EXECUTIVE SUMMARY

# THE STATE OF RENEWABLE ENERGIES IN EUROPE

EDITION 2018

*18th EurObserv'ER Report*

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# ENERGY INDICATORS

**1 122.3 Mtoe**

*Gross final energy consumption in 2017*

**17.5%**

*Percentage of renewable energy in gross final energy consumption in the EU 28 in 2017*

**30.7%**

*Share of renewable energy in the electricity generation of EU 28 in 2017*

**102.2 Mtoe**

*Renewable heat and cooling consumption in the EU 28 in 2017*

**975.2 TWh**

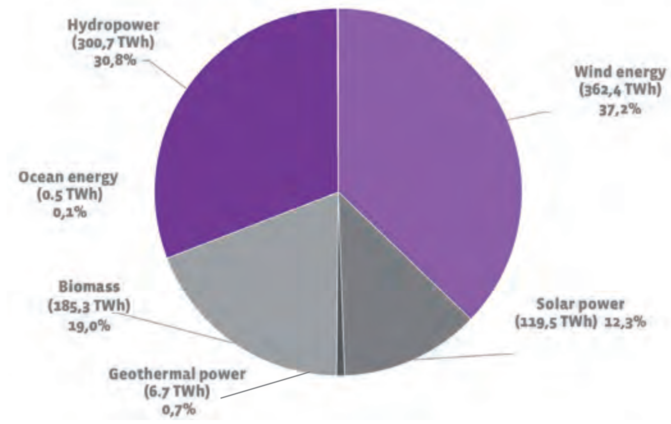
*RES electricity generation in 2017*

## HALF A PERCENTAGE POINT CLOSER TO THE 2020 TARGET

In 2017, the renewable output inched closer to 2020 target set in the Renewable Energy Directive. The renewably-sourced share of gross final energy consumption was 17.5% which is half a percentage point improvement (0.5 pp) as compared to 2016. The year on year increase in the renewable energy share across the European Union was a little higher than that of 2016 when 0.3 pp was added between 2015 and 2016. Nevertheless, the current growth rate is too slow to meet the 2020 target and a growth rate of at least 0.83 pp every year between 2018 and 2020 should be attained to achieve this ambitious target. Nevertheless, a majority of countries remain on course to meet their targets while 11 have already exceeded their nationally defined targets in 2017. This still leaves the possibility to achieve the target collectively if countries that expect to overshoot their targets do not slow down and implement cooperation mechanisms such as "statistical transfers" to countries expecting to fall short of target. Variability in climate conditions has impacted output in different sectors in vastly contrasting ways, depending on the member countries' geography and fluctuating demand. Gross real renewable electricity output (non-normalised), crept up very slightly in 2017 to 975.2 TWh (graph 1), a 2.2% increase over 2016 (953.9 TWh). Renewables in EU's Heat and cooling output contributed to 102.2 Mtoe in 2017, which represents a 2.7% annual growth (an additional 2.7 Mtoe). The renewable heat share reached 19.5%, which is a 0.5 percentage point year-on-year increase. Solid biomass remains the main renewable sector for heat and cooling application with 80.3 Mtoe greatly outperforming, Heat pumps which reached 10.5 Mtoe. However, the succession of mild years and winters in Europe – a quantifiable consequence of climate warming – obfuscates efforts to read the impact of the policies introduced to promote the use of renewable heat. □

**2**

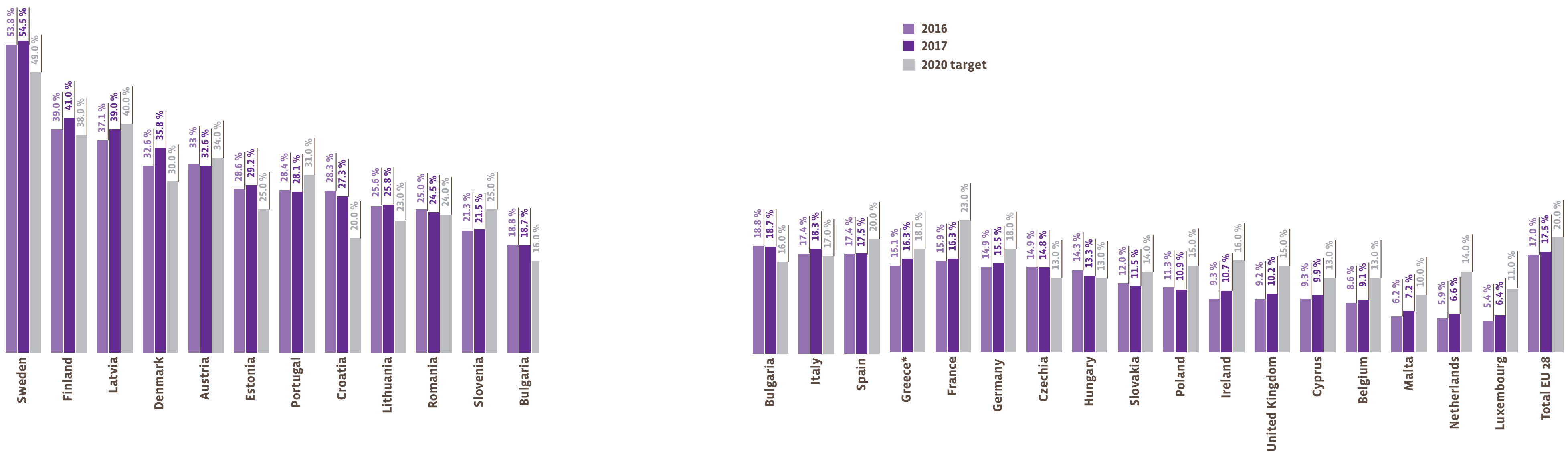
Renewable electricity generation (in TWh) and share of overall renewable generation (in %) in 2017 in the EU 28




