EXECUTIVE SUMMARY

THE STATE OF RENEWABLE ENERGIES IN EUROPE

EDITION 2017

17th EurObserv'ER Report

Barometer prepared for the European Commission (DG ENER) by Observ'ER (FR) with the following consortia members: Renewables Academy (RENAC) AG (DE), ECN (NL), Frankfurt School of Finance & Management (DE), and Fraunhofer- ISI (DE), CBS (NL).

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1 147.4 Mtoe

Gross final energy consumption in 2016

17.0%

Percentage of renewable energy in gross final energy consumption in the EU 28 in 2016

29.6%

Share of renewable energy in the electricity generation of EU 28 in 2016

951.4 TWh

RES electricity generation in 2016

99.3 Mtoe

Renewable heat and cooling consumption in the EU 28 in 2016

JUST THREE POINTS SHORT OF THE 2020 TARGET

In 2016, the European Union moved up a level towards achieving the main 2020 target set in the Renewable Energies Directive. The renewably-sourced energy share of European Union final gross energy consumption was 17% in 2016, which is exactly twice its 2004 level (8.5%), the first year for which data was registered. The European Union is now only 3 points short of its target for 2020.

However, the current growth pace across the European Union is too slow to achieve the 2020 target. While a drop of only 0.3 points in 2016, the pace of growth should increase to at least 0.75 points every year from 2017 to 2020 in order to meet the EU targets. While some countries are experiencing difficulties in achieving their national target, the common European Union target of 20% is still within reach. This especially true as the energy policy in some countries, primarily in Northern Europe, should enable them to sail past their national targets..

For electricity output, the share of renewable energies in EU 28 (non-normalized for wind energy and hydro) rose from 28.8% in 2015 to 29.6% in 2016. This growth amounts to a year-on-year gain of 15.8 TWh and is much lower than the previous years' – increases of 4.0%, or 35.8 TWh in 2015 and of 5%, or 43 TWh in 2014. Part of the explanation for this poor performance can be ascribed to the low winds and photovoltaic production across the European Union due to the climate conditions.

Renewables in EU's Heat and cooling output contributed to 99.3 Mtoe in 2016, which represents a 4.2% growth (an additional 4 Mtoe). The renewable heat share reached 19.1%, which is a 0.4 percentage point year-on-year increase. This share is lower compared to the previous year, when 5.7 Mtoe was added, to reach an 18.7% share (0.6 percentage point more compaired to 2014). 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.□

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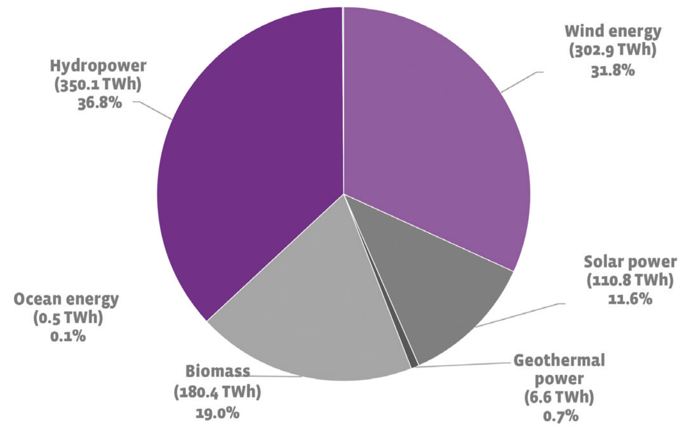
Share of each energy source in renewable electricity generation in 2016 in the EU 28 (in %)



