



EXECUTIVE SUMMARY

THE STATE OF RENEWABLE ENERGIES IN EUROPE

EDITION **2021**
20th EurObserv'ER Report

This barometer was prepared by the EurObserv'ER consortium, which groups together Observ'ER (FR), TNO (NL), Renewables Academy (RENAC) AG (DE), Fraunhofer ISI (DE), VITO (Flemish Institute for Technological Research) (BE) and Statistics Netherlands (NL).



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ENERGY INDICATORS

22.1%

EU-27 RES share in gross final energy consumption in 2020 (19.9% in 2019)

37.5%

EU-27 RES share in gross electricity consumption in 2020 (34.1% in 2019)

23.1%

EU-27 share of energy from renewable sources for heating and cooling in 2020 (22.4% in 2019)

105 Mtoe

EU-27 renewable heat and cooling consumption in the EU 27 in 2020 (104.6 Mtoe in 2019)

1 058.4 TWh

Renewable electricity generation in the EU-27 in 2020 (978.7 TWh in 2019)

THE TARGET WAS REACHED ACROSS THE EUROPEAN UNION

The renewable energy share of gross final energy consumption reached 22.1% in 2020 in the EU-27. This is 2.1 percentage points higher than the collective target defined for 2020 and marks a major intermediate stage in the European Union's strategy to be the first climate-neutral continent by 2050. The renewable electricity share increased from 34.1% in 2019 to 37.5% in 2020.

RENEWABLE HEAT HELD FIRM THANKS TO HEAT PUMPS

According to Eurostat data (updated on 25 January 2022) compiled by EurObserv'ER, the amount of renewable energy used for heating and cooling increased slightly from 104.6 Mtoe in 2019 to 105 Mtoe in 2020. This indicator covers the energy consumed directly by industrial end-users and other sector users (such as residential, commercial, agriculture, forestry and fishery), heat produced by the processing sector (derived heat), and the renewable production recovered by heat pumps. Final energy consumption and heat production from the processing sector of the biogas injected and blended in the natural gas grid are also included in this indicator.

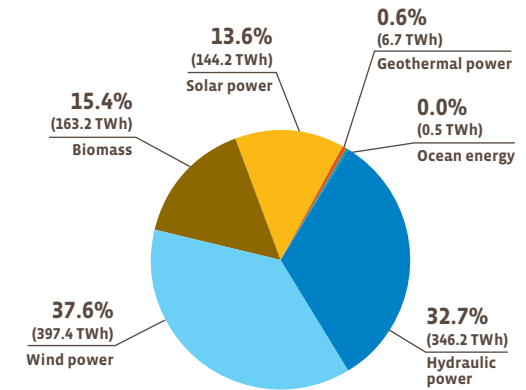


THE 1000-TWh THRESHOLD FOR RENEWABLE ELECTRICITY CROSSED BY THE 27

It has taken the European Union two years to make up for the equivalent loss of renewable electricity output resulting from the United Kingdom's departure. The EU-27 has again crossed this symbolic 1000-TWh threshold two years after crossing it as the EU-28. According to Eurostat's 25 January 2022 data updates, gross European non-normalized renewable electricity excluding pumped storage output came to 1 058.4 TWh in 2020, posting 8.1% year-on-year growth (978.7 TWh). To put this into perspective, this difference is more than the total gross electricity output of a country such as Austria (72.6 TWh in 2020). In 2020, renewable energies provided 38.1% of total gross electricity production in the EU-27. □

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Renewable electricity generation (in TWh) and share of overall renewable generation (in %) in 2020 in the EU 27

