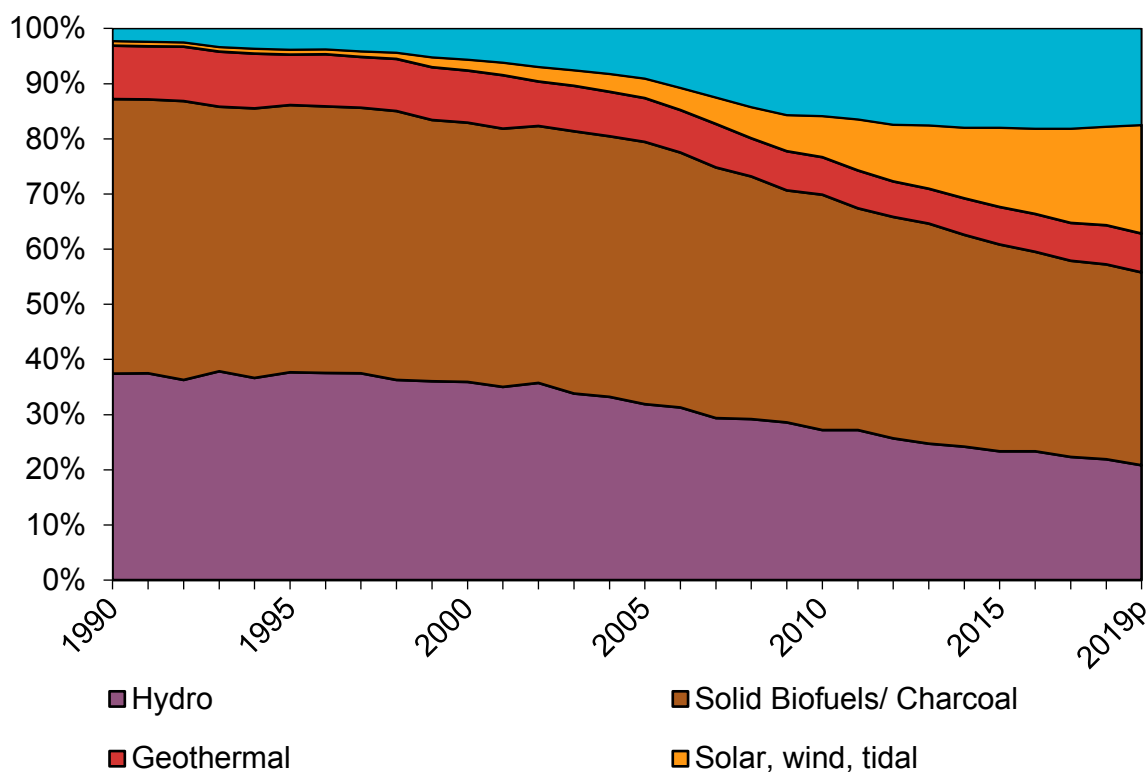
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Source: IEA/OECD World Energy Balances.

In comparison, solid biofuels and hydro influenced much of renewables growth between 1990 and 2000. Despite this, the contribution of modern renewables to the total energy supply was minor until more recently. This can be seen by the average annual growth rate of new renewables from 2010 to 2019, 11.1%. The combined share of total energy supply in the OECD for liquid biofuels, wind, solar, biogases, renewable municipal waste, and tidal represented 3.1% in 1990, 7.6% in 2000, 23.2% in 2010 and 37.2% in 2019.

In the period from 2010 to 2019, renewables TES grew at a rate of 3.3%, which was higher than the growth rate from 1990 to 2019 (3.1%). In this timeframe, tide (7.5%), solar thermal (6.0%), geothermal (3.7%) and hydro (0.3%) had higher growth rates than the period of 1990 to 2019. In the 2010 to 2019 period, solar PV (31.2%) and wind (13.4%) had the highest growth rates, just like the 1990 to 2019 period.

### Shares of OECD Renewable Energy Supply by Product

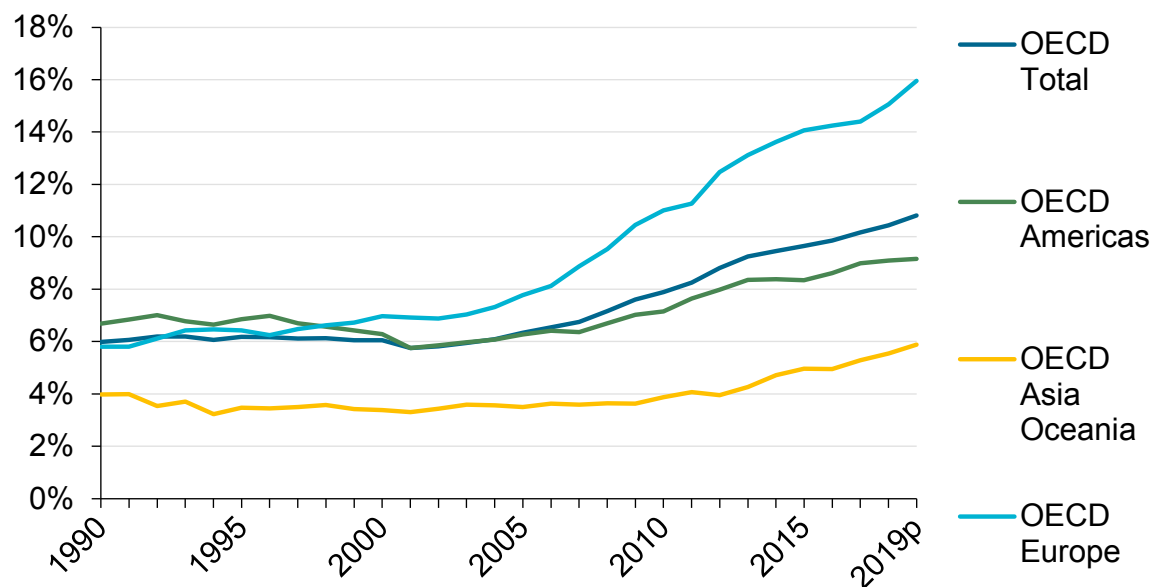


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Source: IEA/OECD *World Energy Balances*.

Among the different OECD regions, OECD Europe has the highest share of primary energy supply from renewable sources, with 16.0% in 2018. It is also the OECD area that has experienced the largest increase (from 6.0%) in its renewable share since 1990. The increase of the renewable share in OECD Europe has certainly been the consequence of the implementation of supporting policies introduced in the late 1990s and 2000s. The renewable share of TES in OECD Americas reached a new high of 9.2% in 2019 from 6.7% in 1990. In OECD Asia Oceania the share of renewable primary energy supply increased from 4.0% in 1990 to reach 5.9% in 2019.

