

Key Renewables Trends

Excerpt from :
Renewables information



The following analysis is an excerpt from the publication “Renewables Information (2016 edition)”.

Please note that we strongly advise users to read definitions, detailed methodology and country specific notes which can be found online under *References* at www.iea.org/statistics/topics/renewables/

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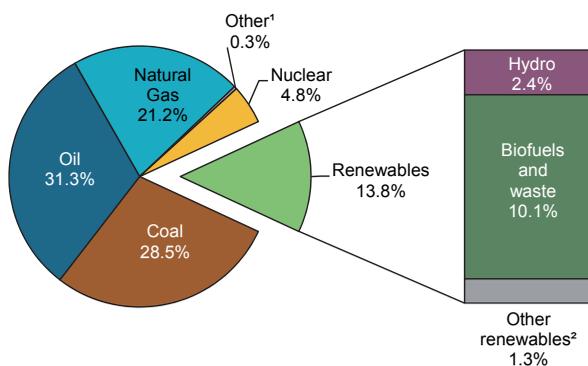
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KEY RENEWABLES TRENDS:

DEVELOPMENT OF RENEWABLES AND WASTE IN THE WORLD

In 2014, world Total Primary Energy Supply (TPES) was 13,700 Mtoe, of which 13.8%, or 1,894 Mtoe (up 2.6% on 2013), was produced from renewable energy sources (Figure 1).

Figure 1: 2014 fuel shares in world total primary energy supply



1. Other includes electricity from energy sources not defined above such as non-renewable wastes, peat, oil shale and chemical heat.

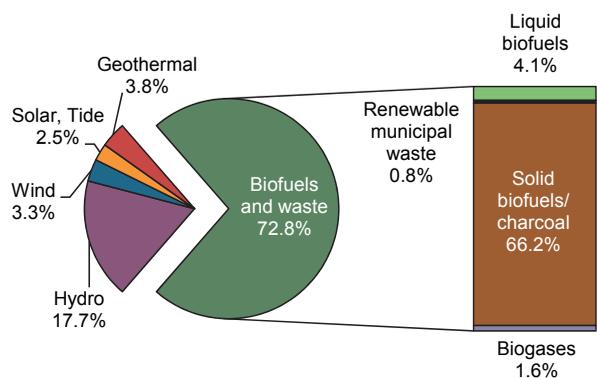
2. Other renewables includes geothermal, wind, solar, tide.

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

Due to its widespread non-commercial use in developing countries (i.e. residential heating and cooking), solid biofuels/charcoal is by far the largest renewable energy source, representing 66.2% of global renewables supply (Figure 2). The second largest source is hydro power, which provides 2.4% of world TPES, 17.7% of renewables. Geothermal, liquid biofuels, biogases, solar, wind, and tide each hold a smaller share making up the rest of the renewables energy supply.

Since 1990, renewable energy sources have grown at an average annual rate of 2.2%, which is slightly higher than the growth rate of world TPES, 1.9% (Figure 3). Growth has been especially high for solar

Figure 2: 2014 product shares in world renewable energy supply



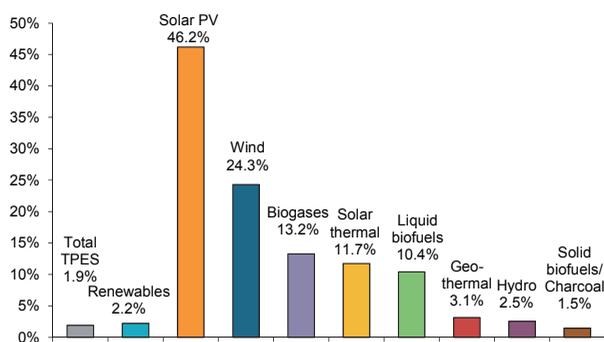
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photovoltaic and wind power, which grew at average annual rates of 46.2% and 24.3% respectively, from very low bases in 1990. OECD countries and China account for most of the world production and growth of solar and wind energy. Biogases had the third highest growth rate at 13.2%, followed by solar thermal which grew at 11.7% and liquid biofuels which grew at 10.4% per year but again both from low bases. Hydro and solid biofuels basically grew in line with overall TPES of 2.5% and 1.5% per year respectively.

The average annual growth rate of hydroelectric power in non-OECD countries, 4.0% between 1990 and 2014, was larger than in OECD countries, which was only 0.7%. Growth was particularly strong in Mozambique, showing growth rate of 18.3%, followed by Viet Nam (10.5%).