Source: EurObserv'ER 2017

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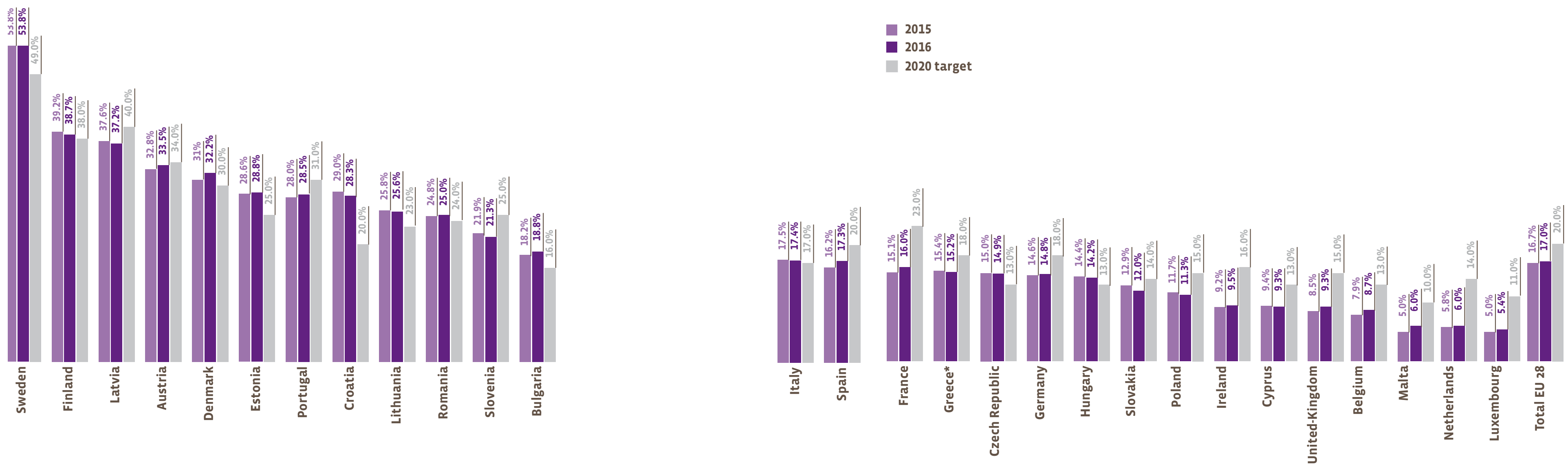
Share of energy from renewable sources in gross final energy consumption in 2015, 2016 and 2020 objective (in %)



*Source: SHARES 2016, published 26th January 2018 * Year 2016 for Greece estimated by Eurostat.*

1 427 400

Jobs in renewable energy sector in the EU in 2016

352 500

Jobs in EU solid biomass sector in 2016

309 000

Jobs in EU wind power sector in 2016

€ 149.3 billion

RES turnover in the EU 28 by technology in 2016

€ 39.3 billion

Turnover of wind power sector in the EU in 2016

METHODOLOGY

For the socio-economic indicators, an important methodological change has been implemented in the 2017 Edition of 'The State of Renewable Energy in Europe' by setting up a modeling environment that formalises the assessment procedure of employment and turnover. The new methodological approach is based on an evaluation of the economic activity of each renewable sector covered, which is then expressed into full-time equivalent (FTE) employment. This new approach focuses on money flows from four distinct activities: 1. Investments in new installations; 2. Operational and maintenance activities for existing plants including the newly added plants; 3. Production and trading of renewable energy equipment; and 4. Production and trading of biomass feedstock.

EMPLOYMENT

The new approach consistently assesses employment initiated from renewable investments, operation and maintenance activities, production and trading of equipment and biomass feedstock. It was found that 1.4 million people were employed in 2016. This was very similar to the number of renewable jobs in 2015. Overall, there was a slight decrease amounting to about 1% (i.e. a reduction of 12 600 jobs in absolute terms) between 2015 to 2016. Technologies for which the 2016 estimates are below the 2015 jobs are the following: wind energy decreased from 315 900 to 309 000 jobs (-2%), solar PV from 113 400 to 95 900 jobs (-15%), hydropower from 94 800 to 75 900 jobs (-20%), biogas from 83 700 to 76 300 jobs (-9%), solar thermal from 30 900 to 29 000 jobs (-6%) and finally geothermal from 12 200 to 8 600 jobs (-30%). On the other hand, some technologies saw an increase in the number of jobs available: jobs in the solid biomass sector grew from 346 100 to 352 500 jobs (+2%), heat pumps increased from 240 300 to 249 400 jobs (+4%), biofuels from 178 200 to 205 100 jobs (+15%) and finally renewable municipal solid waste from 24 500 to 25 700 jobs (+5%).

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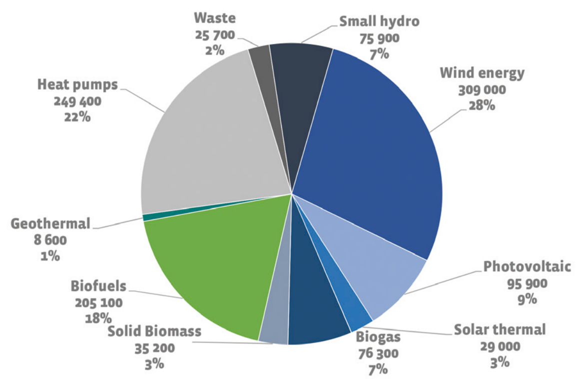
RES employment in the EU 28 by technology in 2016: Total 1.427 million)