### OECD regional shares of renewable energy supply

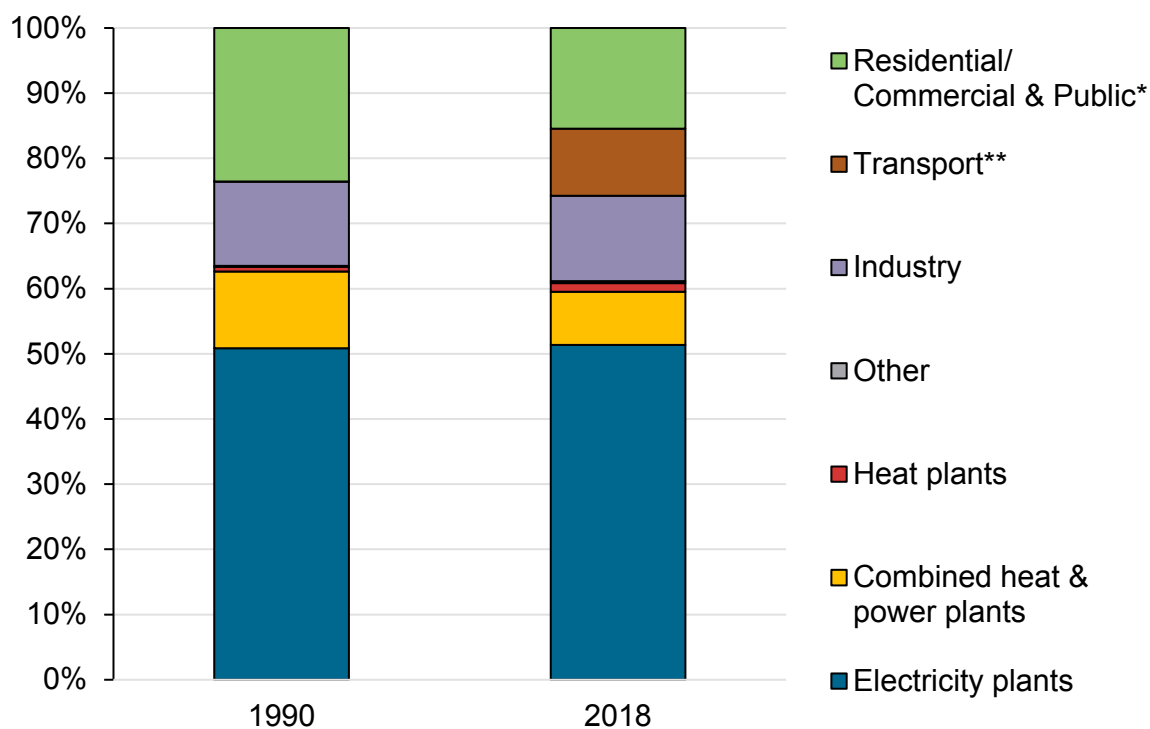


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Source: IEA/OECD World Energy Balances.

In the OECD, the majority of the consumption of renewables has been in the transformation sector for the last three decades. In the other sectors, there has been a diversification of renewables demand, with the most significant trend being the steep growth of biofuels used for transport. In 2018, liquid biofuels and biogases used for transport constituted 10.3% of renewables consumption.

### OECD sectoral consumption of renewables



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\* Includes the Agriculture/ forestry, fishing and non-specified industries.

\*\* Represents less than 0.05%.

Note: Totals in graphs might not add up due to rounding.

Source: IEA/OECD *World Energy Balances*.

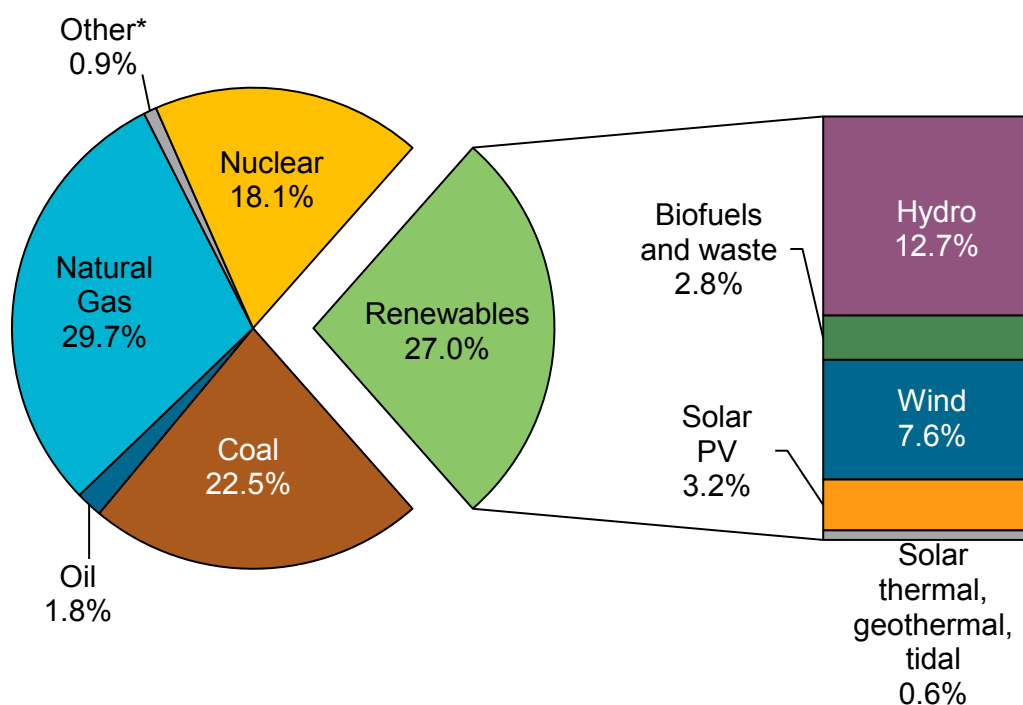
## Electricity production

OECD gross electricity production from renewable products<sup>1</sup> reached 2 964.2 TWh in 2019, 3.7% higher than the 2018 level of 2 859.3 TWh. This represents more than one quarter (27.0%) of total OECD electricity production in 2019, which is the largest share of renewables in gross electricity production and now exceeds coal.

<sup>1</sup> Excluding generation from pumped storage plants.



## Renewable shares in OECD electricity production in 2019



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\* Other includes electricity from non-renewable wastes and other sources not included elsewhere such as fuel cells and chemical heat, etc.