*Source: EurObserv'ER 2018*

**1**

Share of energy from renewable sources in gross final energy consumption in 2016, 2017 and 2020 targets




*Source: SHARES 2017, updated 4th February 2019. * Year 2017 for Greece estimated by Eurostat.*

# SOCIO-ECONOMIC INDICATORS

**1 445 900**

*FTE in renewable energy sector in the EU in 2017*

**154 660**

*RES turnover in the EU 28 by renewable technologies in 2017*

**364 800**

*Jobs in EU solid biomass sector in 2017*

**356 700**

*Jobs in EU wind sector in 2017*

**48 040**

*Turnover of wind power sector in the EU in 2017*

## OVERALL EMPLOYMENT

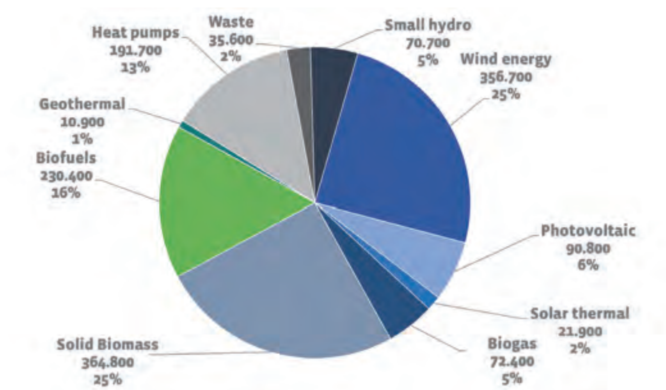
According to the new modelling approach adopted by EurObserv'ER, the number of renewable energy jobs in the EU in 2017 amounted to 1.45 million, with an increase of just over 1%, corresponding to 18 500 jobs. Technologies for which the 2017 estimates were lower than that of 2016 (which implies a contraction in the number of jobs) include: PV which decreased from 95 900 to 90 800 (-5.3%), heat pumps which decreased from 249 400 to 191 700 (-23.1%), biogas which decreased from 76 300 to 72 400 (-5.1%), hydropower which decreased from 75 900 to 70 700 (-6.9%) and solar thermal which decreased from 29 000 to 21 900 (-24.5%). On the other hand, several technologies saw an expansion in the number of FTEs created over the past year: wind power increased from 309 000 to 356 700 (+15.4%), solid biomass increased from 352 500 to 364 800 (+1.3%), biofuels rose from 205 100 to 230 400 (+12.3%), geothermal increased from 8 600 to 10 900 (+26.7%) and municipal solid waste saw job figures rise from 25 700 to 35 600 (+38.5%). The combined turnover for the 10 renewable energy sectors in the 28 EU member states amounted to 154.7 billion euro in 2017, 3.6% higher than 2016. This indicates positive investment activities as this rise occurs despite falling technology costs and political hesitation in many EU member states.

## RENEWABLE ENERGY INDUCED TURNOVER

The combined turnover for the 10 renewable energy sectors covered in the 28 EU member states amounted to 154.7 billion euro in 2017, 3.6% higher than 2016. This indicates positive investment activities as this rise occurs despite falling technology costs and political hesitation in many EU member states. The turnover for wind (€48.0 billion, equivalent to 31% of the total EU RES sector turnover), solid biomass (€34.6 billion, 22%) and heat pump (€22.7 billion, 15%) were the top 3 in terms among all the technologies.