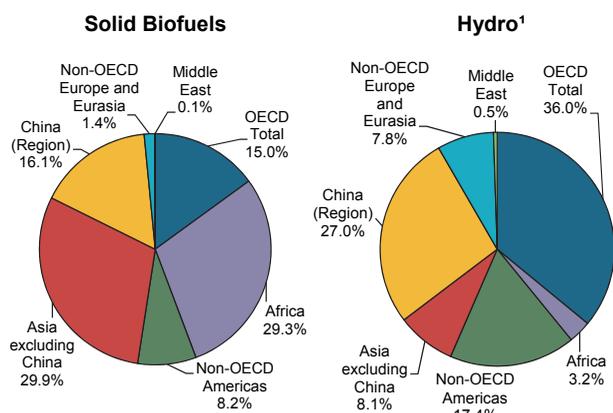
In 2014, non-OECD countries accounted for 64.0% of total hydro power and any further increase is likely to be from these countries, as most of the remaining hydro potential resides in these countries.

Figure 3: Annual growth rates of world renewables supply from 1990 to 2014



Non-OECD countries account for most of the production of solid biofuels, but its growth since 1990 is comparable for OECD and non-OECD countries. In 2014, 85.0% was produced and consumed in non-OECD countries, where developing countries, situated mainly in South Asia and sub-Saharan Africa, use non-commercial biomass for residential cooking and heating (Figure 4). Africa, which accounted for only 5.6% of the world's total TPES in 2014, accounted for 29.3% of the world's solid biofuels supply.

Figure 4: 2014 regional shares in renewables supply



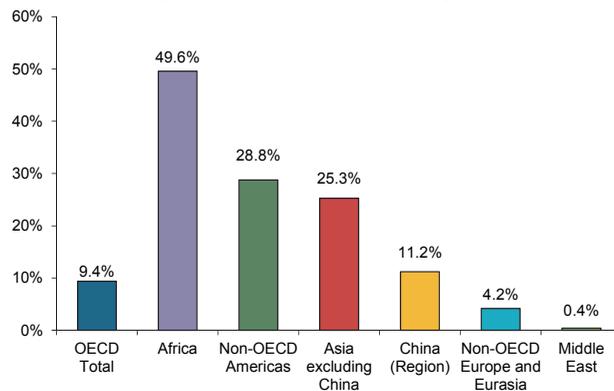
1. Excludes pump storage generation.

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

Largely because of their use of non-commercial solid biofuels, non-OECD countries are the principal renewable energy users, accounting for 73.9% of world total renewables supply. On the other hand, while OECD countries supply only 26.1% of world renewables, they constitute 38.5% of the world TPES. Consequently, in OECD countries the share of renewables in total energy supply is only 9.4% compared to 49.6% in Africa, 28.8% in Non-OECD Americas, 25.3% in

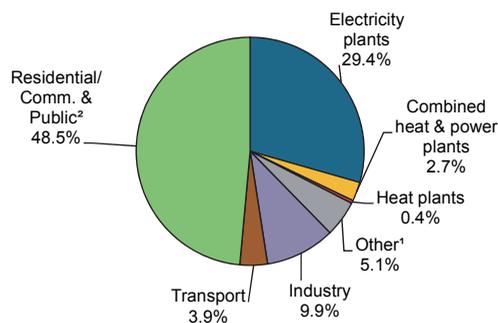
Asia, and 11.2% in China (Figure 5). However, the OECD countries play a major role when looking at “new” renewables, supplying 65.7% of world energy from solar, wind, tide, renewable municipal waste, biogases and liquid biofuels in 2014.

Figure 5: 2014 shares of renewables of regional total primary energy supply



While about half of the renewable primary energy supply in OECD countries is used in the transformation sector to generate electricity and sold heat, on a global level a majority of renewables is consumed in the residential, commercial and public services sectors. Again, this is a consequence of widespread solid biofuels use in the residential sector of developing countries. In fact, globally only 32.5% of renewables are used for electricity production and heat production worldwide, while 48.5% are used in the residential, commercial and public sectors (Figure 6).

Figure 6: 2014 world sectoral consumption of renewables



1. Other transformation, energy industry own use, losses.

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

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

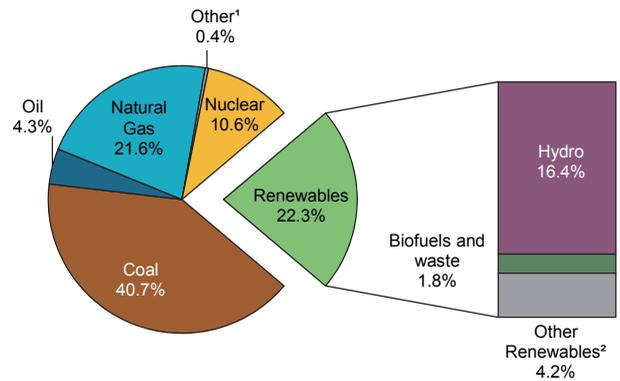
Renewables are the second largest contributor to global electricity production. They accounted for 22.3% of world generation in 2014, after coal (40.7%)

and ahead of gas (21.6%), nuclear (10.6%) and oil (4.3%). Hydroelectricity supplies the vast majority of renewable electricity, generating 16.4% of world electricity, and 73.2% of total renewable electricity, whilst biofuels and waste, including solid biofuels, play a minor role in electricity generation, supplying 1.8% of world electricity. Although growing rapidly, geothermal, solar, wind and tide energies accounted for only 4.2% of world electricity production, 18.7% of total renewable electricity in 2014.