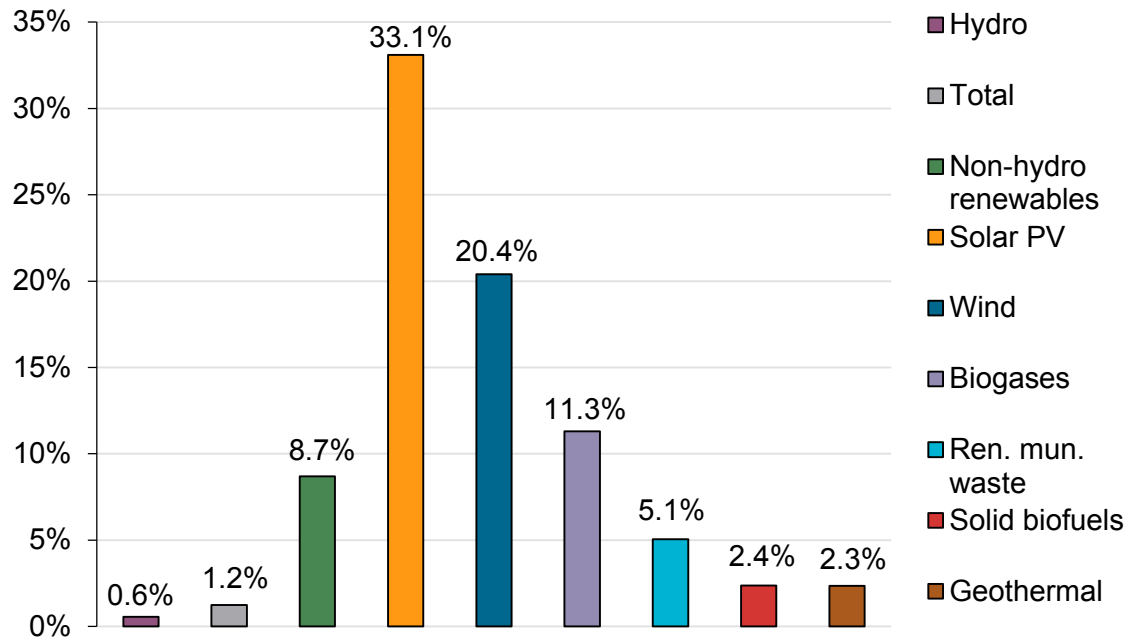
Note: Totals in graphs might not add up due to rounding.

Source: IEA/OECD World Energy Statistics.

Since 1990, OECD electricity generation from renewable energy sources has been growing at an average rate of 2.8% per year, more than double the rate for total electricity generation (1.2%), reflecting the strong growth in “new” renewable products, such as solar PV, wind, renewable municipal waste and biogases for electricity production in recent years.

In the OECD, hydro power production makes up the largest share of renewable sources in power production – but it had the lowest average growth rate of any renewable electricity source from 1990 to 2019. Wind grew from 0.3% in 1990 to 28.3% of renewable electricity in 2019, a 20.4% average annual growth rate, making it the second largest renewable source for electricity. The share of solar PV in OECD renewable electricity production had a 33.1% average annual growth rate in the same time period. Liquid biofuels have not been included in this group because there was no electricity production from liquid biofuels in 1990 so the average annual growth rate for this time period can’t be calculated.

### Average annual growth rates of electricity production between 1990 and 2019 in OECD countries



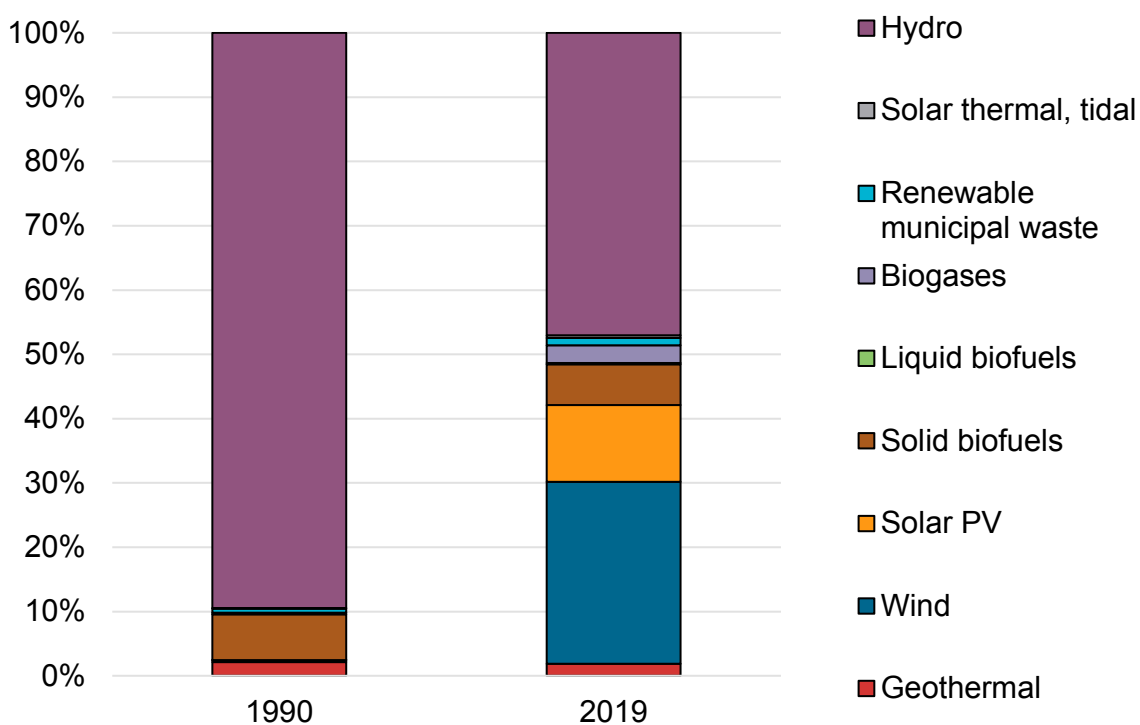
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Source: IEA/OECD *World Energy Statistics*.

With growth in other types of renewables, the hydroelectricity share of electricity from renewable energy sources declined from 89.4% in 1990 to 47.0% in 2019. In 1990, largest contributors to the share of renewables were solid biofuels (67.4%) and geothermal energy (20.4%), whilst solar PV and wind were only 2.8%. However, between 1990 and 2019, solar PV and wind grew much faster than any other power source and now comprise 40.2% of all renewable electricity sources.