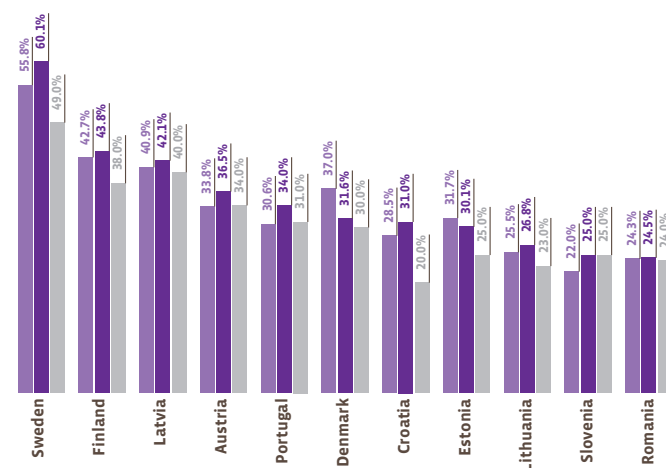


2020: total 1 058.4 TWh

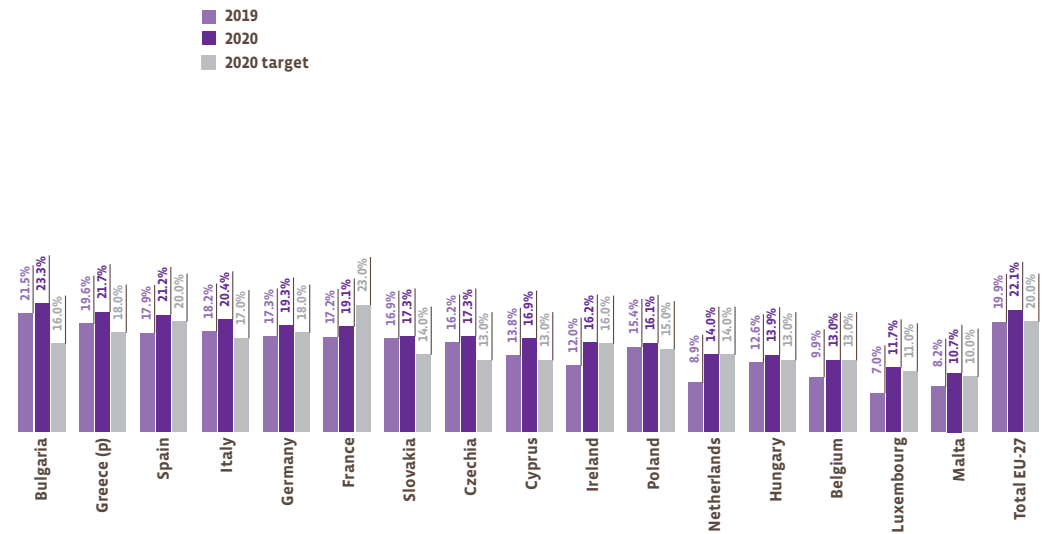
Source: EurObserv'ER based on Eurostat database.

1

Share of energy from renewable sources in total gross final energy consumption in 2019 and 2020 target



* Year 2020 (provisional for Greece). SHARES tool version 2020 takes into account specific calculation provisions as provided by Directive 2009/28/EC, in addition to the new possibility to allocate domestically produced biomethane to the transport sector on the basis of the mass-balance system.



Source: Eurostat SHARES (updated 1 February 2022)

ENERGY INDICATORS

29.4 GW

Additional electrical renewable capacities connected to EU-27 grids in 2020

43.1 GW

Electricity storage capacity installed in the EU-27 at the end of 2020

94.4%

Share of pumped hydro out of total installed EU-27 electricity storage capacity in 2020

35.5%

Consumption share of energy from renewable sources for heating and cooling in buildings in EU-27 in 2019

60.1%

Share of energy from renewable sources in the total gross final energy consumption in Sweden (2020)

91% OF NEWLY CONNECTED ELECTRICAL CAPACITIES IN 2020 IN THE EU ARE RENEWABLE

In 2020, renewable technologies dominated the European Union's mix of newly connected electrical capacities. Coal-fired power plants constituted 6% of the 32.3 GW of new electrical capacity and gas-fired power plants 3% of the new capacity installed in 2020. Meanwhile, photovoltaic weighed in at 55% and wind energy at 32% of newly-installed capacity. No nuclear units were added to the European mix. Only three countries commissioned fossil fuel-fired power plants in 2020. Germany added 1 055 MW of coal-fired capacity and 448 MW of fossil gas capacity, Poland (950 MW of coal-fired and 450 MW fossil gas capacity) and France (11 MW of fossil gas capacity).

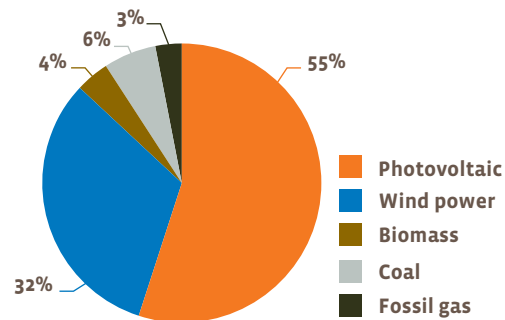
HEATING AND COOLING FROM RENEWABLES IN THE BUILDING STOCK

In the building stock the energy consumption changes only marginally from year to year, given the low changing rate of heating and cooling appliances. Figure 4 presents the consumption shares of heating and cooling with renewable energies in 2019 for residential buildings and services. Gas remains a crucial source of heating for most countries. Especially in the Netherlands, Italy, and to a smaller extent in Hungary, Belgium and Slovakia, gas is still dominating the heating system. Oil boilers are an important heating source in Cyprus, Ireland, Luxembourg, and Greece. Even though the heating market experiences a constant decrease in oil boilers, other countries such as Malta, Belgium, Spain, Portugal, Germany, and Slovenia still have a decent share of this technology in their heating mix.