**3**

Renewable energy employment by technology in the EU-28 in 2017 in FTE (Total: 1.445 million)



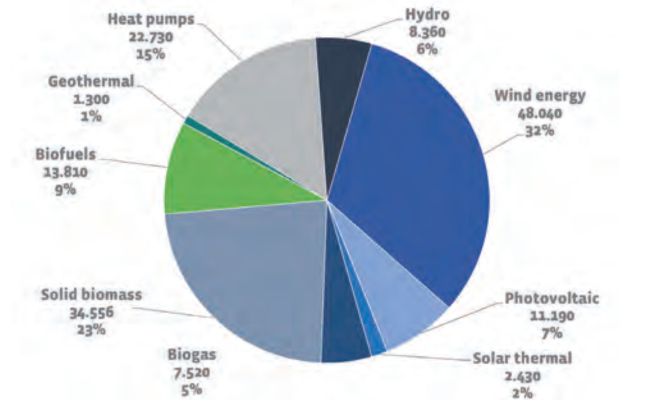

*Source: EurObserv'ER 2018*

## METHODOLOGY CHANGE

Unlike the methodology used in previous years that determined the actual jobs that present or revenues made in a certain year, the methodology utilized for the now determines the jobs and revenues that are related to the capacity of a technology (installed and already present). This change implies that a sudden decline or increase in jobs as presented in this study does not necessarily correspond with what is observed by national sector associations. Instead, it takes into account money flows from investments in new installations, operational and maintenance activities, production and trading of renewable equipment and biomass feedstock. The results obtained from this methodology is then expressed as full-time equivalent employment and as turnover figures for gross direct and indirect employment. □

**4**

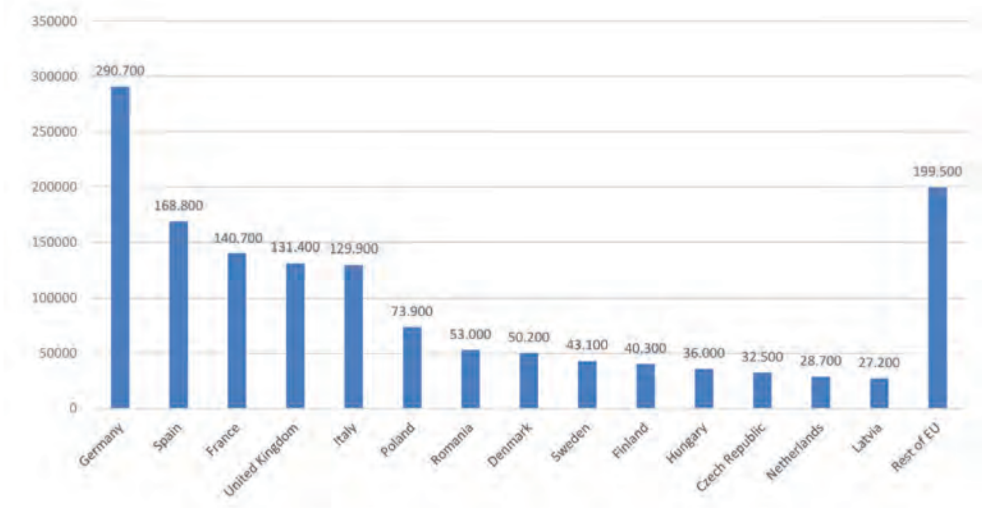
Renewable energy turnover by technology in the EU-28 in 2017 (Total: € 154.6 billion)




*Source: EurObserv'ER 2018*

**5**

Renewable energy employment by country in the EU-28 in 2017




*Source: EurObserv'ER 2018*





THE STATE OF RENEWABLE ENERGIES IN EUROPE – EXECUTIVE SUMMARY 2018 EDITION

# INVESTMENT INDICATORS

**€ 27.0 billion**

*Investments in RES capacity (asset finance) 2017*

**€ 1.63 billion**

*Venture Capital / Private Equity investments in 2017*

**€ 23.9 billion**

*Investment in wind capacity (asset finance) in 2017*

**€ 1.04 million**

*Investment expenditures per MW of solar PV in 2017*

**€ 1.38 million**

*Investment expenditures per MW of onshore wind in 2017*

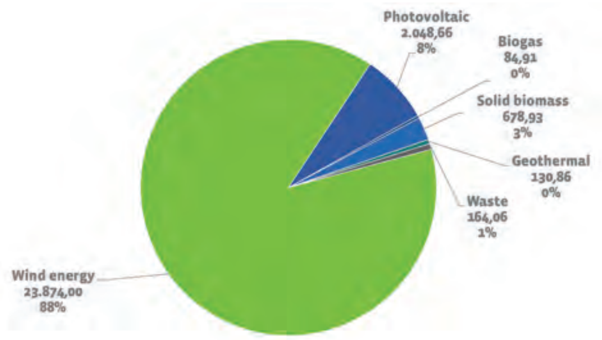
## INVESTMENT (ASSET FINANCE)

Investment in renewable energy can be split into two fields; investments in utility-size RES power plants (asset finance) and venture capital which focuses on very young start-up companies typically with high risks and high potential returns. After a record year in 2016 with EU investments in RES capacity totalling € 46.3 billion, investments slumped to € 27 billion in 2017. In spite of this decline, the 2017 investment amount is still higher than investments in 2014, i.e. prior to the two impressive years 2015 and 2016. Overall, there is a heterogeneous trend across investment in RES technologies in the EU. In 2016, wind investments, including both onshore and offshore wind, reached an absolute record high of € 38 billion since the introduction of the investment indicators. In 2017, overall investments in wind capacity decreased by more than one third to almost 24 billion. In the two sectors with the highest investments, onshore wind and solar PV, investment costs per MW of capacity seem to be below the average of the considered non-EU countries. In addition to the lower absolute investment costs, these costs were still decreasing between 2016 and 2017 in the EU. For biomass and offshore wind, investment expenditures per MW have risen in the EU.