The average annual growth rate for renewable electricity generation from 2010 to 2019 was 4.9%. This was strongly influenced by high growth rates in solar PV (31.2%), solar thermal (22.6%) and wind (13.4%). The remaining growth rates were tide (7.5%), biogases (6.7%), liquid biofuels (3.9%), solid biofuels (3.2%), geothermal (2.9%), renewable municipal waste (1.4%) and hydro (0.3%). Growth in electricity production from new renewables was 14.9% for this timeframe.

## Shares in OECD renewable electricity production in 1990 and 2019

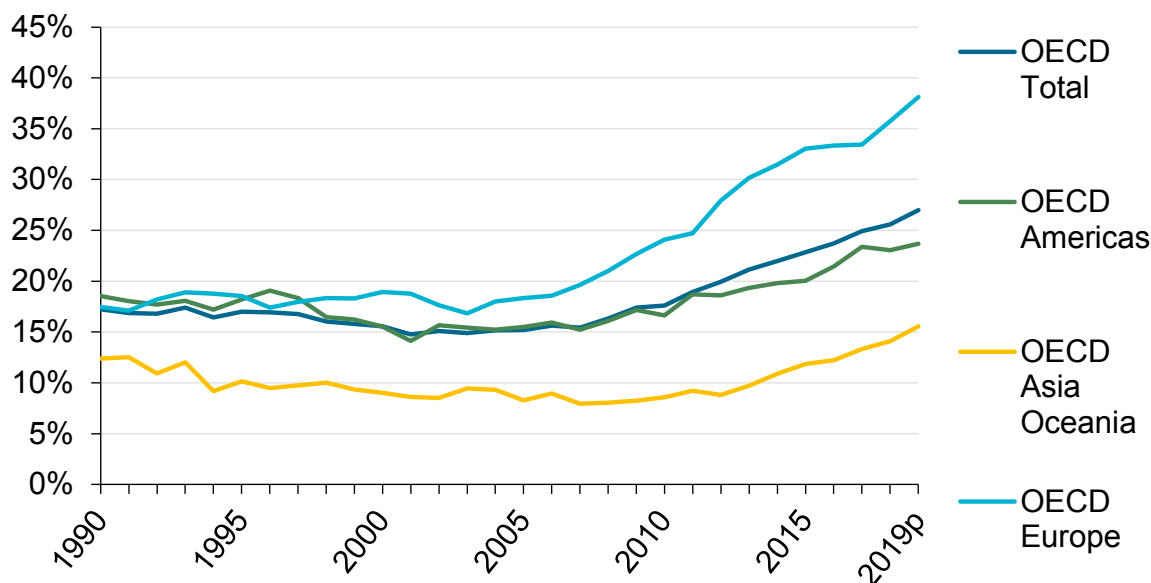


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Source: IEA/OECD World Energy Statistics.

Renewable electricity production in OECD Europe grew 3.8% on an average annual basis since 1990. This growth rate is higher than other OECD regions, 2.1% for OECD Americas and 2.6% for OECD Asia Oceania. The shares of electricity from renewables increased from 18.5% in 1990 to 23.7% in 2019 in OECD Americas, and from 17.5% to 38.1% in OECD Europe, and from 12.4% in 1990 to 15.6% in 2018 in OECD Asia Oceania. As a result of these increases, the OECD region as a whole produced its highest share of electricity from renewable sources from 1990 (17.2%) to 2019 (27.0%).

### OECD regional shares in renewable electricity production from 1990 to 2019



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Source: IEA/OECD World Energy Balances.

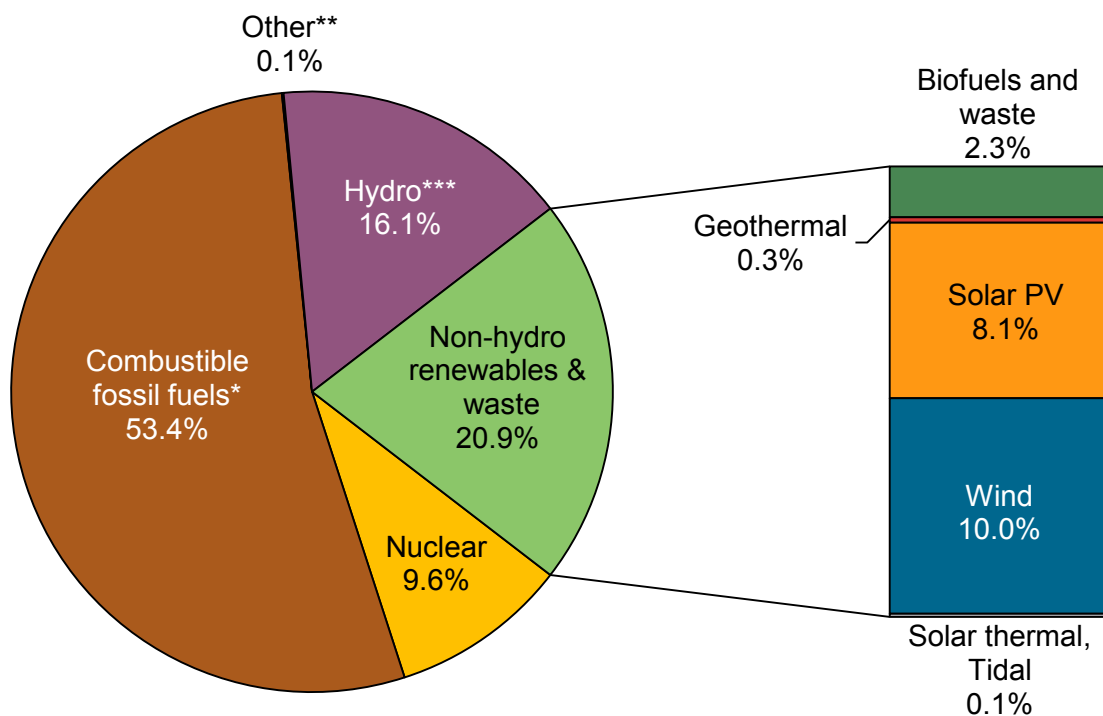
## Installed generating capacity<sup>2</sup>

From 1990 to 2018, the renewable shares of generating capacities for OECD countries have increased and the average annual growth rates of renewables and waste generating capacities (3.8%) have outpaced the average annual growth rates of non-renewable generating capacities (1.4%).

At the end of 2018, approximately 1 140.3 GW, or 37.0%, of total OECD generating capacity, was renewable energy and waste sources. Compared to 2017, total capacity had increased by 61.8 GW, driven by solar PV and wind, increasing 31.4 GW and 21.0 GW, respectively.