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Distribution of additional electrical capacities connected to EU-27 grids in 2020 by technology

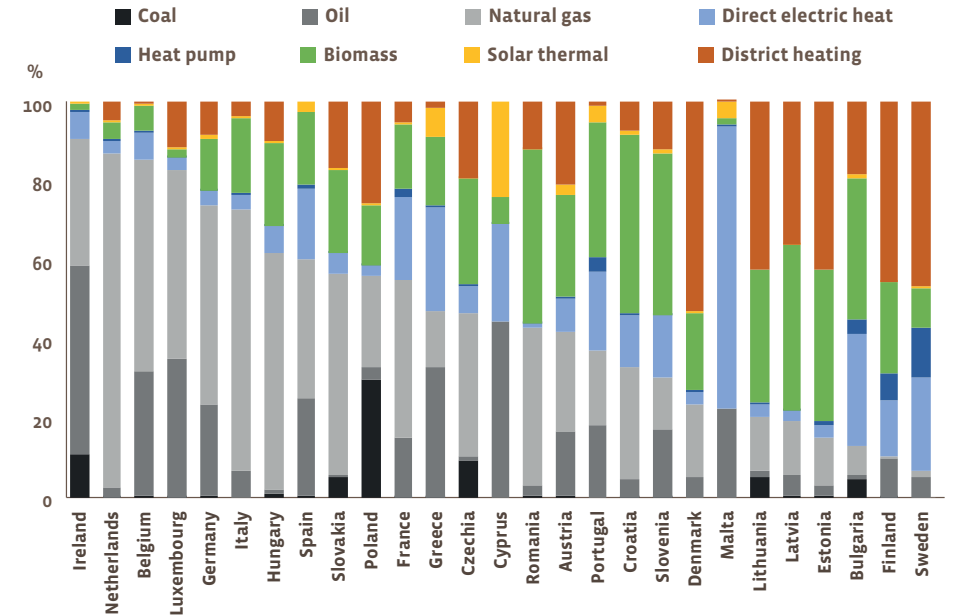


Total: 32.3 GW

Source: EurObserv'ER - Enerdata

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RES consumption shares in heating and cooling in the building stock and urban infrastructure in 2019



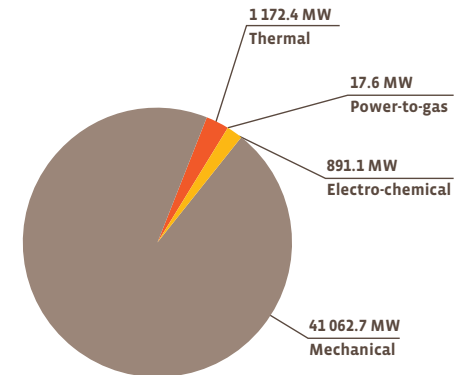
Source: EurObserv'ER - own assessment based on diverse sources. Notes: Heat pumps considers both ambient heat and electricity. District heating contains derived heat obtained by burning combustible fuels like coal, natural gas, oil, renewables (biofuels) and wastes, or also by transforming electricity to heat in electric boilers or heat pumps.

ELECTRICITY STORAGE CAPACITIES

As the share of renewably-sourced electricity consumption continues to grow in Europe, the challenges posed by this energy's storage have become a core issue. At the end of 2020, 43.1 GW of storage capacity total was connected to either the distribution or the transmission networks of the EU-27. Mechanical technologies, such as pumped hydro plants, largely dominates this capacity with 40.7 GW. Among the other developed technologies, Li-ion battery storage accounts for 720 MW, mainly developed in Germany (560 MW). Thermal molten salts storage represents 1 GW, but just one country (Spain) is working on that matter, which is well

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Installed storage capacities by technology in the EU-27 at the end of 2020



Source: EurObserv'ER based on the database of the European energy storage technologies and facilities

compatible with concentrated solar power plants. So far, power-to-gas capacities are very low, with just 17.6 MW of pilot electrolyser geared towards grid balancing. □