Source: EurObserv'ER 2017

TURNOVER

Looking at the turnover estimations by country, 20 out of 28 EU Member states increased or maintained their industrial turnover. However, this positive status is slightly overbalanced by job decline in the 8 other countries. The twenty Member States with zero or a positive growth (France, Spain, Romania, Denmark, Finland, Hungary, Czech Republic, Netherlands, Latvia, Croatia, Bulgaria, Lithuania, Greece, Estonia, Belgium, Ireland, Slovenia, Luxembourg and Malta) grew on average at 11% (absolute growth: + 5 billion euro). The countries which had the highest decline in the number of jobs (Germany, Italy, United Kingdom, Poland, Sweden, Portugal, Austria, Slovakia and Cyprus) had a cumulative loss amounting to 7 billion euros. □

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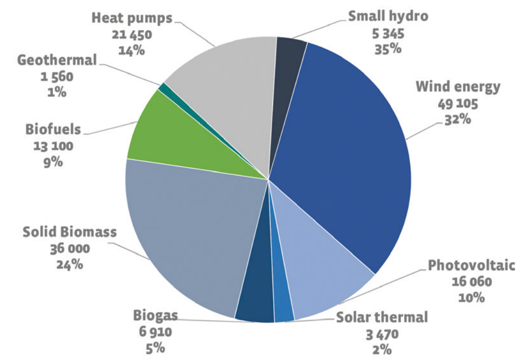
RES turnover in the EU 28 by technology in 2016 (in mln Euro: Total: € 149.3 billion)



Source: EurObserv'ER 2017

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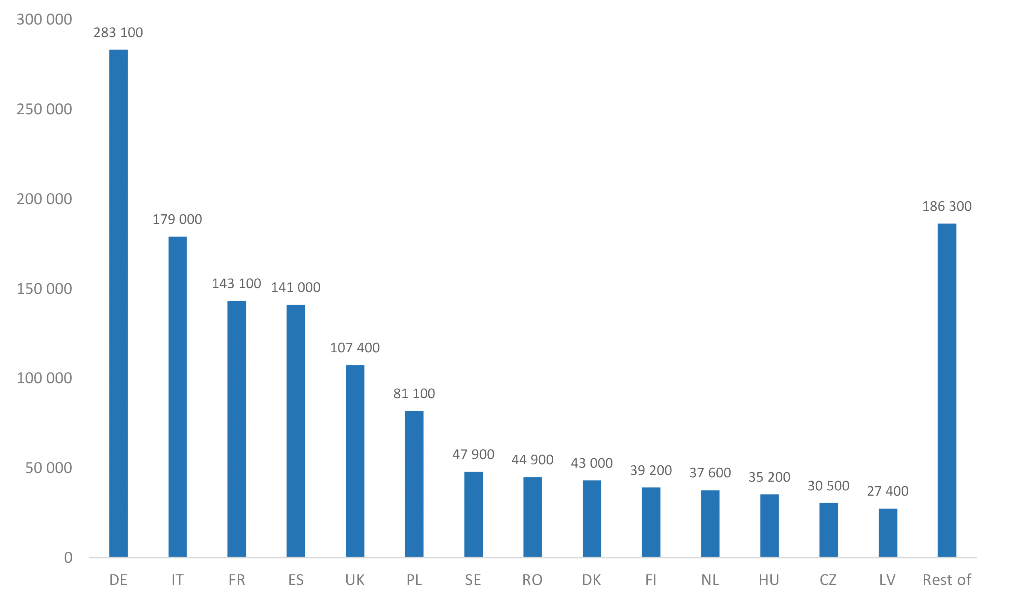
RES employment in the EU 28 by country in 2016



Source: EurObserv'ER 2017

€ 38.8 billion

Investments in RES capacity 2016

€ 2.02 billion

Venture Capital / Private Equity 2016

€ 4.2 billion

Investment in small scale PV

€ 34.1 billion

Investments in wind capacity in 2016

INVESTMENT IN RENEWABLE ENERGY CAPACITY

The indicators for investment in renewable energy projects capture asset finance for utility-scale renewable energy generation projects. Aggregating asset finance for all RES sectors shows that investment in energy generation capacity fell marginally between 2015 and 2016. In 2015, EU investments in RES capacity totalled € 40.6 billion, while 2016 investments amounted to € 38.8 billion.
The analysis of the respective RES sectors has revealed a very heterogeneous picture. In 2015, wind investments, including both onshore and offshore wind, totalled € 31 billion and grew to € 34 billion in 2016. This increase in wind investments was mainly driven by the offshore investments. The PV sector experienced a dramatic reduction in investments in utility-scale capacity from € 4.6 billion to € 1.6 billion. PV installations dropped less dramatically, namely from € 5.2 billion in 2015 to € 4.3 billion in 2016. On a more positive note, it is worth mentioning that geothermal investments in both years are rather high compared to the investment volumes in the last years. With respect to investment costs, there were also notably different trends across RES sectors. While the investment expenditures per MW of onshore wind capacity remained almost constant in the EU with € 1.42 million in 2015 and € 1.44 million in 2016, investment costs for offshore wind fell between both years. Investment expenditures per MW for solar PV plants dropped notably in the EU, namely from € 1.43 million in 2015 to € 1.12 million in 2016. For the wind sector, investment costs within the EU seem to be marginally higher than the average non-EU investment cost. For PV however, EU investment expenditures per MW are notably below the average of the analysed non-EU countries.