<sup>2</sup> Capacity data is only available for OECD countries through the end of 2018 at the time of publication.

## OECD generating capacity 2018



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\* The capacities of plants which co-fire biofuels and waste with fossil fuels (e.g. solid biofuels that are co-fired with coal) are included under the dominant fuel.

\*\* Other: fuel cells, waste/chemical heat.

\*\*\* Includes pumped hydro.

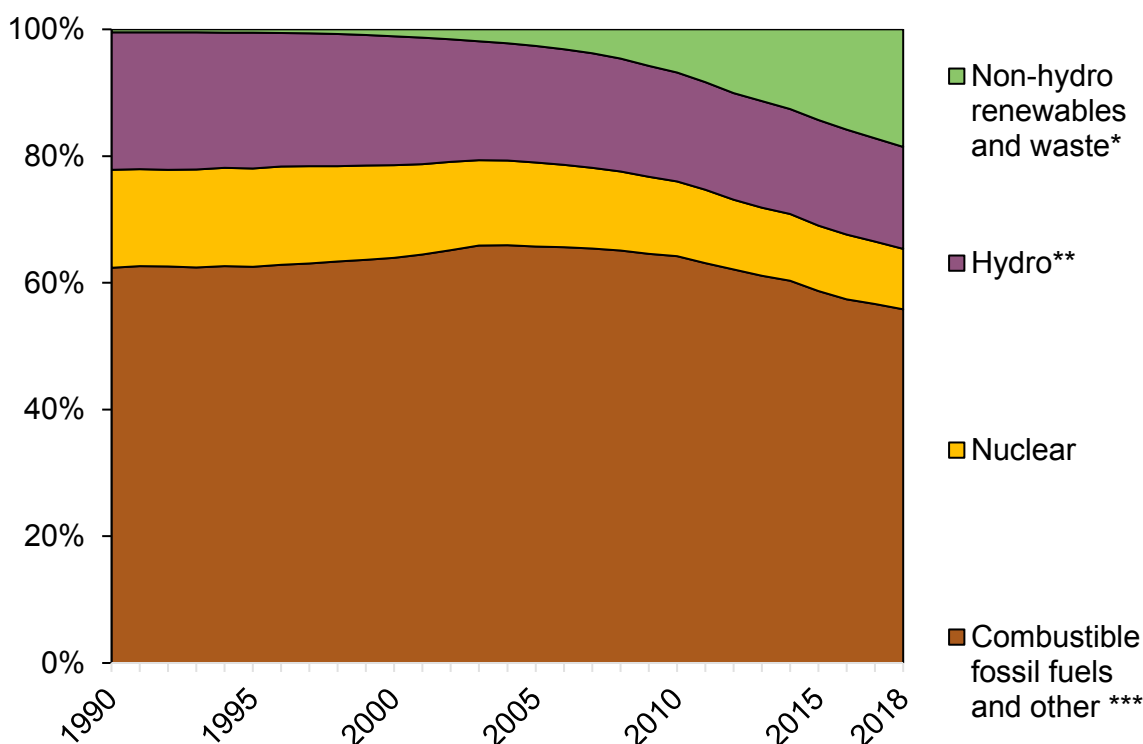
Note: Totals in graphs might not add up due to rounding. Generating capacities include pure hydro, mixed hydro and pure pumped storage.

Source: IEA/OECD *Electricity Statistics*.

The largest share (53.4%) of total generating capacity in 2018 was from combustible fossil fuels, 1 646.9 GW, which is dominated by natural gas and coal. This is followed by 495.7 GW of total generating capacity from hydroelectric plants (16.1%), 308.4 GW from wind (10.0%), 295.4 GW from nuclear (9.6%), 251.3 GW from solar PV (8.1%), 72.5 GW from biofuels and waste (2.3%), 7.8 GW geothermal (0.3%) and 4.6 GW from solar thermal and tidal (0.1%). Within biofuels and waste, 37.0 GW was solid biofuel capacity, biogases were 16.0 GW, municipal waste was 13.8 GW, and liquid biofuels was 2.4 GW. While renewables and wastes have made some recent strides in the share of total generating capacity for OECD countries, further progress can still be made.

From 1990 to 2018, the renewable shares of generating capacities for OECD countries have increased. Over this time period, the average annual growth rates of renewables and waste generating capacities (3.7%) have outpaced the average annual growth rates of non-renewable generating capacities (1.4%).

## Changing shares of OECD generating capacities 1990 – 2018



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\* Includes solar PV, solar thermal, wind, biofuels, tidal, industrial and municipal wastes and geothermal.

\*\* Includes pumped hydro.

\*\*\* The capacities of plants which co-fire biofuels and waste with fossil fuels (e.g. solid biofuels that are co-fired with coal) are included under the dominant fuel. Also includes "other" which is defined as fuel cells and waste/chemical heat.

Source: IEA/OECD *Electricity Statistics*.