1 313 300

FTE jobs in the European renewable energy industry in 2020

€162.9 bn

Turnover generated by renewable energy sources in EU-27 in 2020

318 800

Jobs in EU-27 heat pump sector in 2020

283 000

Jobs in EU-27 solid biofuels sector in 2020

280 400

Jobs in EU-27 wind sector in 2020

€43.6 bn

in turnover of wind power sector in the EU in 2020

EMPLOYMENT

Overall, around 1.3 million people are directly or indirectly employed in the European Union RE sector. This represents a gross increase of 65 000 jobs (5.2%) from 2019 to 2020. 13 out of 27 Member States either increased or maintained their number of renewable energy jobs. The top 4 countries in terms of employment are: Germany (242 100 jobs, 18% of all EU renewable employment), France (164 400 jobs, 13%), Spain (140 500 jobs, 11%), and Italy (99 900 jobs, 8%). The largest growth in employment was found in the Netherlands (+42 700 new jobs, equal to +100%), France (+23 900, equal to +17%), and Greece (+21 900 jobs, equal to +107%). The greatest losses were observed in Portugal (-43 000 jobs, equal to -41%), Spain (-15 300, -10%) and Bulgaria (-8 600 jobs, equal to -32%). Heat pumps (318 800 jobs, 24% of the total EU) became the largest sector in terms of renewable-energy-induced employment, ahead of solid biofuels (283 000 jobs, 22%) and wind power (280 400 jobs, 21%). The most significant upward jump in employment per technology was in the heat pumps sector, with an additional 64 900 jobs (+26%), followed by wind power that saw an addition of 61 700 new jobs (+28%). Employment estimates for all other renewable energy sectors decreased in 2020.

TURNOVER

In total, the renewable-energy-related industry turnover in EU-27 Member States in 2020 amounted to around €163 billion, representing a gross growth of around €13.7 billion against 2019 (+9.2%). 13 out of 27 EU Member States either increased

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2020 Employment distribution in the EU-27

	Country total
Germany	242 100
France	164 400
Spain	140 500
Italy	99 900
Poland	92 600
Netherlands	85 800
Portugal	60 800
Sweden	57 600
Greece	42 300
Denmark	35 400
Hungary	35 400
Romania	32 600
Czechia	27 500
Belgium	25 000
Finland	24 400
Lithuania	22 000
Austria	19 700
Bulgaria	17 900
Slovenia	17 500
Latvia	15 000
Estonia	14 200
Croatia	14 000
Slovakia	13 900
Ireland	6 200
Malta	3 700
Luxembourg	1 800
Cyprus	1 100
Total EU-27	1 313 300

Source: EurObserv'ER



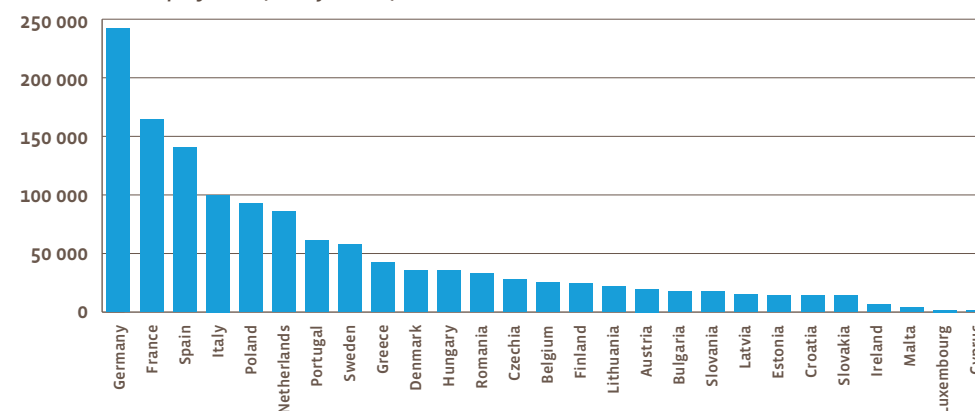
or maintained their industrial turnover created by renewable energy sources. The top 5 Member States in terms of turn-over are Germany (€37.5 billion), France (€24.5 billion), Spain (€15.9 billion), the Netherlands (€13.1 billion), and Italy with €12.9 billion. These are also the countries where the gross

value added is largest. The largest growth in turnover according to the EurObserv'ER modelling was observed in the Netherlands (+€6.4 billion), France (+€3.7 billion), Germany (+€2.2 billion), and Greece (+€2.0 billion). The largest dips in turnover occurred in Portugal (-€2.4 billion) and Spain (-€1.2 billion). The largest renewable

energy technologies in, in terms of industry-sector turnover, were wind power with €43.6 billion, followed by heat pumps (€41.0 billion), and solid biofuels (€29.8 billion). The gross value added was also largest for these sectors: €18.5 billion for wind power, €16.4 billion for heat pumps and €14.4 billion for solid biofuels. □