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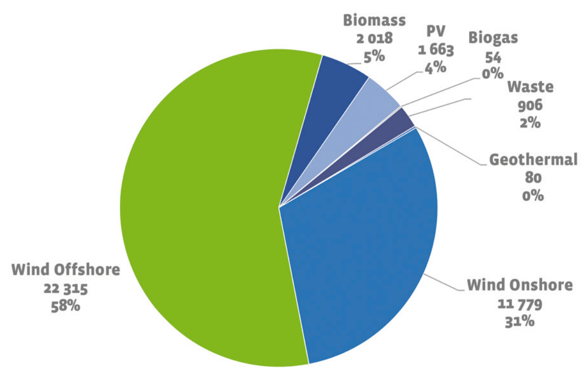
Asset finance - New Built (in mln €) in 2016 by technology



Source: EurObserv'ER 2017

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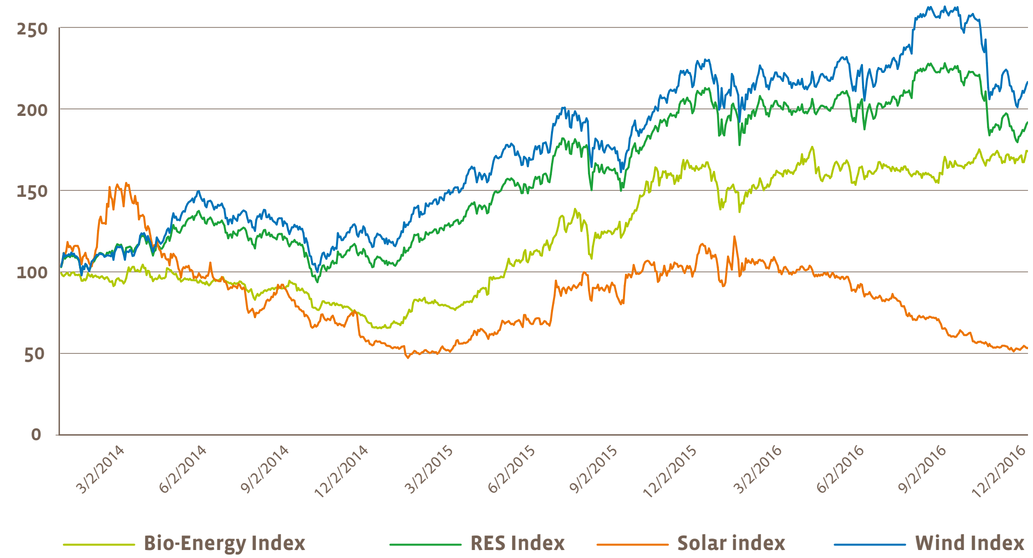
Evolution of RES indices during 104, 1015 and 1016



Source: EurObserv'ER 2017

VENTURE CAPITAL & PRIVATE EQUITY

Total venture capital (VC) and private equity (PE) investments in renewable energy companies seemed to have stabilized between 2015 and 2016 after the substantial decline between 2014 and 2015. VC/PE in the EU totalled € 2.04 billion in 2015 and € 2.02 billion in 2016. However, while PE investments fell by almost 9%, VC investments tripled from € 78 million in 2015 to € 231 million in 2016. Overall, VC/PE investments were conducted in more RES sectors in 2015 as compared to 2016.

PERFORMANCE OF RES TECHNOLOGY FIRMS AND RES ASSETS

In order to capture the performance of RES technology companies, i.e. companies that develop / produce the RES components needed for RES plants to function, EurObserv'ER constructed several indices based on RES company stocks. The three presented indices, the Wind Index, the Solar PV Index, and the Bio-Energy Index, comprises of the ten largest quoted RES companies in their respective sectors.
Although the trend of all three RES indices were quite similar in 2015, this picture changed significantly in 2016. The Wind Index trend shows by far the most positive development, in particular for 2015. The Bio-Energy Index has a similar trend, but at a lower level compared to the former. However, the Solar Index trend shows a substantially different development. In 2015, the Solar PV Index shows a positive trend, but the performance of listed solar firms declines notably in 2016.
In order to track the performance of RES assets on public markets, EurObserv'ER tracked the development of YieldCos in the EU. YieldCos are own cash-generating infrastructure assets, e.g. renewable energy plants, where the ownership is offered on public markets. However, it remains to be seen whether the positive development EU YieldCos continues in the long run. □

RENEWABLE ENERGY COSTS, PRICES AND COST COMPETITIVENESS

Electricity generation from offshore wind has rapidly decreased in terms of generating costs

Cost-competitiveness of renewable energy technologies varies per technology and also with the differences in reference energy prices in each Member State.