## Detailed electricity production by source

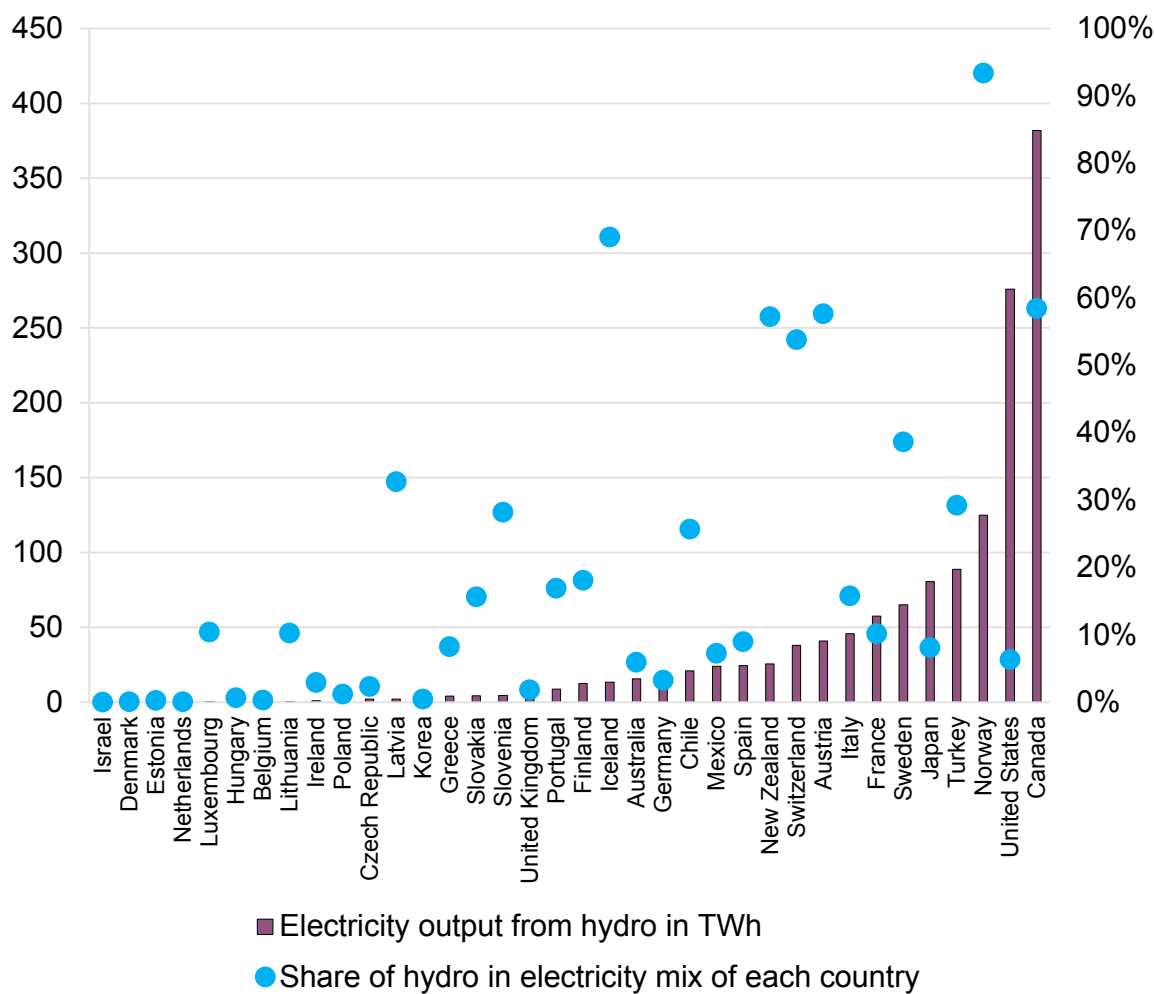
This section provides more detailed analyses of individual renewable and waste energy sources in electricity production. The energy sources are listed in the order of decreasing share in the renewable electricity production of OECD countries.

### Hydroelectricity

Hydroelectric power is nearing its potential capacity limit in most OECD countries. Between 1990 and 2019, electricity generated from hydroelectric plants (excluding generation from pumped storage plants) increased from 1 185.2 TWh to 1 394.4 TWh in the OECD, yielding an average annual increase of 0.6%. In 2019, the largest hydroelectric power generating countries were Canada, the United States and Norway which represented 27.4%, 19.8% and 9.0%, respectively, of OECD hydroelectric production. The countries with the highest reliance on hydroelectric power are

Norway, Iceland and Canada, where the share of hydro generation was 93.4%, 69.1% and 58.4%, respectively, in 2019. The output from hydro is dependent on rainfall, and fluctuations in weather patterns can have a strong effect on a country's hydroelectric production.

**Hydroelectricity output in the OECD in 2019 and percentage of hydroelectricity in total electricity production for each country**



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Source: IEA/OECD World Energy Statistics.

## Wind

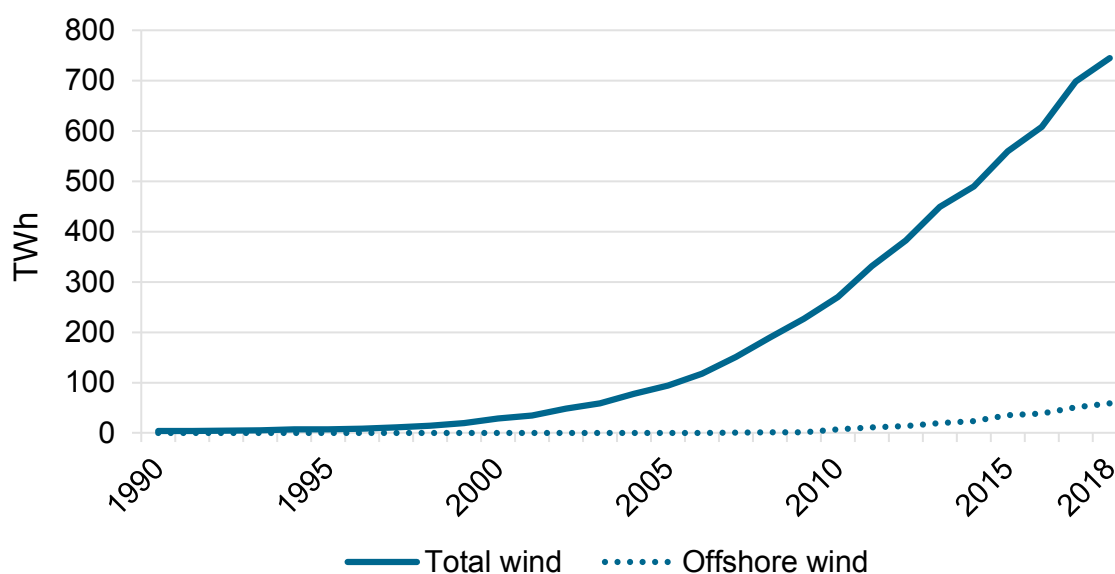
In 2019, wind turbines produced 28.3% of renewable electricity in the OECD. Between 1990 and 2019, wind power increased from 3.8 TWh to 838.5 TWh, achieving an average annual growth rate of 20.7%. This is the second fastest growth rate of renewable electricity after solar photovoltaic. The electricity generation for wind grew from 269.8 TWh to 838.5 TWh between 2010 and 2019, leading to a growth rate

of 13.4%. Wind had the third fastest growth rate in this period, behind solar PV (31.2%) and solar thermal (22.6%). Among OECD regions, wind electricity production is the highest in OECD Europe, with 53.4% of the total OECD production in 2019 and an average growth rate of 24.5% per annum since 1990. In absolute terms, the United States, Germany and the United Kingdom are the largest producers of electricity from wind in 2019 within the OECD, producing 303.4 TWh, 126.0 TWh and 64.1 TWh, respectively.

Offshore wind will be an area of significant growth in OECD countries in the coming years. Since 2004, the first year that data are available, the average annual growth rate through 2018 was 64.3%. In 2018, the country with the largest share of offshore wind production in the OECD was the United Kingdom with 45.4%. The next largest contributors were Germany (33.1%), Denmark (7.9%) and the Netherlands (6.2%).