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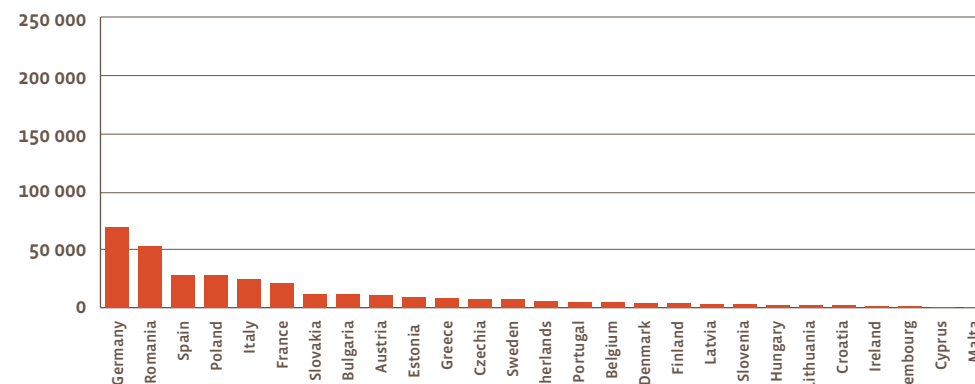
Gross renewable employment (data for 2020)



Source: EurObserv'ER

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Indicator for equivalent replaced fossil employment, looking at operation, maintenance and fuel production activities only (data for 2020)



Source: EurObserv'ER

RENEWABLE ENERGY COSTS AND ENERGY PRICES

from **46%** to **85%**

Decrease of residential PV investment costs between 2010 and 2020

€120/MWh

Average estimated cost level for residential solar PV

€1.33 m/MW

European onshore wind investment costs by 2020 (€2.13 m/MW in 2010)

INTERNATIONAL COMPARISON OF INVESTMENT COSTS

Overall, average investment costs for onshore wind decreased from 2010 to 2020. In Europe, onshore wind investment costs dropped from 2.13 M€/MW in 2010 to 1.33 M€/MW by 2020. For onshore wind, costs are quite specific to local circumstances and therefore vary substantially per country.

For solar PV, the global capacity weighted-average total installed cost of projects commissioned in 2020 was 81% lower than in 2010, while solar PV capacity grew 16-fold between 2010 and 2020. Solar PV total-installed cost reductions are related to the optimisation of manufacturing processes, reduced labour costs, enhanced module efficiency and developers getting more experience and better supply chain structures. In 2020, significant total-installed cost reductions

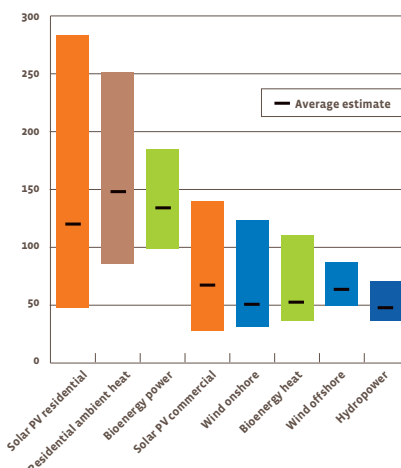
occurred across all the major historical markets, such as China, India, Japan, the Republic of Korea, the United States and Germany.

RENEWABLES FINANCING CONDITIONS

Besides the investment costs, another parameter that influences the resulting energy generation costs is the cost of financing. To calculate the levelized cost of energy (LCoE), a level of financing cost is assumed. The Weighted Average Cost of Capital (WACC) is used to measure the financing costs for a company or project. It is the average, after tax cost of raising debt and equity capital from different sources. The WACC is not typically a value that is publicly available for individual companies or projects. Estimating the WACC for different renewable energy technologies across the 27 EU Member States provided a basis for the LCoE calculations. The methodology for estimating

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Estimated Levelised cost of renewable energy in the EU (€/MWh)

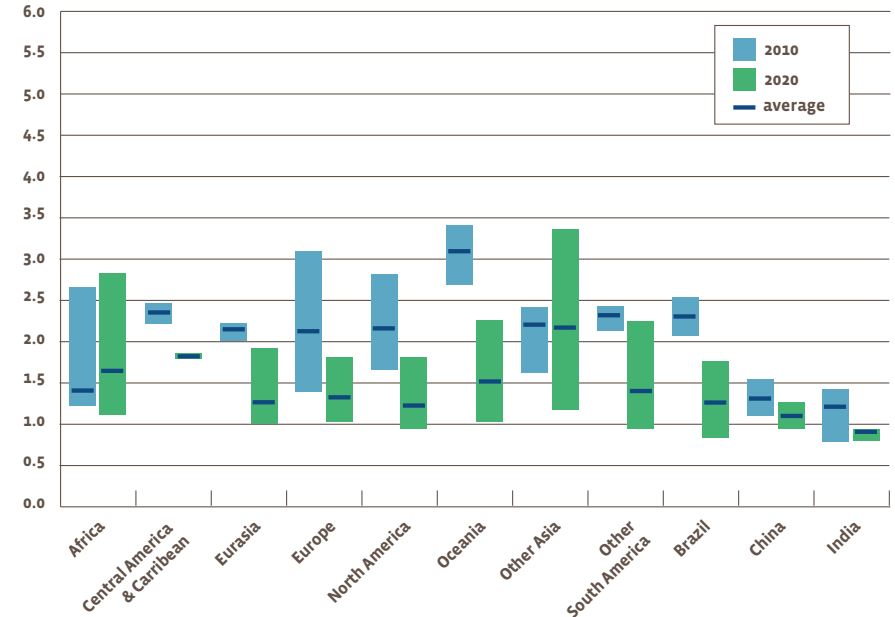


Source: EurObserv'ER



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Onshore wind investment costs worldwide according to IRENA (M€/MW)