Since 1990, renewable electricity generation worldwide grew on average by 3.6% per annum, which is slightly faster than the total electricity generation growth rate (2.9%). So whilst 19.4% of global electricity in 1990 was produced from renewable sources, this share increased slightly to 22.3% in 2014. Over this period, hydroelectric power saw its share of total world electricity production falling from 18.1% in 1990 to 16.4% in 2014. Taking out hydroelectricity from renewables, the share of the remaining

renewable sources used to produce electricity grew from 1.3% in 1990 to 6.0% in 2014.

Figure 7: Fuel shares in world electricity production in 2014



1. Other includes electricity from energy sources not defined above such as non-renewable wastes, peat, oil shale, and chemical heat.

2. Other renewables includes geothermal, wind, solar, tide.

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

DEVELOPMENT OF RENEWABLES AND WASTE IN OECD COUNTRIES

In 2015, the share of renewables in total OECD primary energy supply reached 9.7%, the highest share since the IEA time series began in 1990 (Figure 8). This share increased from 9.4% in 2014 and 6.0% in 2000. This growth is mainly driven by OECD Europe, which experienced an increase in renewable TPES from 13.4% in 2014 to 14% in 2015, whilst OECD Asia and OECD Americas showed growth of 0.2% and 0.1% points respectively).

Primary energy supply

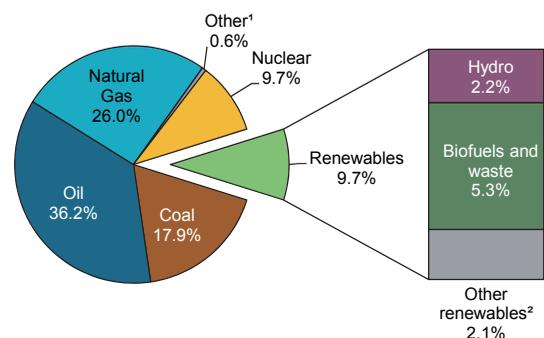
Summary: 1990 – 2015 provisional

In OECD countries, total primary energy supply (TPES) from renewable sources increased from 271 Mtoe to 510 Mtoe between 1990 and 2015, an average annual growth rate of 2.6%. By comparison, the growth of TPES from non-renewable energy sources (including coal, oil, gas and nuclear) is 0.4%. Over this time period, renewables contribution to total OECD primary energy supply grew from 6.0% to 9.7%.

The largest portion of renewable primary energy supply in the OECD comes from biofuels and waste, which accounts for 55.1% of the renewable supply (Figure 9). Of these biofuels, solid biofuels, including wood, wood wastes, other solid wastes and charcoal, constitutes the largest share, 37.4% of the supply. The second largest renewable energy source is hydroelectric power, providing 23.2% of renewable primary energy.

These two renewable energy sources constituted 60.6% of the total OECD primary renewable energy in 2015. The average annual growth rate of solid

Figure 8: 2015 fuel shares in OECD total primary energy supply

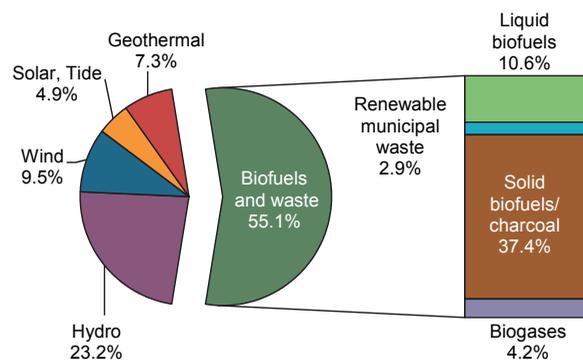


1. Other includes energy sources not classified elsewhere such as non-renewable combustible wastes, ambient air for pumps, fuel cells, hydrogen, etc.

2. Other renewables includes geothermal, wind, solar, tide.

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

Figure 9: 2015 product shares in OECD renewable energy supply

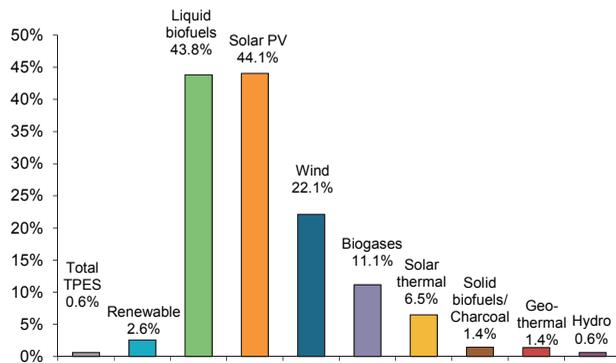


Note: Totals in graphs might not add up due to rounding.

biofuels between 1990 and 2015 is 1.4% and 0.6% for hydro. These are lower than the average annual growth rate of all renewable energies, 2.6%, over the

same time period. Because hydroelectric capacity is mature in most OECD member states, it is increasingly difficult to locate suitable environmentally acceptable sites to expand this energy form.