Investments expenditures per MW of onshore wind capacity in the European Union dropped by more than 3% from € 1.42 million per MW in 2016 to € 1.38 million in 2017. In the EU solar PV sector, investment costs of utility-scale plants dropped by more than 6%, a rate that was even higher than for onshore wind, namely . Investment expenditures per MW of solar PV decreased from € 1.11 million per MW in 2016 to only € 1.04 million in 2017.

**6**

Asset finance - New Built (in mln €) in 2017 by technology

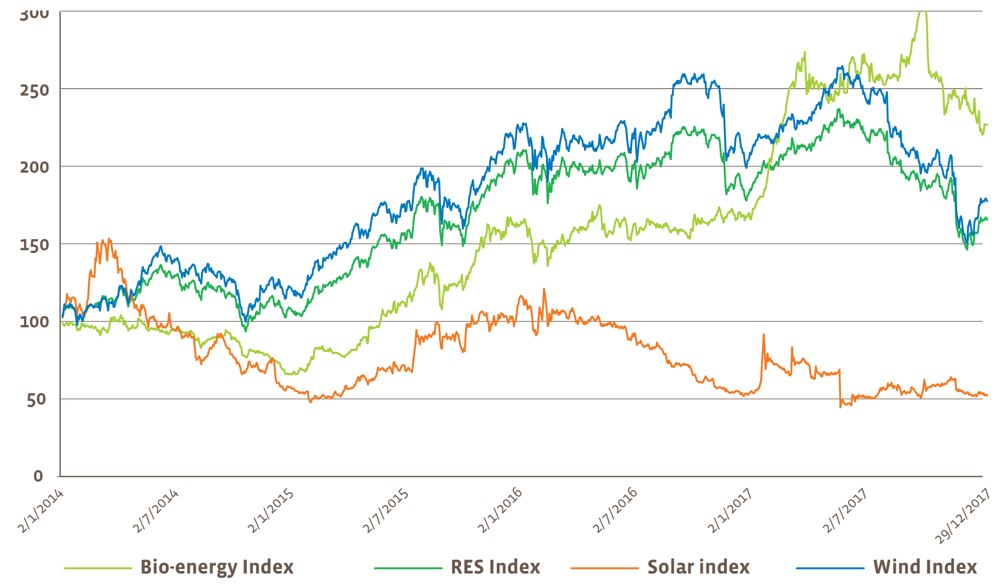



*Source: EurObserv'ER 2018*



**7**

Evolution of the RES indices during 2014 to 2017




*Source: EurObserv'ER 2018*

## VENTURE CAPITAL & PRIVATE EQUITY

Total venture capital (VC) and private equity (PE) investments in renewable energy companies decreased between 2016 and 2017 by around 18% to € 1.6 billion compared to € 2 billion in 2016. Thus, the development of VC/PE investments in the RES sectors runs against the overall positive trend in VC/PE investments in the EU. According to the data of the European Private Equity and Venture Capital Association (EVCA), overall EU-wide VC/PE investments (covering all sectors) increased by around 29%. VC/PE investments in the solar PV sectordominates all other RE sectors in both 2016 and 2017. The relatively high investments in this solar PV sector, however, were largely driven by very large PE Buy-outs in both years. Thus, the innovative activities in the solar PV sector relative to other RES should not be over-interpreted. C/PE investments in the wind sector dropped notably from € 663 million in 2016 to € 267 million in 2017.

## PERFORMANCE OF RES TECHNOLOGY FIRMS AND RES ASSETS

Indices based on RES company stocks were compiled in order to assess the performance of companies that develop / produce RES technology. The Wind Index experienced substantial growth in the first and second quarter of 2017. At its peak, the index reached almost 268 points. However, listed firms in the wind sector soon experienced a noticeable decline in their performance. Likewise, the Bio-Energy Index grew substantially from around 180 points at the start of 2017 to more than 270 points at the end of the first quarter but then settled once again at the 250 points mark before yet another peak was attained in the third quarter (where more than 300 points were observed). On the other hand, the Solar Index shows substantially development trends as compared to compared to the other two RES indices in 2017, as it remains relatively stable at on one level. At the end of the year it closed at almost the identical value as at the beginning of that year. □