Note: The region 'Other Asia' represents Asia excluding China and India. The region 'Other South America' excludes Brazil. Source: IRENA

the WACC has been introduced in the 2021 Edition of The State of Renewable Energies in Europe.

LEVELIZED COSTS OF ENERGY

In addition to the WACC estimates and the investment costs, the renewable energy technology LCoE analysis requires a significant amount of data and assumptions on operational expenditures, fuel costs (for biomass technologies), economic life, annual energy production, auxiliary energy requirements (for heat pumps), fuel conversion efficiency and the project duration. All input parameters are defined as data ranges. A Monte Carlo (MC) approach is then applied to perform the LCoE calculation.

RENEWABLE ELECTRICITY

The LCoE from solar PV has continued to decrease over the past few years. Solar PV in the residential sector is small in system size (it should fit on rooftops) and therefore is relatively expensive. There are less benefits from economies of scale for modules and inverters, and in relative terms, more labour is involved to install the PV system. Although all cost components in a PV system have seen significant cost reductions over the past decades, it remains the most expensive renewable technology, although that varies strongly from country to country.

RENEWABLE HEAT

For the technologies producing heat, bioenergy heat LCoE is relatively low, indicating it is competitive in many countries. According to the analysis, heat captured from ambient heat via heat pumps (through small-scale equipment) shows relatively high LCoE levels. Scaling up to collective systems, possibly in combination with district heating, may decrease the costs further. □

AVOIDED FOSSIL FUEL USE AND RESULTING AVOIDED COSTS

164.6 Mtoe

EU-27 substituted fossil fuels by RES in 2020

528 MtCO₂ eq

Avoided GHG emissions through RES consumption in the EU-27 in 2020

€34.6 bn

EU-27 avoided expenses through renewable energy sources in 2020

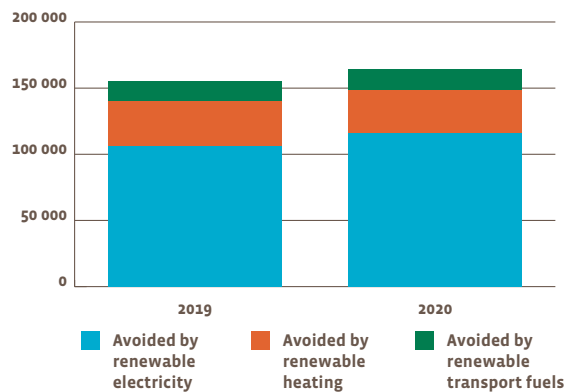
MORE FOSSIL FUELS AVOIDED BY RENEWABLE ENERGY IN 2020

Progress achieved in EU-wide renewable energy deployment since 2005 is largely attributed to the presence of mandatory national targets for 2020; first set under the Renewable Energy Directive, or RED (Directive 2009/28/EC), which has been recast under the ‘Clean Energy for all Europeans’ package: REDII (Directive 2018/2001/EU), entered into force in December 2018. In response to these targets, national support instruments were put in place, such as feed-in tariffs, feed-in premiums, auction/tender systems, quotas, tax credits and grants. The increase in the use of renewable energy leads to less consumption of fossil fuels, both domestic and imported. In 2020 and 2019, the increase in the use of renewable energy substituted around 164.6 Mtoe

and 155.6 Mtoe of fossil fuels respectively, compared to the level of use of renewable energy in 2005. These figures correspond to an avoided annual cost of EUR 43.5 billion for EU-27 collectively in 2019, decreasing to EUR 34.6 billion in 2020. In 2019 the largest financial contributions derive from renewable electricity and renewable transport (at approximately equal contributions together representing about 84% of the avoided expenses). For 2020 the picture is different: renewable electricity and renewable transport again show the largest financial contributions (together representing about 77% of the avoided expenses), but the contribution from renewable electricity because of the sharper decrease in end-user prices for fossil transport fuels compared to wholesale natural gas and coal prices.

