EXECUTIVE SUMMARY

THE STATE OF RENEWABLE ENERGIES IN EUROPE

EDITION 2016

16th EurObserv'ER Report

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1 121.4 Mtoe

Gross final energy consumption

16.7%

Share of renewable energy in gross final energy consumption in the EU-28 in 2015

28.8%

Share of renewable energy in the electricity generation of EU-28 in 2015

935.8 TWh

RES electricity generation in 2015

94.2 Mtoe

Renewable heat and cooling consumption in the EU-28

THE EUROPEAN UNION IS ON THE RIGHT TRACK

Gross final energy consumption's increase of 2.2% between 2014 and 2015 did not make up for the exceptional 4.2% drop over the previous year. While the particularly mild climate conditions stifled the expansion of energy consumption yet again, they had a high impact on hydropower and wind energy production. Across the European Union, the hydropower deficit hit the sector with a 9% fall in output. By contrast, weather conditions hit wind energy production with extremely good conditions in most of Europe's regions with 19.3% growth, also helped by the additional 15 394 MW of windpower connected to the grid in 2015.

The actual share of renewable energies in EU's total electricity output (non-normalised for wind energy and hydro) rose from 28.2% in 2014 to 28.8% in 2015 while overall output of electricity (conventional and renewable) increased for the first time since 2011.

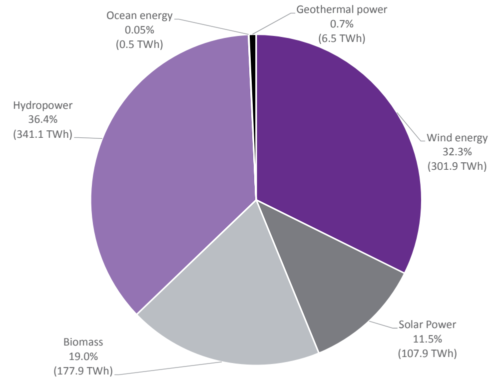
Renewable heat (and cooling) consumption returned to growth in 2015 (5.6% higher than in 2014) with a 5 Mtoe increase following an "unusual" drop in consumption of about 2 Mtoe in 2014. Most of the credit for the increase can be ascribed to additional input by solid biomass (3.9 Mtoe). Leaving aside annual variations, the renewable heat contribution of the EU of 28 has seen a sharp increase since 2004. It has risen by 39.2 Mtoe, which equates to 45.5% growth.

ELEVEN COUNTRIES HAVE ALREADY MET THEIR EUROPEAN TARGET FOR 2020

In 2015, most countries have either already met their target (Sweden, Finland, Denmark, Croatia, Estonia, Lithuania, Romania, Bulgaria, Italy, the Czech Republic and Hungary), or they are on course as per the indicative trajectory defined in the RE Directive. Only three countries were behind their indicative trajectory – France, the Netherlands and Luxembourg. While these countries may find it hard to meet their national targets, achievement of the common 20% target is very much on the cards, boosted by the fact that the energy policies of a number of countries, especially in Northern Europe, should easily take them well over target.