# RENEWABLE ENERGY COSTS, PRICES AND COST COMPETITIVENESS

**RES-E**

*Energy costs for wind and solar PV reduced significantly since 2010*

**RES-H**

*LCoE for solid biomass heat is competitive in many EU countries*

## METHODOLOGY

The energy competitiveness of renewable energy technologies was assessed by presenting aggregate results for the European Union. The estimated renewable energy production costs are expressed in euro per megawatt-hour, €/MWh and are compared to conventional forms of energy. Comparing the levelised cost of energy (LCoE) allows for the presentation and subsequent analysis of different technologies in a comparable manner. The renewable energy technology LCoE analysis requires a significant amount of data and assumptions, such as the capital expenditures, operational expenditures, fuel costs, economic life, annual energy production, auxiliary energy requirements, fuel conversion efficiency, project duration and the weighted average cost of capital (WACC). A Monte Carlo (MC) approach is then applied to perform the LCoE calculation resulting in LCoE ranges. while technology costs were derived from (JRC 2018), fuel price assumptions were taken from (Elbersen et al, 2016) and interpolated from modelled data.

## LCOE RESULTS AND COST COMPETITIVENESS

As LCoE from renewable sources as well as reference energy carrier prices vary across Member States, the outcomes were presented as data ranges. Estimates for historic costs have been calculated using data from ECN on cost development and are unchanged unlike the estimates used in the 2017 Edition of the EurObserv'ER report 'The state of renewable energies'. The reference energy prices have been presented in the graphs as well in order to be able to indicatively compare them with the calculated LCoE's. The (nominal) reference prices have been presented without taxes and levies, for large consumer types.

## RENEWABLE ELECTRICITY

For renewable electricity, cost reductions are most pronounced for wind energy, where the upper range, constituted by offshore wind power, has decreased. Both solar PV variants are assumed to have encountered important cost reductions as compared to 2005, making this technology increasingly competitive. In the residential sector, PV is deemed to be more competitive compared to residential electricity prices in multiple countries. Wind energy investment costs are assumed to have decreased rapidly since 2005, both for onshore and offshore, resulting in lower LCoE levels.

## RENEWABLE HEAT

In terms of renewable heat, the LCoE for solid biomass overlapped with the reference heat range, indicating it is competitive in many countries. The LCoE range for solar water heaters and heat captured from ambient heat via heat pumps shows, according to the analysis, relatively high LCoE levels. Only small-scale equipment was considered here and scaling up to collective systems and including district heating might decrease overall costs.

## RENEWABLE TRANSPORT

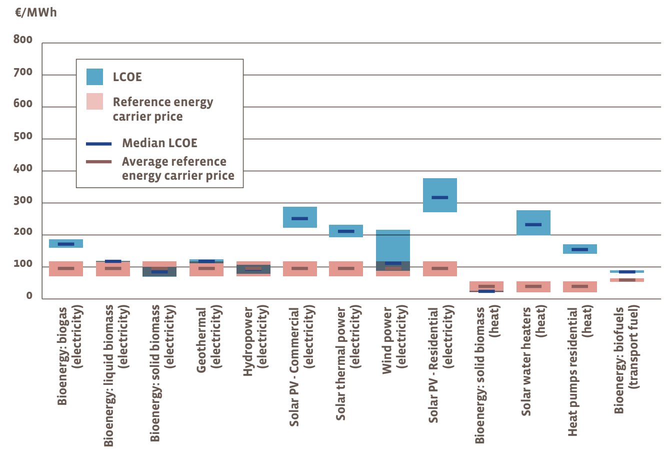
LCoEs for biofuels for transport purposes show quite a narrow range, above the reference transport fuel price levels. ☐





**8**

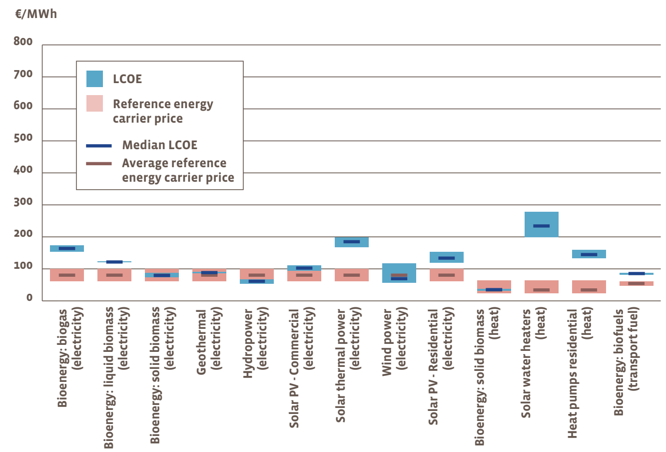
LCoE and reference energy carrier (€/MWh) EU ranges derived from Member State analysis for 2010




*Source: EurObserv'ER 2018*

**9**

LCoE and reference energy carrier (€/MWh) EU ranges derived from Member State analysis for 2017