The past few years have proven that costs of electricity generation from offshore wind energy have rapidly decreased, leading to tender bids nearly without any subsidy appeal in Germany and the Netherlands..

Approximate historic costs are estimated in this chapter for a number of technologies, based on a backward-looking approach. The overarching question whether renewable technologies are competitive or not depends, among others, on the reference prices paid for energy. In some demand sectors in a number of EU Member States, various renewables are already competitive while this is not the case in others. In this barometer, levelised costs of energy (LCoE) are estimated for various renewable energy technologies and their cost competitiveness is assessed by comparing the LCoE to reference prices. Undoubtedly, this is not merely a black-and-white issue: firstly, there is not a 'single technology cost' (many factors determine the costs, notably locational and operational aspects, but also quality and financing characteristics); secondly the energy yield from various renewables differs widely across Europe; and finally, reference prices can vary significantly.

The cost-competitiveness of renewable energy technologies varies per technology per Member State and with the differences in reference energy prices in each Member State. Mature technologies such as hydropower and solid biomass can in principle provide low-cost power that is comparable to the reference electricity prices in some of the Member States. Likewise, onshore wind and large scale commercial solar PV can be cost-competitive in countries with good wind resources or high insolation and relatively high electricity prices. Heat generation from solid biomass is already cost-competitive when compared with the reference heat prices.

RENEWABLE ELECTRICITY

Looking at the development over time, biomass and hydropower are assumed to have been quite stable in their level of LCoE. Geothermally sourced electricity and power from PV and wind have seen a considerable decrease in LCoE values from 2005. Variations among Member States are mostly a result of differences in assumed yield and financing conditions.

Among the technologies producing electricity from bioenergy (via biogas, liquid and solid biomass), the LCoE for technologies based on solid biomass are found to be the least expensive, and in the same range as the reference electricity price. For electricity obtained from deep geothermal energy, all countries have estimated LCoE values displayed although no realizations might have occurred in the period under consideration and in fact, the potential might be non-existent. Both PV variants are assumed to have realized important cost reductions, making this technology more and more competitive. In the residential sector, the price of energy derived from PV is more competitive in multiple countries as compared to residential electricity prices. Wind energy LCoE levels are assumed to have decreased rapidly since 2005, both for onshore and offshore technologies. For offshore wind, the most recent cost developments have not yet been considered in the graph. In a few countries offshore wind bid prices in recent tenders demonstrate that perhaps offshore wind LCoE is undercutting onshore wind LCoE levels.

RENEWABLE HEAT

For technologies producing heat, the LCoE for solid biomass is overlapping 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.

RENEWABLE TRANSPORT

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

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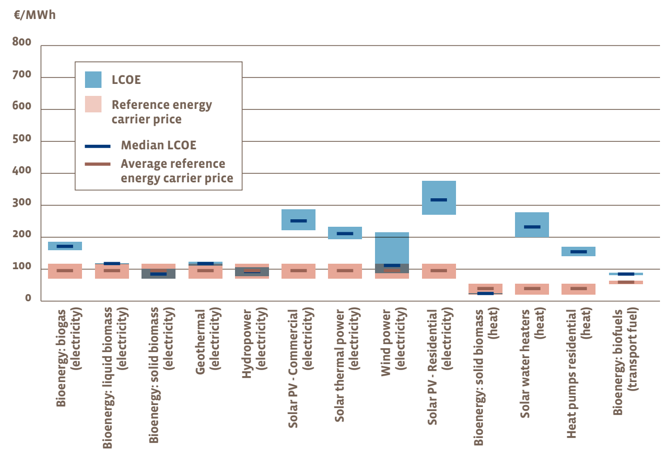
LCoE and reference energy carrier (€/MWh) EU ranges derived from Member State analysis for 2005.



Source: EurObserv'ER 2017

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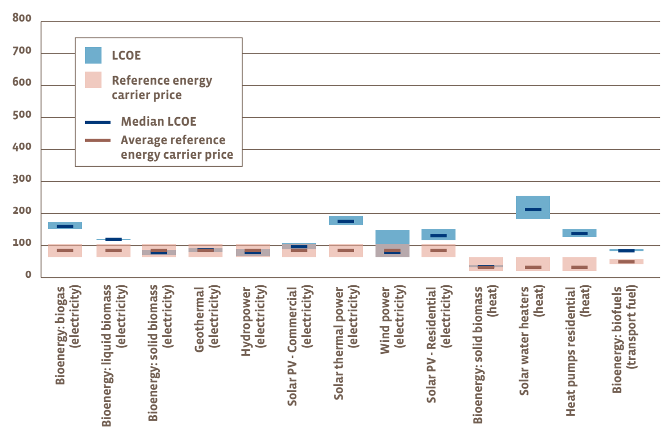
LCoE and reference energy carrier (€/MWh) EU ranges derived from Member State analysis for 2016.