In 2018, the share of offshore wind in total wind production was 7.8%.

### OECD electricity production from wind and offshore wind 1990 - 2018



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Source: IEA/OECD World Energy Statistics.

## Solar photovoltaic

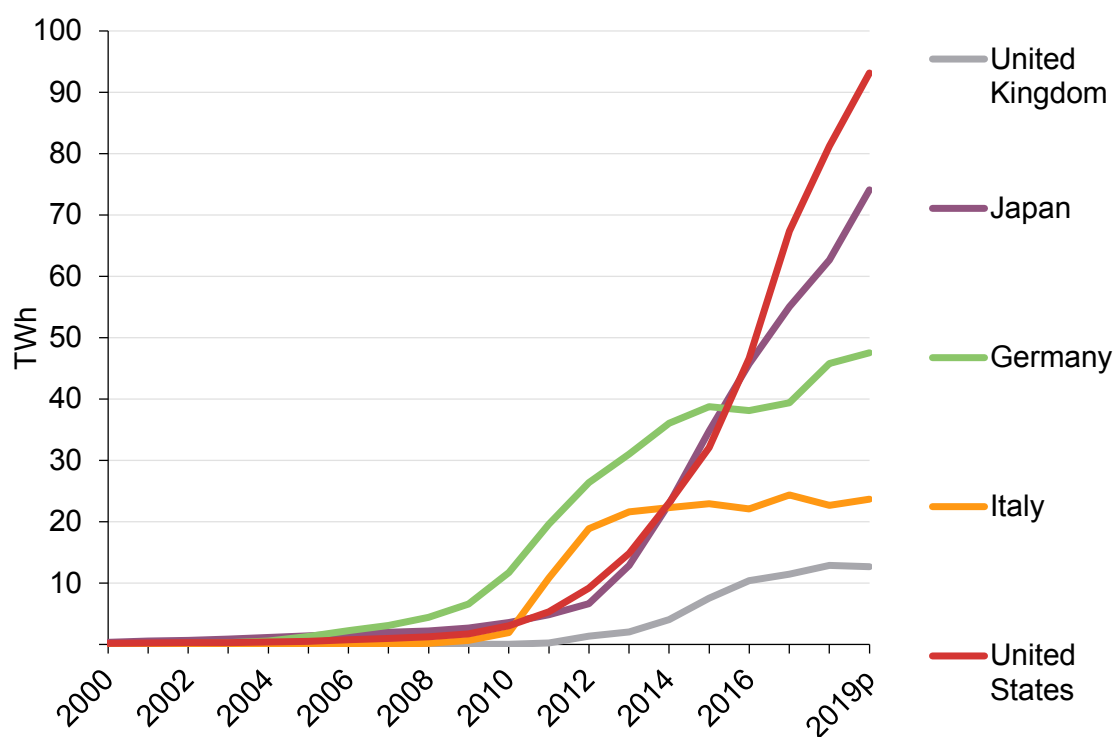
The OECD produced 354.5 TWh of solar PV electricity in 2019, 12.0% of its total renewable electricity production. The five largest producers of solar PV electricity in the OECD were the United States with 93.1 TWh, Japan with 74.1 TWh, Germany with 47.5 TWh, Italy with 23.7 TWh, and Australia with 14.8 TWh. These five countries combined produced 71.0% of the PV electricity in the OECD.



The countries with the highest share of solar PV in their electricity generation in 2019 are Luxembourg (10.9%), Italy (8.2%), Greece (8.1%), Germany (7.8%) and Canada (7.8%). Luxembourg imports most of the electricity consumed in the country, which leads to a higher than average solar PV generation share.

Electricity from solar PV increased from 88.7 GWh in 1990 to 354.6 TWh in 2019, achieving a 34.5% annual growth rate, the fastest of all renewable electricity technologies. There was a slight slow down in the growth rate between 2010 and 2019 (31.2%) as solar PV grew from 30.7 TWh to 354.6 TWh. The United States, the largest producer among OECD countries, increased production from 183 GWh in 2000 to 93.1 TWh in 2019, reflecting a 41.4% average annual growth rate over that time.

### Solar photovoltaic electricity in five major OECD producing countries from 2000 to 2019



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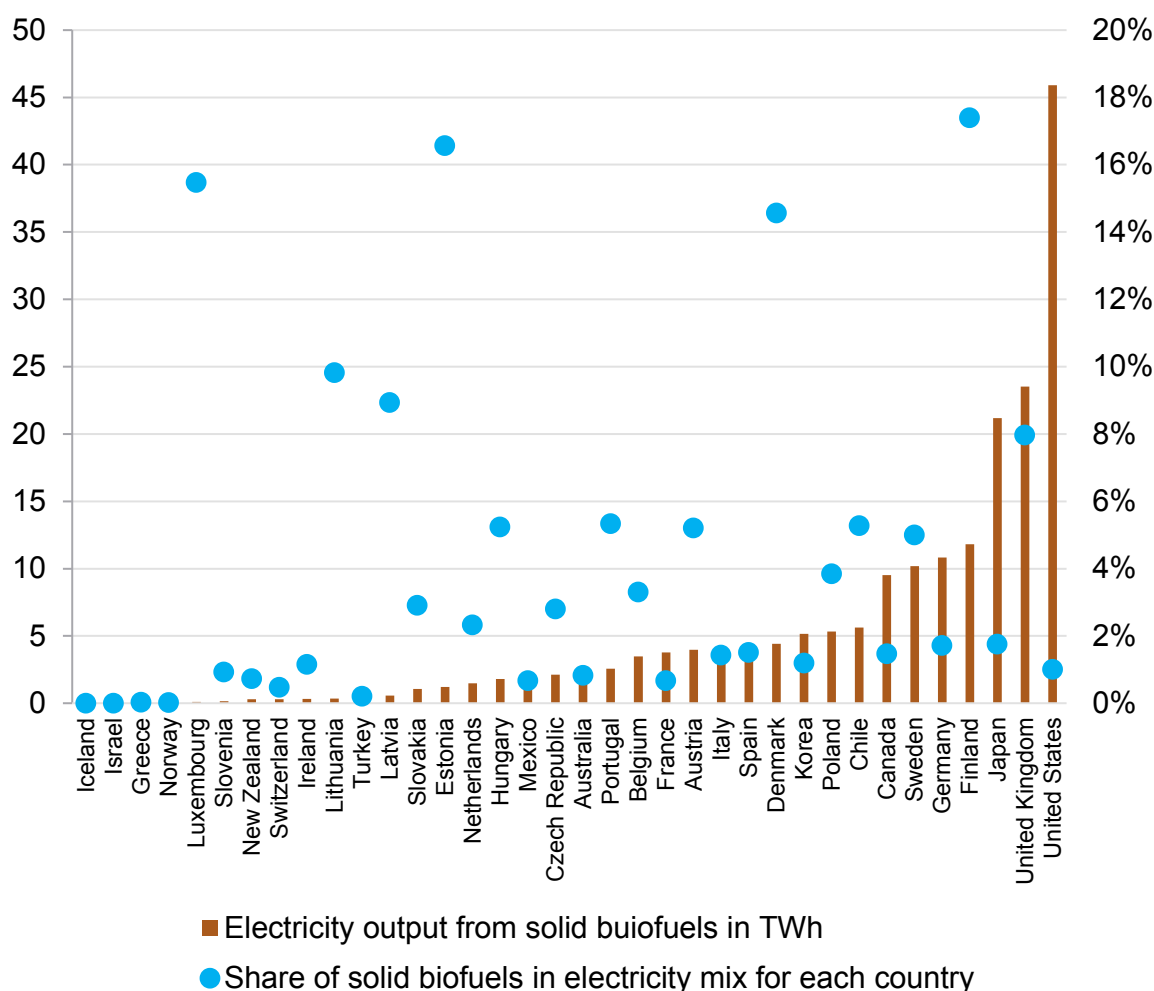
Source: IEA/OECD World Energy Statistics.