Graph. n° 2

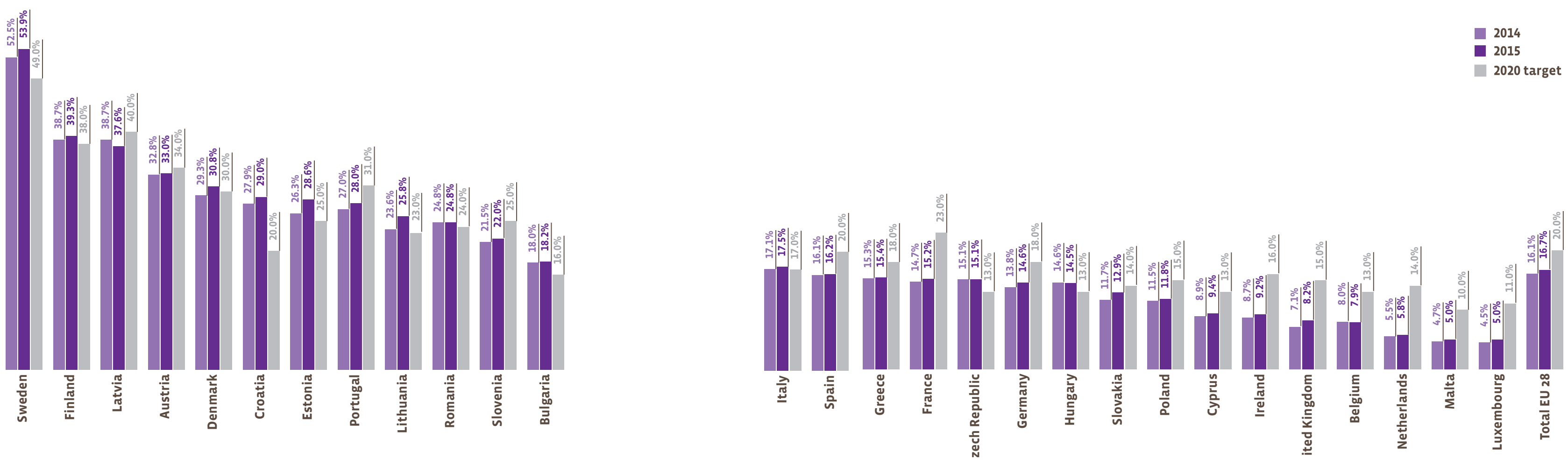
Share of each energy source in renewable electricity generation in 2015 in the EU 28 (in %)



Source: EurObserv'ER 2016

Graph. n° 1

Share of energy from renewable sources in gross final energy consumption in 2014 and 2015 and 2020 objective (in %)



Source: EurObserv'ER 2016

1 139 million

Jobs in renewable energy sector in the EU

332 350

Jobs in EU wind power sector in 2015

314 700

Jobs in EU biomass sector in 2015

€ 153 billion

Turnover generated by all RES in 2015 in the EU

€ 36 billion

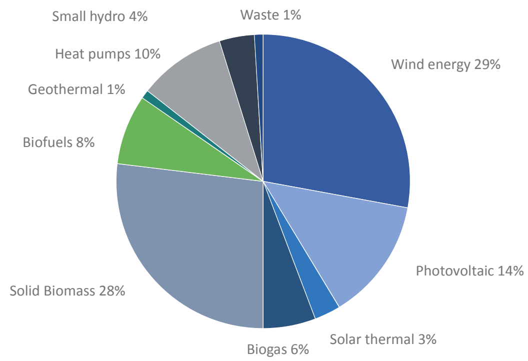
Turnover of solid biomass energy sector in the EU in 2015

EMPLOYMENT

The EurObserv'ER job head count for 2015 for the EU-28 indicates a consolidation on a high level and even small growth – a noteworthy finding as it reverses the trend of recent years. According to the conducted estimations and in contrast to the two editions before, EurObserv'ER assumes a growing renewable energy work force of 1.139 million persons employed throughout the EU for the ten monitored RES technologies, a growth of 10 000 jobs. Looking at this amount by country, also here Germany defended its top slot with 322 300 jobs, although it also was the country with the highest absolute job losses (-25 000 jobs against 2014, -8000 thereof in Onshore wind, -7000 in PV, and another – 5 000 jobs in hydropower) all due to significantly lower domestic investment activity.). In absolute numbers, the next big countries are France (162 100 jobs), the United Kingdom (109 200 jobs), Italy (97 100 jobs). According to EurObserv'ER estimations 20 out of 28 member states maintained or slightly increased their renewable energy related work force, which is more than an encouraging sign, even more so considering that these growth also occurred in crisis affected countries such as Spain (+3 900 jobs), Greece (+500 jobs), and Portugal and Ireland as well as notable increases for new member states Poland (+4 650 jobs), Croatia (+600 jobs) or Lithuania (+1 200 jobs). Analyzed by technology, the heat pump sector displayed the largest growth (+12 000 new jobs out of a total of over nearly 111 000), followed by solid biomass (+8 000 jobs), and wind energy (332 350 jobs) with 3 000 new persons employed.