*Source: EurObserv'ER 2018*

# AVOIDED FOSSIL FUEL USE AND RESULTING AVOIDED COSTS

**322 Mtoe**

*of fossil fuels substituted by RE in 2017*

**€ 93.5 billion**

*Avoided annual cost in 2017*

## LESS CONVENTIONAL ENERGY CARRIERS, AVOIDED BY RENEWABLE ENERGY

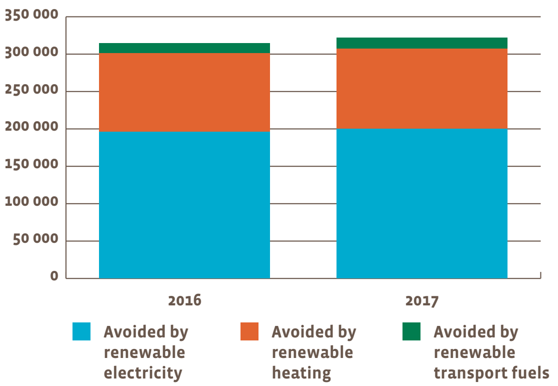
Avoided fossil fuels represent conventional non-renewable energy carriers not consumed – both domestic and imported fuels – due to development and use of renewable energy. In this chapter, fossil fuels and non-renewable waste are collectively named fossil fuels. Avoided costs refer to the expenses that do not occur as a result of avoided fossil fuels. Thus, cumulative amounts of avoided fossil fuels multiplied by the corresponding fuel price levels observed in the various ountries represent the avoided costs.

## AVOIDED FOSSIL FUEL USE AND COSTS PER TECHNOLOGY

In 2017, renewable energy substituted around 322 Mtoe of fossil fuels which corresponds to an avoided annual cost of € 93.5 billion in 2017. This amounts to a year-or year increase in avoided costs of 10.5%. The largest financial contributions were derived from renewable electricity and renewable heat (at approximately equal contributions which contributed to approximately 90% of the avoided expenses). Renewable electricity use was the main driver for this increase in avoided costs (to € 47.2 billion) followed by renewable heating and cooling sectors (€ 37.3 billion) and renewable transport fuels (€ 9.0 billion). The avoided cost derived from not consuming fossil fuels were also increased by higher fossil fuel prices in 2017 as compared to 2016. Among all RES technologies, solid biomass for heating purposes avoided the purchase of fossil fuels the most, amounting to € 31.8 billion in 2017 (€ 29.5 billion in 2016). The largest share of avoided fossil fuels comes from natural gas (37% for both 2016 and 2017), followed by solid fuels . Next are oil products, with a contribution of 22% in both 2016 and 2017. The remaining fuels (transport fuels and non-renewable waste) cover the remaining share).

### 10

Avoided fossil fuels through renewables in 2016 / 2017 per sector (ktoe)



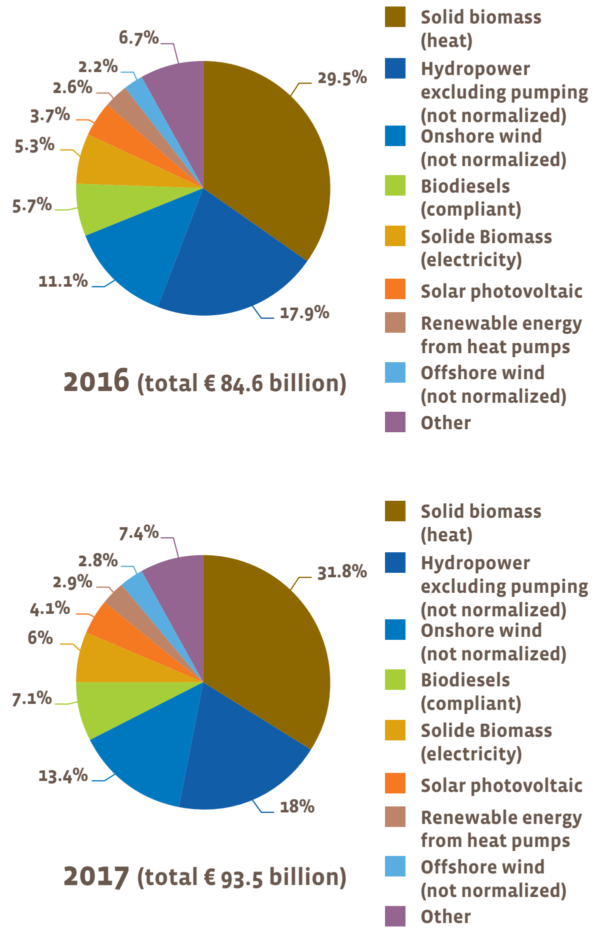

*Source: EurObserv'ER 2018 based on EEA data*





### 11

Avoided fossil fuel costs in EU-28 through renewables in 2016 and 2017




*Source: EurObserv'ER 2018 based on EEA data*

## AVOIDED FOSSIL FUELS AND EXPENSES PER MEMBER STATE

The avoided cost follow the fuel price development: with fossil fuel prices higher in 2017 compared to 2016, almost all counties show a similar pattern. A strong correlation can be observed between the size of a country and avoided fossil fuel costs. Despite decreasing fuel costs, four Member States show a downward trend in avoided fossil fuels expenses due to decreased renewable energy deployment in 2017 compared to 2016. These countries are France, Hungary, Italy and Portugal. □