## Solid biofuels

Electricity generation from solid biofuels grew from 94.3 TWh to 186.4 TWh between 1990 and 2019, a 2.4% average annual growth. The average annual growth rate between 2010 and 2019 was the seventh fastest in the OECD at 3.2%. As the fourth largest renewable electricity source after hydropower, wind and solar PV, solid

biofuels accounted for 6.3% of renewable electricity generation in 2019. The United States (43.4 TWh) accounted for 23.3% of electricity generated from solid biofuels within the OECD, where it makes up 5.7% of the country’s renewable electricity production. The second largest producer of electricity from solid biofuels is the United Kingdom (25.6 TWh), where it represents 21.5% of the country’s renewable electricity supply. Other large producers of electricity from solid biofuels in the OECD in 2019 are Japan, Finland and Germany with 17.4 TWh, 12.0 TWh, and 10.5 TWh, respectively. The countries with the largest share of electricity generation from solid biofuels in their generation mix are Finland (17.4%), Estonia (16.6%), Luxembourg (15.5%) and Denmark (14.6%).

**Electricity generation from solid biofuels in the OECD in 2019 and share of total electricity production for each country**



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Source: IEA/OECD World Energy Statistics.

## Biogases

Electricity in the OECD from biogases grew from 3.7 TWh in 1990 to 81.4 TWh in 2019. Production of electricity from biogases grew by an average annual rate of 11.3% since 1990, making it the fourth fastest growing source of renewable electricity in the OECD. In the period of 2010 to 2019, biogases were the fifth fastest growing source of renewable electricity at 6.7%. The driver of this growth is OECD Europe, which accounted for 81.2% of OECD production in 2019. Much of the growth is attributable to Germany, where electricity production from biogases grew by an average growth rate of 18.5% per annum since 1990 to 33.7 TWh in 2019, making it the largest producer in the OECD with 41.4% of the total OECD electricity generation from biogases.

The second largest OECD producer in 2019 is the United States which produced 11.7 TWh, or 14.3% of electricity from biogases in the OECD. However, despite its large share in OECD production, the United States average annual growth rate (5.5% since 1990) has been much slower than many of the European Union countries that use biogases, e.g. 33.2% in Italy and 18.6% in Belgium. The third and fourth largest OECD producers were also located in Europe. Italy produced 8.1 TWh or 10.0% of OECD production, and the United Kingdom produced 7.2 TWh (8.9%).

## Geothermal

Similar to hydroelectric power, geothermal electricity production has not experienced significant growth between 1990 and 2019. It grew at an average annual rate of 2.3%, from 28.6 TWh to 56.0 TWh. During the timeframe of 2010 to 2019, geothermal electricity grew from 43.4 TWh to 56.0 TWh, leading to an average annual growth rate of 2.9%. The United States is the largest producer with 32.5% of the OECD total in 2019, with a production of 18.2 TWh, slightly above the 16.0 TWh level in 1990. The second largest producer is Turkey, with 8.9 TWh in 2019, representing 15.9% of total OECD production and 2.9% of its total electricity generation. Other major producers are New Zealand (14.2% of total OECD in 2019), Italy (10.8%) and Iceland (10.7%).

## Renewable municipal waste<sup>3</sup>

Renewable municipal waste represented 1.2% of renewable electricity generation in 2019 in OECD countries, making it one of the smallest portions of the renewable

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<sup>3</sup> It should be noted that sometimes data are estimates rather than observations because the energy classification systems of some countries do not separate renewable and non-renewable municipal waste.

electricity portfolio. The United States had the highest generation of electricity from renewables municipal waste with 7.1 TWh. This represented 20.8% of total OECD electricity production. The second highest producer was Germany with 5.8 TWh, followed by the United Kingdom with 3.7 TWh and France with 2.3 TWh. In 2019, 34.4 TWh of electricity was produced from renewable waste in the OECD.

## Solar thermal

Solar thermal power production experienced rapid growth in the 1990's reaching 887 GWh in 1998, but stagnated in the following years. From 2007, solar thermal electricity production grew in Spain, followed by the U.S., with average annual growth rates of 73.0% and 17.2%, respectively. These two countries account for almost 100% of solar thermal electricity production in 2019 with 5.7 TWh in Spain and 4.5 TWh in the United States. The remaining 4.5 GWh were produced in Australia.

## Liquid biofuels

Liquid biofuels for electricity production is a relatively new technology. The first country to report electricity production of this type was Germany in 2001 with only 15 GWh. Since then, an increasing number of countries have produced substantial amounts of electricity from liquid biofuels. In 2019, 14 countries reported a total of 7.0 TWh of production. The largest producer was Italy with 4.4 TWh. Liquid biofuels are also commonly used for blending with fossil fuels or in final consumption.

## Tide, wave, ocean

In 2019, at least one country in each OECD region used tide, wave and ocean motion to produce electricity. Some of the main producers were France (480 GWh), Korea (474 GWh) and the United Kingdom (13 GWh).

# INTERNATIONAL ENERGY AGENCY

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