Graph. n° 3

RES employment in the EU 28 by technology in 2015



Source: EurObserv'ER 2016

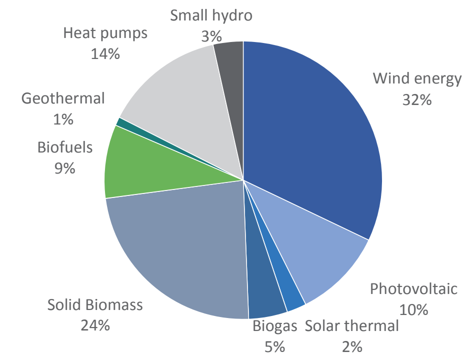
TURNOVER

The combined turnover of 10 renewable energy sectors in all 28 EU member states reached € 153 billion in 2015 and thus slightly grew compared to 2014 (€ 148.7 billion). Wind energy maintained its leading role in generating tur nover (€ 49.1 billion, equivalent to over 31% of total EU industry turnover), followed by solid biomass (€ 36 billion), and the pumps sector (€ 21.4 billion against € 18 billion in 2014).

Looking at the turnover estimations by country, 17 out of 28 EU member states should have increased or maintained their industrial turnover. Germany, despite some substantial declines, maintained its top slot for industry turnover at € 29.6 billion. France (€ 20 billion) is catching up, as well as the third ranked United Kingdom (€ 19.5 billion), Italy on fourth place (€ 18.7 million), and Spain (€ 13.5 billion) overtaking Denmark that still stands at a remarkable € 12.7 billion. □

Graph. n° 4

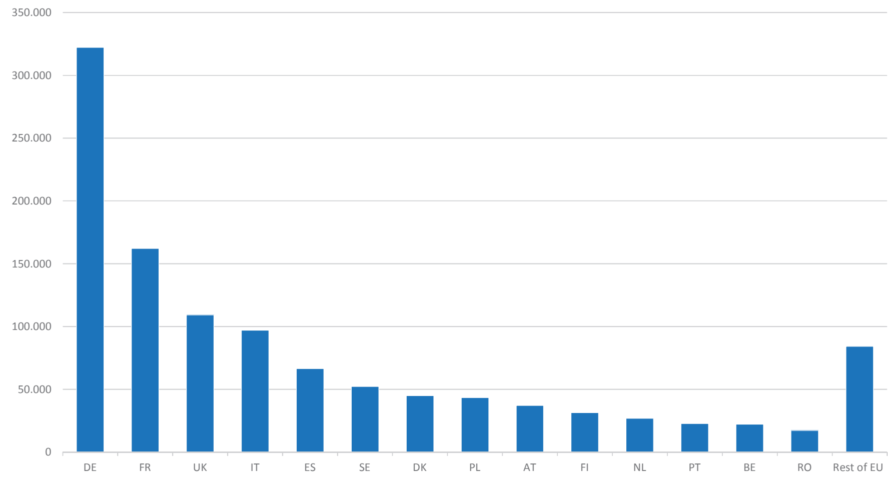
RES turnover in the EU 28 by technology in 2015 (in mln Euro)