Source: EurObserv'ER 2017

€ 83 billion

Avoided expenses in EU-28 through renewables 2016

322.2 Mtoe

Renewable energy substituted around 322 Mtoe of fossil fuels in 2016.

AVOIDED FOSSIL FUEL USE AND RESULTING AVOIDED COSTS

In 2015 and 2016 renewable energy substituted around 314 Mtoe and 322 Mtoe of fossil fuels respectively. These figures correspond to an avoided annual cost of EUR 97 billion for EU28 collectively in 2015, decreasing to € 83 billion in 2016. This decrease is due to lower fossil fuel prices in 2016 compared to 2015. The largest contributions are derived from renewable electricity and renewable heat (approximately equal contributions representing about 90% of the avoided expenses). □

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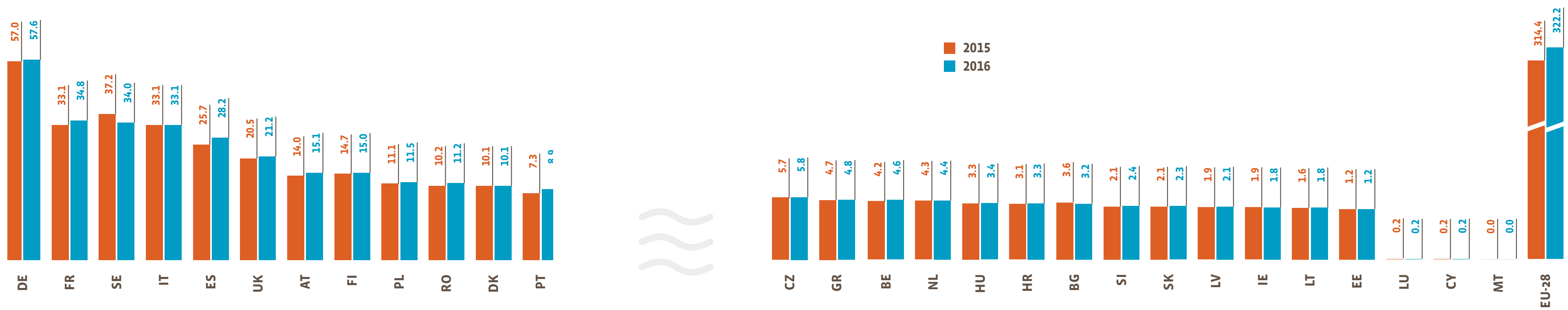
Avoided fossil fuels per country (Mtoe)



Source: EurObserv'ER 2017 based on EEA data

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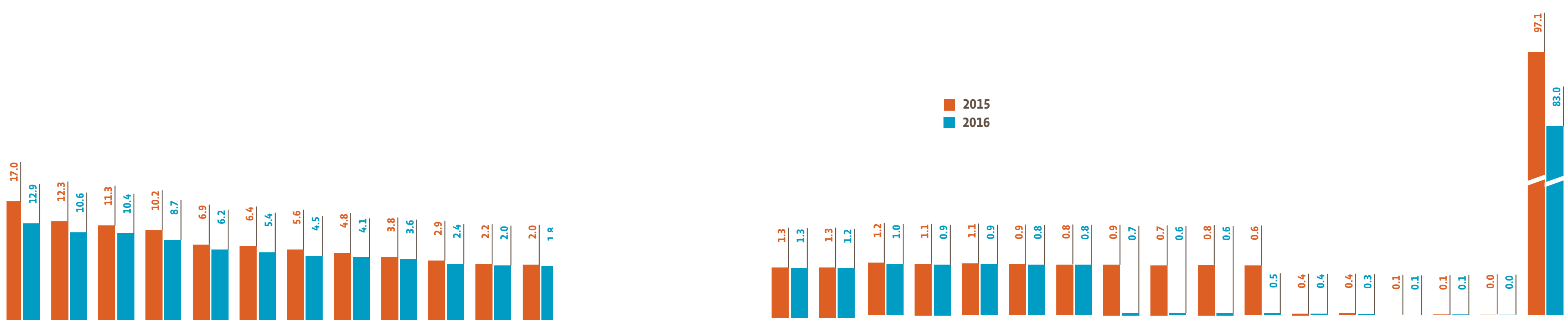
Avoided expenses per country (billion Euro)