Figure 10: Annual growth rates of renewable supply from 1990 to 2015 in OECD total



These major sources influenced much of the growth of total renewables between 1990 and 2001 (Figure 11). However, since 2001, the majority of renewables growth can be attributed to “new” renewables, a loosely defined term used to delineate between traditional and more recent technologies used to produce renewable energy. For example, liquid biofuels experienced the highest growth among the renewables, averaging 43.8% between 1990 and 2015. Also experiencing growth rates well above total renewables are solar photovoltaic, 44.1%, and wind, 22.1% per annum since 1990, the second and third highest growth rates, respectively. Biogases have grown much more rapidly than solid biofuels, with an average annual growth rate of 11.1%.

However, despite these significant growth rates, the contribution of such “new” renewables to the total energy supply is still minor. Wind, solar, and tide combined still represent only 1.4% of total primary energy supply. Nevertheless, their growing contribution to the renewable energy supply should be noted as their share of total renewables in OECD countries increased from 0.9% in 1990 to 14.4% in 2015.

Among the different OECD regions, OECD Europe has the highest share of primary energy supply from renewable sources, with 14.0% in 2015 (Figure 12). It is also the OECD area that has experienced the largest increase (from 5.8%) in its renewable share since

Figure 11: OECD renewable primary energy supply by product

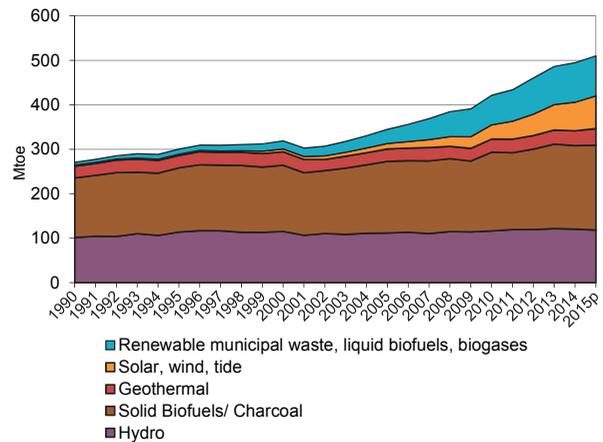
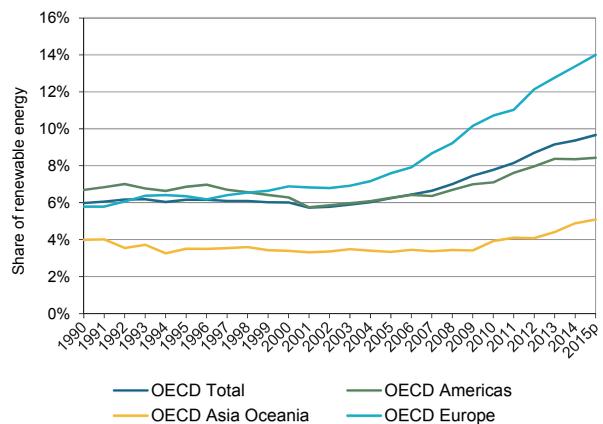


Figure 12: OECD regional shares in renewable energy supply

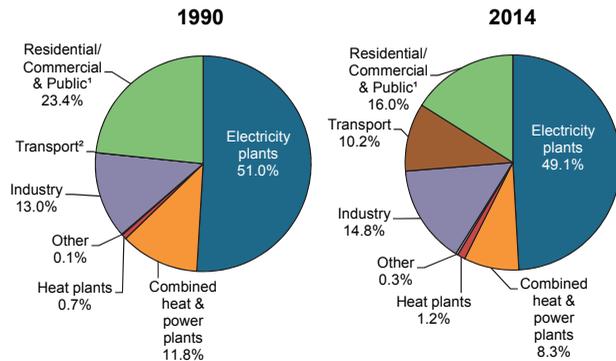


1990. The increase of the renewable share in OECD Europe is the result of the implementation of strong policies supporting renewable energy in the late 1990s and early 2000s, in particular the European Union’s directive to increase the share of renewable energy in TFC to 20% by 2020, which includes targets for individual countries. The renewable share of TPES in OECD Americas reached 8.4% in 2015, the highest level since the IEA time series began. In OECD Asia Oceania the share of renewable primary energy supply remained almost constant (from 4.0 to 5.1%) between 1990 and 2015.

As a result of diversification in the use of renewable, the overall renewable share in electricity generation has fallen. In 1990, 51.0% of renewable energy was

used in electricity plants for electricity production. However, this share declined to 49.1% in 2014 (Figure 13).