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EU-27 avoided fossils fuels per sector (ktoe)

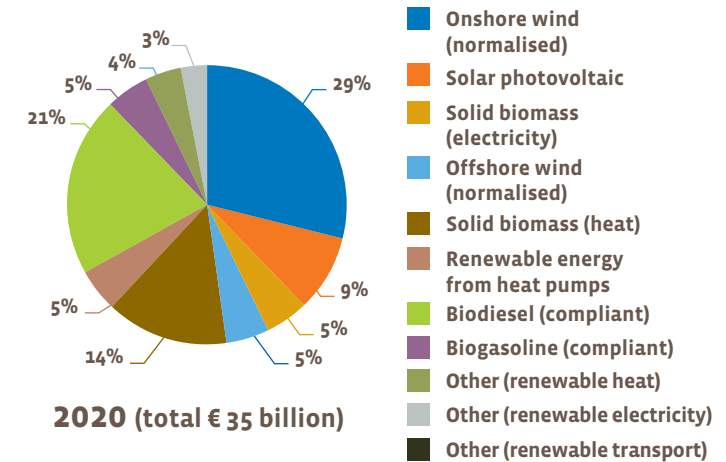


Note: Reference year 2005. Note: for 2020 proxy data are used. Source: Eurostat, EurObserv'ER based on EEA data.



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EU-27 avoided expenses through renewables



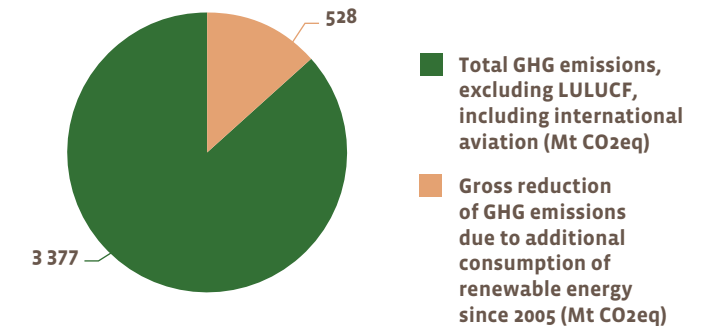
Note: Reference year 2005. Note: for 2020 proxy data are used. Source: EurObserv'ER based on EEA data.

AVOIDED GHG EMISSIONS IN EU-27

For the EU-27, a gross reduction of 528 Mt CO₂eq of GHG emissions has been realised due to the additional consumption of renewable energy. While total EU-27 GHG emissions were approximately 3377 Mt CO₂eq in 2020, the additional uptake of renewable energy has led to a gross reduction of GHG emissions of 13.5% in 2020. The gross reduction of GHG emissions due to the additional consumption of renewable energy has increased from 500 Mt CO₂eq in 2019 to approximately 528 Mt CO₂eq in 2020. □

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Effect on GHG emissions in EU-27 in 2020



Note: Reference year 2005. Note: for 2020 proxy data are used. Source: Eurostat, EurObserv'ER based on EEA data.

INDICATORS ON INNOVATION AND COMPETITIVENESS

€335.3 m

Public R&D expenditure in all renewable energy technologies in 2020 in the EU-27

€4 355 m

Private R&D expenditure in all renewable energy technologies in 2020 in the EU-27

1 399

Number of renewable energy patent filings in the EU-27 in 2018

€15.29 bn

EU-27 trade (exports) in 2020 - all renewable energy sources (RES)

R&D INVESTMENTS

R&D investments can be seen as an indicator to measure innovative performance of economies or innovation systems. Public and private R&D expenditures are presented for a selected set of countries and renewable energy technologies. The aggregated results of public R&D investments for all renewable energy technologies in the EU-27 amount to nearly 1 billion euros (data for 2019): more than two-thirds from national contributions (624.0 million euro) and one-third from the European Commission (293.4 million euro). The public R&D expenditure in 2020 in the selected EU-27 Member States amounts to 0.0025% of the GDP. Private R&D investment in all renewable energy technologies in a selection of EU Member States amount to 3636.3 million euros (data for 2018). Germany has the highest private R&D expenditures, and Denmark,

France, the Netherlands and Spain come next. The total GDP share of the selected EU-27 Member States has increased from 0.028% in 2017 to 0.032% in 2018. The data on public and private R&D investment were provided by JRC SETIS.

PATENT FILINGS

The technological performance of countries or innovation systems can be measured by analysing the patent filings. The patent data were provided by JRC SETIS, and originate from the EPO Worldwide Patent Statistical Database (PATSTAT). Worldwide, China has filed the largest number of patents for renewable energy technologies in 2018, followed by Korea and thirdly the EU-27. Within the EU-27, a strong position of Germany is noted, followed by Denmark, France and the Netherlands. In terms of GDP shares, Denmark is leading, followed by Germany, Poland and Finland.