Source: EurObserv'ER 2017 based on EEA data

€ 820 million

Public R&D expenditure in RES in 2015 in the EU 28

1 708

Patents per € trillion GDP in 2013 for all RES technologies in the EU 28

23.5 %

Share of EU in global exports of renewable energy technologies in 2016

€ 3 267 million

Value of EU net exports (all RES) in 2016

PUBLIC AND PRIVATE R&D INVESTMENTS

Regarding public R&D expenditure, the US holds a strong position in 2015, which could even be strengthened in 2016 while the EU-28 seems to have lost ground. However, only a limited set of data is available for 2016 so far which make these comparisons challenging. The GDP shares display the strong position of Norway, Switzerland, Japan and Korea (2015) as compared to the EU-28 and the U.S. Within the EU, the largest shares can be found in Denmark, Finland, the Netherlands and Ireland (2015). In terms of wind energy, Japan displays the highest public R&D support. The EU is leading in terms of solar and ocean energy while the US has the highest public R&D share in geothermal energy, hydro power and biofuels.

Private R&D expenditures are available only for a limited set of EU countries and for 2013 as most recent year. With respect of the share of private R&I expenditures by GDP, Germany is leading in solar energy, Sweden and Poland in geothermal energy, Czech Republic in hydro power (2012), Denmark in biofuels and wind energy and Sweden in ocean power.

PATENT FILINGS

Overall, the number of patent applications in the EU has decreased between 2012 and 2013. Korea shows a very strong position with respect to the number of patent applications per GDP, followed by Japan and China (when patent applications only at the domestic market are also included). The US ranks after the EU. In particular, Korea had the most number of patents for solar, wind, ocean and geothermal energy. The EU's position falls behind these Asian countries with regard to patents for wind power as well. Within the EU, Germany mostly files the largest number of patents; but this is due to its size. However, it is one of the few countries that shows a certain activity level across all renewable technology fields. Denmark and Spain, for example, show remarkable filings in wind energy, while the UK is most active in ocean energy.

INTERNATIONAL TRADE

The analyses of export data in RET technologies have shown that China has indeed achieved a relatively strong position in the last years and continues to grow. The Chinese strength in RET exports mostly originates from a strong position in photovoltaics, although the shares in this field have decreased slightly between 2015 and 2016. In contrast to PV, assembling wind turbines is more complex and the EU remains extremely competitive in this market. Nevertheless, the Chinese shares in wind and hydro power have slightly increased. Only in biofuels however, is China's trade position is far behind the EU.

This picture changes when looking at the other RET subfields, i.e. wind energy and hydroelectricity. In terms of wind energy, Denmark, Germany and Spain in particular can be seen as strong competitive countries which dominate the worldwide export markets. These three countries generate a worldwide export share totaling nearly 90%, while China only plays a minor role. However China is catching up -not only with respect to patenting activities but also with respect to trade shares. At the same time, the EU as a whole had a marginal loss in shared in wind power in 2016 compared to 2015. Nevertheless, a balanced picture can be observed in the case of hydro-electricity. Here, several European countries are active on worldwide export markets, while China is also responsible for comparably large shares. Although China is proceeding at low level and pace, it is catching up in patent applications – at least in the domestic market – as well as in exports and might become a more competitive player in the future. In contrast, the EU is losing shares slightly.

Overall, the EU displays a strong competitiveness in all RET fields, but is losing trade shares and competitiveness in all RET fields, while China is gaining. The strength of the US lies in biofuels, and is enforcing its position there while for other RETs, its contribution is far below that of the EU.□

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Public R&D investment in all RES technologies in 2016

	Public R&D Exp. (in € m)		Share of Public R&D Exp. by GDP	
	2015	2016	2015	2016
EU 28				
Germany	185.0	180.1	0.0061%	0.0063%
France	181.1		0.0083%	
Netherlands	97.8		0.0145%	
Denmark	70.3	46.5	0.0259%	0.0178%
United Kingdom	69.3	79.0	0.0027%	0.0038%
Spain	51.0		0.0047%	
Sweden	36.9	34.2	0.0083%	0.0081%
Finland	36.7		0.0175%	
Ireland	26.7		0.0105%	
Austria	21.7		0.0064%	
Belgium	17.6		0.0043%	
Poland	17.4		0.0041%	
Portugal	4.4		0.0025%	
Czech Republic	3.3	3.0	0.0020%	0.0017%
Slovakia	0.9	9.2	0.0011%	0.0117%
Hungary	0.0	0.0	0.0000%	0.0000%
Total EU	820.2	355.8	0.0056%	0.0026%
Other Countries				
United States	702.5	777.6	0.0043%	0.0046%
Japan	366.2	315.6	0.0093%	0.0071%
Korea	103.8		0.0083%	
Australia	93.1	56.0		
Canada	92.2	89.2	0.0066%	0.0065%
Switzerland	84.5	84.5	0.0140%	0.0174%
Norway	61.3	54.9	0.0176%	0.0154%
Turkey	7.3	10.7	0.0009%	0.0013%
New Zealand	5.8	4.2		

Source: JRC SETIS, Eurostat, WDI Database ; Note : the sum across technologies is only given, if data of all RET in one country are available, i.e. as soon as one RET is missing, the data are indicated as n.a.