# INDICATORS ON INNOVATION AND COMPETITIVENESS

Private R&D/GDP is 6 x higher than public R&D/GDP in the EU

Private R&D in solar and wind power is € 2.7 bn in the EU

**91.5 %**

*EU's trade share wind power*

## R&D INVESTMENTS

The Energy Union strives to provide a secure, sustainable, affordable energy supply by increasing renewable energy uses, energy efficiency, internal energy market integration and competitiveness. Expenditures for research and development are seen as investments into new or better processes, products or services that might create new markets or increase market shares and strengthen competitiveness of firms, sectors and nations. Investments into R&D is commonly considered as a significant input indicator for technological competitiveness. Public spending can be used to overcome externalities and to leverage private capital. On a global scale, the EU 28 (2016/17) scores first in public solar energy R&D spending as compared to the U.S., Japan and Korea. Within Europe, Germany, France, the Netherlands and the UK have clinched the top spot for the investing in public R&D. Germany had the largest private R&D investments amounting to € 33.3 billion in 2015 but the expenditures have been declining since 2013. With respect to private R&D spending, most of the resources are dedicated to solar and wind power research in the EU.

## PATENT FILINGS

Within the EU 28, it is once again Germany, Denmark as well as Spain (2016) and the Netherlands with the largest public R&D budget. Overall, the data had that private R&D financing by far exceeds public R&D financing. Thus, it supports the theoretical assessments, saying that public R&D spending can be seen as a driver for private R&D investments. Technological competitiveness is commonly measured by filed or granted patents. They are employed as major output indicators for R&D projects. Apart from biofuels, solar energy shows the largest number of patent filings in the EU and worldwide (incl. China), followed by wind energy. Within the EU 28, Germany filed the greatest number of patents. However, this is due to its size. In terms of patenting per GDP, Denmark ranks first in Europe. Germany is also one of the few countries that files patents across all renewable energy technology fields, while most other countries are specialized in only one or two RET technologies. Denmark and Spain, for example, show remarkable filing figures in wind energy, while the UK is most patent-active in ocean energy.

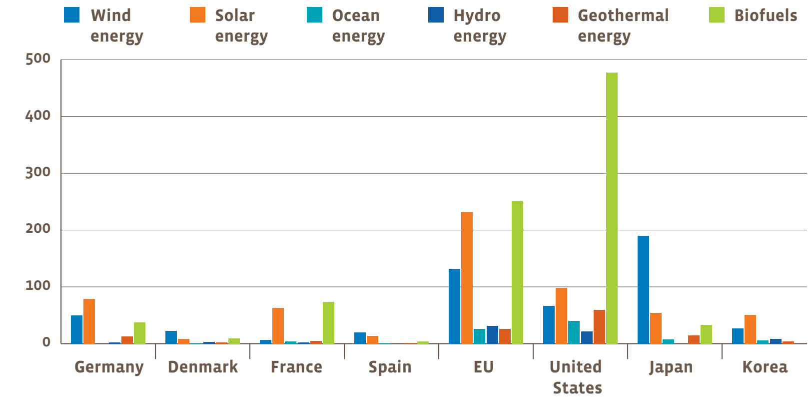
## INTERNATIONAL TRADE

Trade shares in RET show competitive countries are in selected RET and whether they could transform their RET deployment into economic value added. Within the EU 28, wind energy and solar energy plays a major role in the exports market. Denmark, Germany and Spain display as strong competitiveness in the wind power sector, dominating the worldwide export markets and generating an export share of more than 90%. The largest volume that is globally traded is solar energy. China is top in exports of solar energy technologies. Hydroelectricity is yet another sector in which the EU is holding shares despite a slight decline between 2015 and 2016. □



## 12

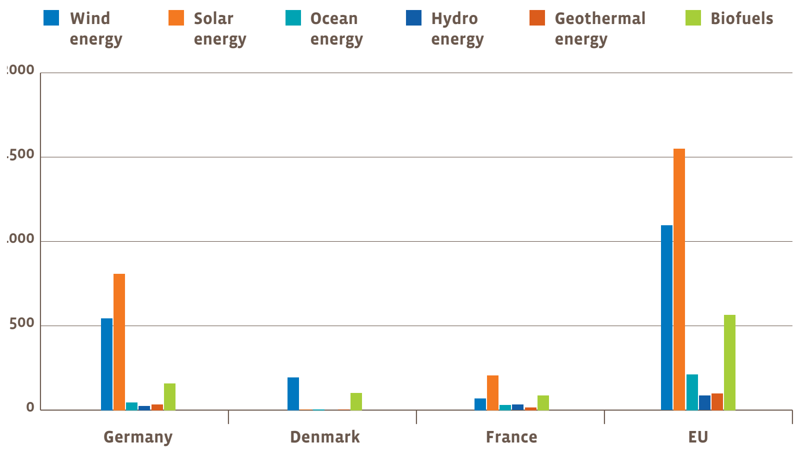
Number of patent families per country and RET, 2014