14

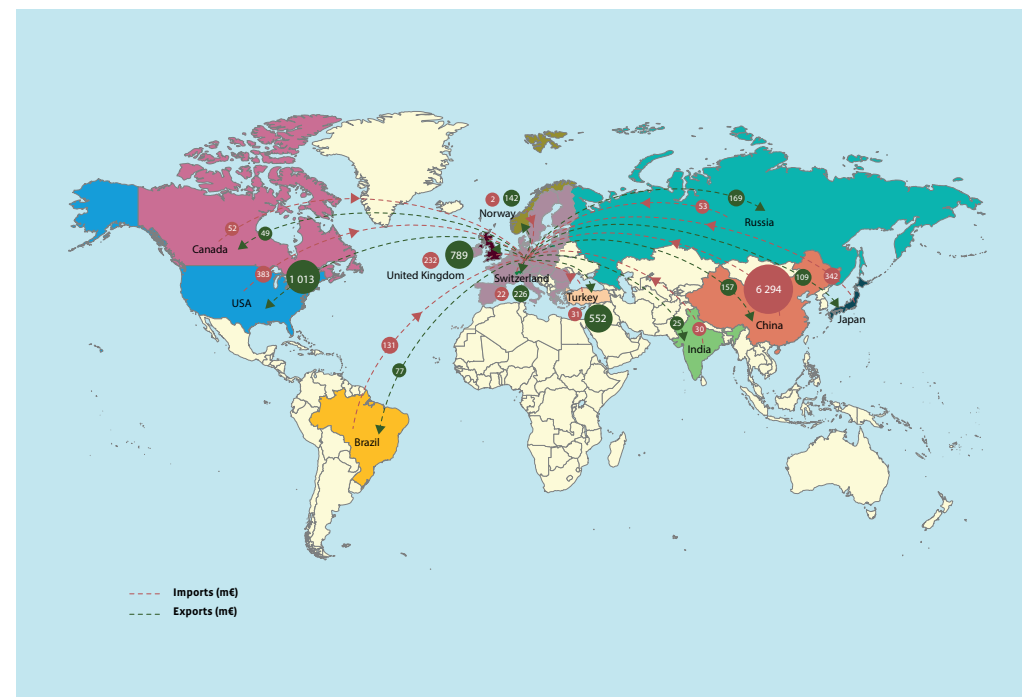
Main EU partners' trade with the rest of the world (including EU-27), 2020 - all RES

	Imports (in € m)	Exports (in € m)	Net exports (in € m)	Share of global exports	Exports specialisation (RCA)
China	6 379	22 228	15 849	32,9%	32
Switzerland	360	194	-166	0,3%	-67
Brazil	1 435	1 257	-179	1,9%	18
Japan	3 364	3 111	-253	4,6%	9
Norway	334	4	-330	0,0%	-96
Russia	461	112	-349	0,2%	-79
Canada	1 098	365	-733	0,5%	-56
United Kingdom	1 147	285	-862	0,4%	-63
Turkey	1 125	164	-961	0,2%	-55
India	1 618	420	-1 198	0,6%	-39
USA	10 305	4 179	-6 125	6,2%	-13
Rest of the world	23 507	20 027	-3 481	29,6%	-1



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EU-27 trade with its main trading partners, 2020 - all RES



INTERNATIONAL TRADE

The trade in RET between the EU-27 and main trading partners is illustrated in the figures 14 and 15. The net trade balance with China is very negative, i.e. much more is imported from China to the EU-27 than the reverse. Imports from China increased by almost €1 000 million in 2020 compared to 2019. The EU-27 also has a negative RET trade balance with Japan and

Brazil. On the other hand, the EU-27 has a significant positive RET trade balance with the U.S., the U.K., Turkey, Switzerland, Norway and Russia. Net exports to these countries also increased in 2020 compared to 2019. In Canada, net exports of €70 million in 2019 changed to net imports of €3 million in 2020. □

EUROSERV'ER BAROMETERS ONLINE

All *EurObserv'ER* barometers can be downloaded in PDF format at the following address:

www.eurobserv-er.org

The screenshot shows the EurObserv'ER website interface. At the top, there is a navigation bar with icons for solar, wind, hydro, and other energy sources. The main content area is titled 'Latest barometers released' and features a prominent article for the 'OCEAN ENERGY BAROMETER' with a value of 243.4 MW. Below this, there is a section for 'Interactive EurObserv'ER Database' and a 'Twitter' feed. The page also includes a sidebar with a newsletter sign-up form and a map of Europe.



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Schedule for the 2022 EurObserv'ER barometers

Wind power	>> March 2022
Photovoltaic	>> April 2022
Solar thermal	>> June 2022
Ocean Energy	>> September 2022
Renewables in transport	>> November 2022
Solid biofuels	>> December 2022



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