44 %

Top share of installed vRE capacities

72 %

Top flexible generation share in critical hours

98 %

Top transmission share in critical hours

RESULTS AND INTERPRETATIONS

To depict how well renewables are integrated in the power system, four indicators were selected. First, the generation flexibility shows how much of the available flexible power generation capacity is used in critical times, i.e. when there are large changes of load and variable Renewable energy (vRE) generation. Second, the share of cross-border flows in critical times shows how much flexibility is provided by transfers and interconnectors. The market flexibility is depicted by the share of volume in critical hours to maximum volume traded in the intraday market. Finally operational flexibility is provided by the reserve markets, illustrating the share of activated reserves to its potential.

Because increasing vRE shares of wind and solar power make successful balancing of power supply and load more difficult, one might expect countries with a higher share of vRE to face more challenges when integrating vRE. Germany, Denmark, Great Britain, Portugal display high vRE shares in decreasing order. In contrast, countries with a low share of vRE such as Latvia and Hungary are supposed to display a small use of flexibility mechanisms.

Regarding the flexibility mechanisms of countries with high vRE shares, Germany and Spain strongly rely on the intraday market while Great Britain mainly uses transmission and flexible generation capacities in various markets to compensate unexpected changes. Denmark displays a balanced mix of all mechanisms. Countries with lower shares of vRE such as Latvia, Finland or Hungary do not display a homogenous picture: the intraday market represents an important flexibility mechanism for the Czech Republic and Estonia, while Finland relies on transmission. Latvia as well as the Czech Republic use flexible generation capacities for adjustments to changing supply and load.

Overall, in critical hours, all countries dispose of sufficient flexibility in the system. Countries with low or high vRE shares do not display a pattern regarding the use of flexibility mechanism, rather the use of mechanisms depends on a combination of various country specific characteristics. For example, France has only 15% of renewable energies but over 60% of nuclear power while Sweden disposes of a high amount of water reservoirs and therefore has a good source to balance forecast differences. On the other hand, despite its high share of flexible generation capacities, the UK uses mainly the transmission mechanism as prices in France or the Netherlands are comparatively lower. □

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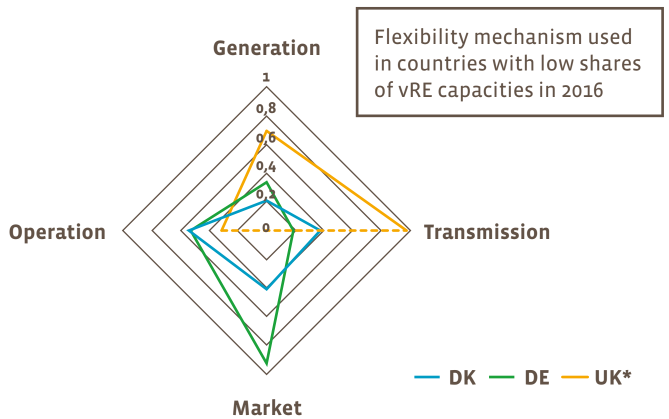
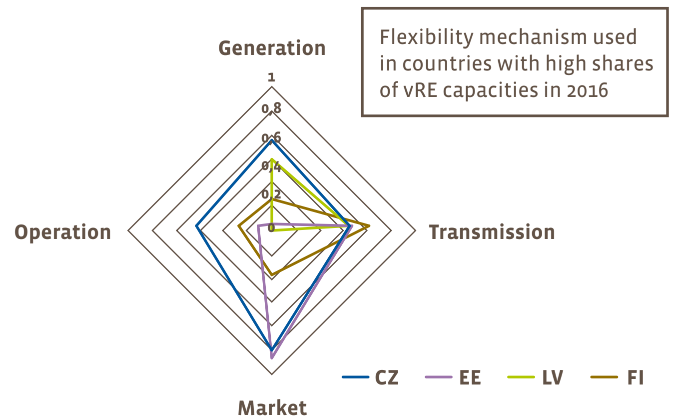
Pattern of flexibility in critical times, 2015 and 2016





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