Figure 13: OECD sectoral consumption of renewables



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

2. Represents less than 0.05%.

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

The majority of the growth of renewable energy has taken place in the final consumption sectors, such as the residential, commercial, industry, and most significantly, transport sectors. In 2014, half of renewable primary energy was used in places other than electricity plants. The most significant trend is the growth of biofuels used for transport. In 2014, liquid biofuels and biogases used for transport constituted 10.2% of the consumption of renewables, compared to a negligible what in 1990.

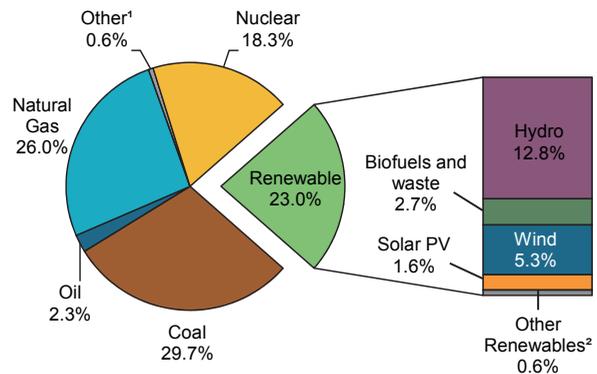
Electricity production

Summary: 1990 – 2015 provisional

OECD gross electricity production from renewable products (excluding generation from pumped storage plants) reached 2,471.1 TWh in 2015, a 3.8% increase from the 2014 level of 2,381.6 TWh. This represents 23.0% of total OECD electricity production in 2015 (Figure 14), which is the largest share of renewables in gross electricity production for any year in the renewables time series beginning from 1990.

In 2015, there was large increase in electricity production from wind and solar PV compared to

Figure 14: Renewable shares in OECD electricity production in 2015



1. Other: electricity from energy sources not classified by other categories such as non-renewable combustible wastes, peat, chemical sources, etc.

2. Other renewables includes geothermal, solar thermal, tide/wave/ocean.

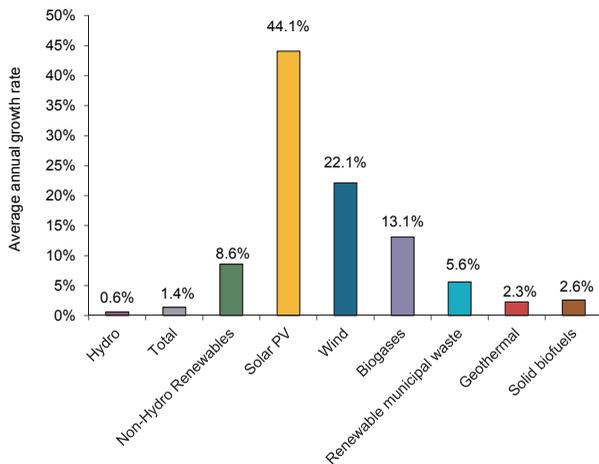
Note: Totals in graphs might not add up due to rounding.

2014. For wind, electricity production had increased by 78.1 TWh. This increase is mostly coming from Germany (30.6 TWh), followed by US (9.4 TWh) and UK (8.4 TWh). Solar PV increased by 27.3 TWh, mainly driven by Japan, which had increased electricity production from solar PV by 11.5 TWh. The second largest increase can be seen in the UK (3.5 TWh), followed by Italy (2.9 TWh) and Germany (2.4 TWh).

Since 1990, electricity generation from renewable energy sources in OECD has been growing at an average rate of 2.5% per year, greater than the rate of 1.4% for total electricity generation. This increase can be explained by the strong growth in “new” renewable products, such as solar PV, wind, renewable municipal waste and biogases for electricity production in recent years.

Apart from oil, whose use in generating electricity has been cut in half since 1990, hydroelectric power production has experienced the lowest average growth rate of any electricity source from 1990 to 2015, 0.6% (Figure 15). This is because hydroelectric power has reached its capacity limit in most OECD countries. Hydroelectricity generated 15.4% of total OECD electricity in 1990 but this share has decreased to 12.8% in 2015. With growth in other types of renewables, the hydroelectricity share of electricity from renewable energy sources declined from 89.3% in 1990 to 55.7% in 2015.