*Source JRC Setis, Eurostat, WDI Database, EurObserv'ER 2018*

## 13

Private RD spending by technologies and selected countries in 2014 in Mio Euro




*Source: JRC Setis, Eurostat, WDI Database, EurObserv'ER 2018*

# FLEXIBILITY OF THE ELECTRICITY SYSTEM

**0**

*Number of countries having used more than 75 % of their flexible generation capacity during critical hours*

*in 2017*

### METHODOLOGY

With increasing shares of volatile renewable energy (vRE) in the power system, the demand on flexibility of the system to compensate unforeseen changes in supply is increasing. To depict the flexibility of a power system in critical hours four indicators are employed that cover generation, transmission, intraday market and operational balancing.
Together, these indicators test the degree to which a system is responsive to the changes in electricity supply and load during critical hours.

### GENERATION FLEXIBILITY

Overall, all EU Member States have a sufficient range of flexibility in their generation. Even though the number of countries (11) using more than 50% of their flexible generation capacity rose in 2017 compared to 2016 (5), none of them got close to the critical threshold, i.e. the 100% line.

### MARKET FLEXIBILITY

The depicted market flexibility indicators vary between 2017 and 2016. In 2017 the highest electricity trading volume in all considered intraday markets was reached within the common German, Austrian and Luxembourgish power exchange.



### OPERATIONAL FLEXIBILITY

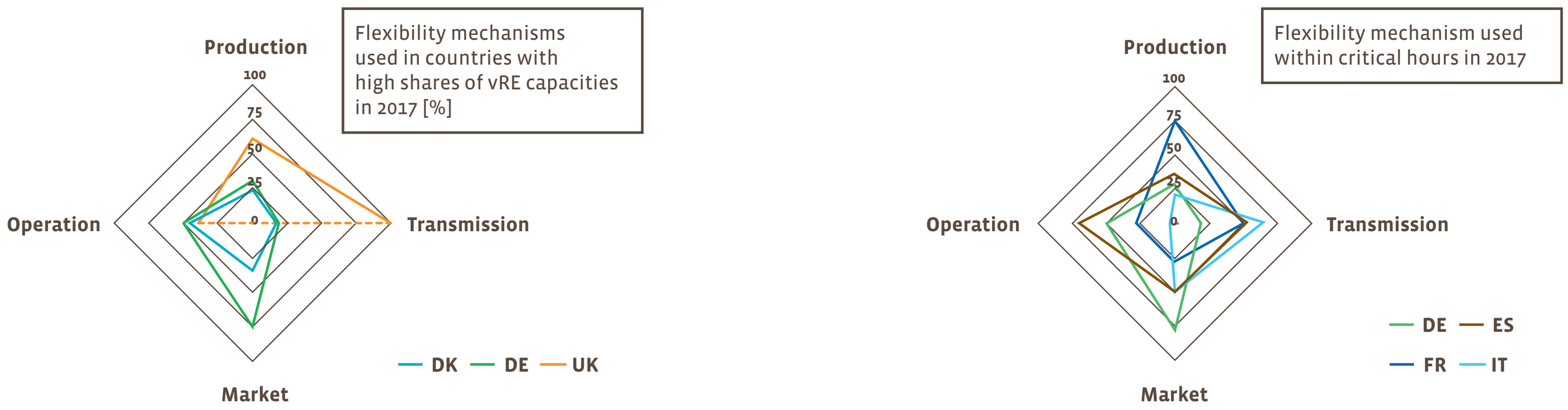
For 2016 and 2017, on average 40% and 32% of the maximum possible reserve power was used during critical hours, but it varies strongly among countries.

### RESULTS AND INTERPRETATIONS

Overall, countries both with low and high volatile RE shares do not display a pattern regarding the use of flexibility mechanism. This is instead deppendant on various country specific characteristics. For example: in the United Kingdom, a country with a high vRE share of 34%, transmission flexibility is mainly used. In contrast, Slovakia with less vRE displays a similar pattern but at a lower level of use.
Even though Denmark and Hungary are characterized by high and low vRE shares respectively, both countries demonstrate rather low levels of up-flexibility usage with respect to all four indicators.
On the other hand, Latvia compensates for unexpected changes in load and supply by generation flexibility and intraday market flexibility and Germany relies on the intraday market as an outstanding mechanism to balance volatile RE generation.
It msut be noted that no intraday market exists in Slovakia, and market data was not accessible for the United Kingdom. □

**14**

Pattern of flexibility in critical hours and hours of maximum load




*Source: EurObserv'ER 2018*

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