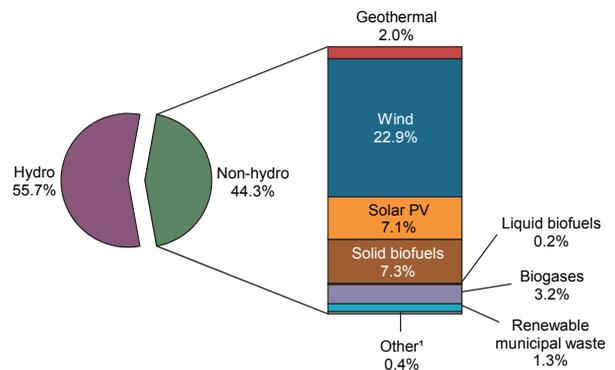
Figure 15: Annual growth rates of electricity production between 1990 and 2015 in OECD countries



The share of non-hydro renewable electricity in total OECD electricity production increased from 1.8% in 1990 to 10.2% in 2015. In 1990, the majority of non-hydroelectricity was generated by solid biofuels (7.2%) and geothermal energy (2.2%), whilst solar photovoltaic, wind, biogases and liquid biofuels combined represented less than 0.6% of renewable electricity (Figure 16). However, between 1990 and 2015, these technologies grew much faster than any other power source (Figure 15). Most notable is wind, which grew from 0.3% in 1990 to 22.9% of renewable electricity in 2015, a 22.1% average annual growth rate, making it now the second largest renewable source for electricity. The share of solar PV in OECD renewable electricity production increased from 0.0% to 7.1% in the same time period, and biogases increased from 0.3% to 3.2%, 44.1% and 13.1% average growth from 1990 respectively. All of these sources experienced higher average growth rates than older technologies such as hydro power (0.6%), solid biofuels (2.6%) and geothermal (2.3%). As a result, non-hydro renewable electricity production experienced an 8.6% annual growth rate between 1990 and 2015 (Figure 15).

The increase in non-hydro renewable electricity is mainly due to OECD Europe, where implementation of strong renewables stimulation policies by European Union member countries encouraged their growth.

Figure 16: Shares in OECD renewable electricity production in 1990 and 2015

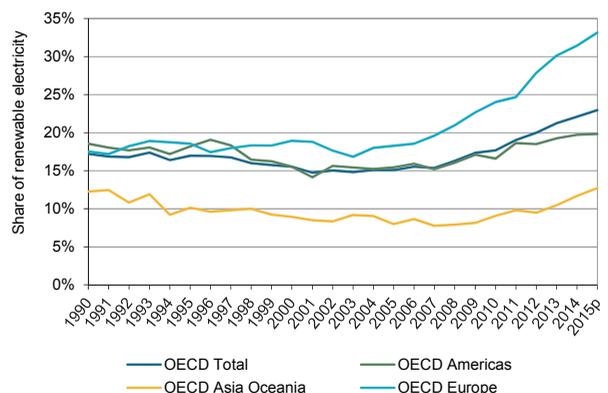


1. Other includes solar thermal, tide/wave/ocean.

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

Renewable electricity production in OECD Europe grew 3.8% per annum since 1990. This growth rate is higher than other OECD regions, 1.6% for OECD America and 2.1% for OECD Asia Oceania. OECD Europe supplied 47.5% of total OECD renewable electricity production in 2015, up from 35.3% in 1990, slightly higher than the level of OECD Americas of 42.6%. The shares of electricity from renewables increased from 18.5% in 1990 to 19.8% in 2015 in OECD Americas, from 17.5% to 33.1% in OECD Europe, and from 12.3% in 1990 to 12.7% in OECD Asia Oceania (Figure 17). As a result of these increases, the OECD region as a whole produced a higher share of electricity from renewable sources in 2015 (23.0%) than it did in 1990 (17.2%).

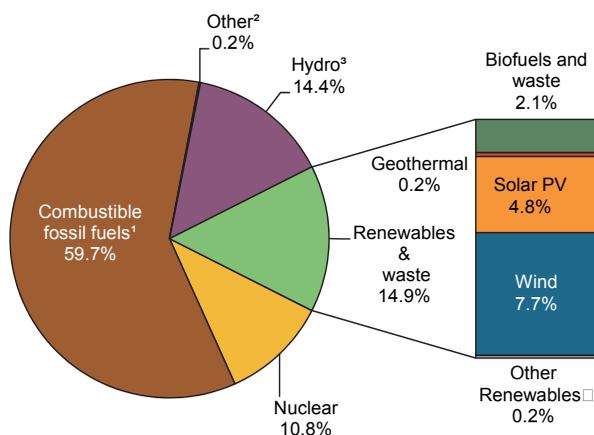
Figure 17: OECD regional shares in renewable electricity production from 1990 to 2015



Installed generating capacity

In 2014, 819.1 GW, 29.3% of total OECD generating capacity, was accounted for by renewable energy and waste sources (Figure 18). Compared to 2013, total capacity had increased by 47.8 GW, where the main factors were solar PV and wind, increasing 22.5 GW and 19.1GW respectively. The largest increase in solar PV occurred in Japan as they added 9.7 GW, followed by US (3.1 GW) and UK (2.5 GW). The sum of these three countries account for 68.4% of total increase. Regarding wind capacity, the largest growth was in Germany, 4.5 GW, followed by the US with 4.3 GW increment.

Figure 18: OECD generating capacity 2014



1. 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.
2. Other: fuel cells, waste/chemical heat.
3. Hydro does not include pumped storage capacity.
4. Other renewables includes solar thermal, tide/wave/ocean.

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

The largest share (14.4%) of total generating capacity is hydroelectric plants, 402.9 GW excluding pumped storage, followed by 213.9 GW from wind (7.7%), 132.9 GW from solar photovoltaic (4.8%), and 58.2 GW from biofuels and waste (2.1%).

Of the biofuels and waste, 29.2 GW represented solid biofuel capacity, 11.4 GW represented municipal waste, 12.9 GW represented biogases and 2.2 GW represented liquid biofuels. The remaining generating capacity is accounted for by geothermal (0.2%), solar thermal, tide, wave and ocean power capacity, with

less than 0.2%. Hydro pumped storage capacity represented 69.3 GW.

As developments in the production of the various renewable energy sources in the electricity production section suggest, their growth of capacity has been strongest in the wind and solar power sectors and these two markets are heavily concentrated in Europe and the United States.

The following more detailed analysis of individual renewable and waste energy sources and their development in the electricity market provides further insights into this trend.

Hydroelectricity

As mentioned above, hydroelectric power is nearing its potential capacity limit in most OECD countries. Between 1990 and 2015, electricity generated from hydroelectric plants (excluding generation from pumped storage plants) increased from 1,179.3 TWh to 1,375.7 TWh in the OECD, yielding an average annual increase of 0.6%. While 89.3% of electricity produced from renewable sources came from hydroelectric plants in 1990, this share decreased to 55.7% in 2015 due to the rapid growth of electricity generation from other renewable sources. Despite this decrease, hydroelectric power is still the largest electricity producer among renewable energy. In 2015, the largest hydroelectric power generating countries were Canada, the United States and Norway which represented 27.6%, 18.4% and 10.1%, respectively, of OECD hydroelectric production.

Wind

In 2015, wind turbines produced 22.9% of renewable electricity in the OECD. Among OECD regions, wind electricity production is the highest in OECD Europe, with 55.5% of the total OECD production in 2015. Between 1990 and 2015, wind power increased from 4.0 TWh to 565.8 TWh, achieving an average annual growth rate of 22.1%. This is the second fastest growth rate of renewable electricity after solar photovoltaic. Most of the growth occurred in OECD Europe, where wind grew by 27.1% per annum. In absolute terms, the United States, Germany and Spain are the largest producers of electricity from wind within the OECD, producing 193.3 TWh, 88.0 TWh and 49.3 TWh respectively.

Solid biofuels

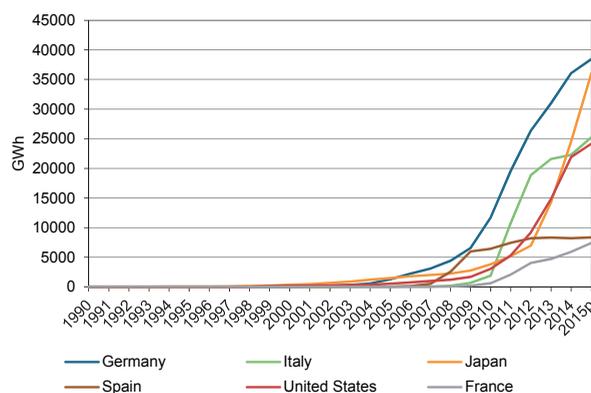
Electricity generation from solid biofuels grew from 95.2 TWh to 179.8 TWh between 1990 and 2015, yielding a 2.6% average annual growth. As the third largest renewable electricity source after hydropower and wind, solid biofuels accounted for 7.3% of renewable electricity generation in 2015. The United States (47.6 TWh) accounted for 26.5% of electricity generated from solid biofuels within the OECD, where it makes up 8.5% of the country's renewable electricity production. The second largest producer of electricity from solid biofuels is Japan (32.6 TWh), where it represents 19.8% of the country's renewable electricity supply. Other large producers of electricity from solid biofuels in the OECD in 2015 are UK, Germany, and Finland, producing 19.6 TWh, 12.3 TWh and 10.0 TWh respectively.

Solar photovoltaic

The OECD as a whole produced 174.5 TWh of PV electricity in 2015, 7.1% of its total renewable electricity production. The five largest producers of solar photovoltaic (PV) electricity in the OECD were Germany with 38.4 TWh, Japan with 36.0 TWh, Italy with 25.2 TWh, the United States with 24.1 TWh, and Spain with 8.3 TWh. These five countries combined produced 75.7% of the PV electricity in the OECD.

While being small in absolute terms, electricity from solar PV increased from 19 GWh in 1990 to 174,521 GWh in 2015, achieving a 44.1% annual growth rate, the fastest of all renewable electricity technologies. Since the 2000, growth has been the strongest in the countries of the European Union (Figure 19). Germany, the largest producer due to its support for solar photovoltaic electricity generation, has increased production from 60 GWh in 2000 to 38,432 GWh in 2015, achieving a 53.9% growth rate over that time. Japan, the second largest producer, increased production from 347 GWh in 2000 to 35,974 GWh in 2015, with a growth rate over those years of 36.3%. The United Kingdom experienced the fastest growth rate over the same period increasing from 1 GWh in 2000 to 7,556 GWh in 2015, a growth rate of 81.4%. France experienced 62.7% of growth rate, the second fastest growth rate, increasing from 5 GWh in 2000 to 7,400 GWh in 2015.

Figure 19: Solar photovoltaic electricity in six major producing countries from 1990 to 2015



Biogases

Electricity in the OECD from biogases grew from 3.7 TWh in 1990 to 78.8 TWh in 2015. With an average annual growth rate of 13.1% since 1990, biogases are the third fastest growing source of renewable electricity in the OECD.

The driver of this growth is OECD Europe, which accounted for 79.4% of OECD production in 2015. Much of the growth is due to Germany, where production grew by 21.5% per annum since 1990, making it the largest producer in the OECD (40.5%). The third and fourth largest OECD producers were also located in Europe. Italy produced 9.8 TWh or 12.4% of OECD production, and the United Kingdom produced 7.6 TWh (9.7%).

The second largest OECD producer in 2015 is United States which produced 13 TWh, or 16.5% of electricity from biogases in the OECD. However, despite its large share in OECD production, the United States growth rate (6.8% per year since 1990) has been lower than many of the European Union countries that use biogases, e.g. 40.5% in Italy and 11.9% in the United Kingdom.

Geothermal

Similar to hydroelectric power, geothermal electricity production has not experienced significant growth between 1990 and 2015. It grew at an average annual rate of 2.3%, from 28.6 TWh to 50.2 TWh.

Geothermal electricity generation remained almost static in OECD Americas over the period 1990 to 2015, although the region remains the largest geothermal electricity producer, with a 49.6% share of OECD production in 2015. The United States is the largest producer with 37.0% of the OECD total in 2015, with a production of 18.6 TWh, slightly above the 16.0 TWh level in 1990. The second largest producer is New Zealand, with 7.9 TWh in 2015, representing 15.7% of total OECD production. Other major producers are Mexico (12.5%), Italy (12.3%) and Iceland (10.0%).

Renewable municipal waste

Renewable municipal waste represented 1.3% of renewable electricity generation in 2015 in OECD countries. Renewable municipal waste is one of the smallest portions of renewable electricity portfolio. The highest share it represented in any one country is the Netherlands at 14.4%, Luxembourg at 9.9% and Belgium at 8.1%.

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.

In 2015, 32.2 TWh of electricity is produced from renewable waste in the OECD. By far the largest producer of electricity from renewable municipal waste is the United States, generating 8.4 TWh, or 26.1% of OECD production. The second largest producer is Germany, with a production of 5.9 TWh (18.4%). With 3.3 TWh (10.2%), Japan is the third largest producer. Italy experienced the highest growth rate, increasing production from 37.0 GWh to 2,217 GWh (a growth rate of 17.8% per annum).

Liquid biofuels

Liquid biofuels for electricity production is a relatively new technology. The first country to report electricity production of this type is Germany in 2001 with 15 GWh. Since then, an increasing number of countries have produced substantial amounts of electricity from liquid biofuels. In 2015, seven countries reported

a total of 4,663 GWh of production. The largest producer from far is Italy with 4,060 GWh.

Solar thermal

Solar thermal power production experienced rapid growth in the 1980's and 90's reaching 887 GWh in 1998, but stagnated in the following years. During the period of 1999 to 2006, average annual growth rates for solar thermal were essentially zero. Due to the recent renewed interest in solar thermal, the US has increased its production from 527 GWh in 1999 to 2,960 GWh in 2015. Prior to 2007, OECD solar thermal production took place mostly in the United States with small demonstration plants in Australia. With the opening of a new solar thermal power plant in 2007, Spain became the third OECD country to report electricity production from solar thermal with 5.5 TWh in 2015. These three countries combined produced all 8.5 TWh of OECD electricity from solar thermal in 2015.

Tide, wave, ocean

In 2015, 1,033 GWh of electricity were generated from tide, wave and ocean motion in four OECD countries. In 2015, Korea and France produced 529 GWh and 487 GWh respectively. The other contributors were Canada and United Kingdom producing 15 GWh and 2 GWh respectively in 2015.

Non-renewable municipal waste and industrial waste

Industrial waste and non-renewable municipal waste generated 0.4% of OECD total electricity in 2015. Electricity from industrial waste more than doubled between 1990 and 2002. It declined back to its 1990 level in 2007 and it is almost constant until 2015. Electricity generation from non-renewable municipal waste increased from 8.1 TWh in 1990 to 31.4 TWh in 2015, an average annual growth rate of 5.6%. It should be noted that this information should be used with caution because many countries (including some of the largest municipal waste producers such as Japan) do not report renewable and non-renewable municipal wastes separately.