Source: EurObserv'ER 2016

Graph. n° 5

RES employment in the EU 28 by country in 2015



Source: EurObserv'ER 2016

€ 2 034 billion

Venture Capital / Private Equity (mln. €) 2015

€ 52.1 billion

Asset Finance - New Built (mln. €) 2015

€ 5.2 billion

Investment in small scale PV

INVESTMENT IN RENEWABLE ENERGY CAPACITY

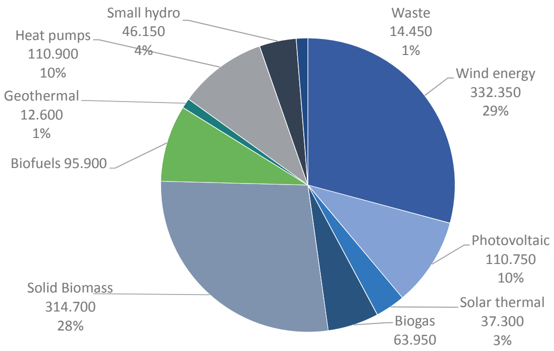
The indicators on investment in renewable energy projects capture asset finance for utility-scale renewable energy generation projects. Aggregating asset finance for all RES sectors shows that investment in renewable energy generation capacity grew notably between 2014 and 2015. EU investments in RES capacity totalled € 33.2 billion in 2014 and € 38.4 billion in 2015, which is an increase by almost 16%. This upsurge in investments is even more astonishing, when considering that RES investments already increased substantially between 2013 and 2014. However, the individual analysis of all RES sectors has revealed very heterogeneous developments. As in the previous years, investments in wind (on- and off-shore) dominate aggregate asset finance with respect to investment amounts (see Graph n°6). In 2015, wind investments grew by more than 33% to almost € 31 billion (€ 23 billion in 2014). Apart from the wind sector, the biomass sector is the only RES sector with a notable positive trend between the two years. In contrast, a substantial drop in investments could be observed for solar PV, the second largest RES sector with respect to asset finance. Investments in utility-size PV capacity dropped by almost 31% to € 4.2 billion in 2015. Investments in small scale PV installations (residential and commercial PV) with capacities below 1MW, dropped slightly to € 5.2 billion in 2015 (€ 5.9 billion in 2014).

VENTURE CAPITAL & PRIVATE EQUITY

Between 2014 and 2015, VC/PE investment in renewable energy fell by more than 44% in the EU. While VC/PE investments totalled € 3.67 billion in 2014, they only amounted to € 2.03 billion in the subsequent year. The decline in VC/PE investments in the RES sectors, however, was mainly driven by slumping PE investment. Venture capital, in particular early-stage VC, increased between both years. As in the previous years, the largest VC/PE investments by far occurred in the wind sector (see Graph n°7). In 2014 90% of all VC/PE investments were aimed at project developers or technology firms in the wind sector. However, the wind sector also experienced the largest slump in VC/PE investments between the two years. VC/PE investments in solar PV ranked second in both years and increased by almost 19% to € 343 million in 2015 (€ 299 million in 2014). In the biofuels sector, an even larger increase in VC/PE investments could be observed. While the biogas, biomass, and waste sectors experienced the lowest investments in both years, there are two sectors that only experienced VC/PE investments in 2015, namely geothermal and small hydro.

Graph. n° 6

Asset Finance - New Built (mln. €) 2015 by technology



Source: EurObserv'ER 2016

Tab. n° 1

Venture Capital and Private Equity Investment in Renewable Energy per Technology in the EU in 2014 and 2015

	2014		2015	
	Venture Capital / Private Equity (mln. €)	Number of Projects	Venture Capital / Private Equity (mln. €)	Number of Projects
Wind	3 311.97	10	1 490.00	7
Solar PV	288.95	14	343.12	13
Biofuels	53.00	2	112.83	3
Geothermal	0	0	57.72	2
Small Hydro	0	0	18.40	1
Biogas, Biomass & Waste	11.22	4	12.71	5
Total EU	**3 665.13**	**30**	**2 034.76**	**31**

Source: EurObserv'ER 2016

PERFORMANCE OF RES TECHNOLOGY FIRMS AND RES ASSETS

EurObserv'ER constructed several indices based on RES company stocks to capture the performance of RES technology companies, i.e. companies that develop / produce the RES components needed for RES plants to function. Of the three presented indices, the Wind Index shows the most positive development by far, in particular in 2015. The Bio-Technologies Index shows substantially different development in 2014 and 2015. While the trend is overall negative in 2014 and the beginning of 2015, it reverses and shows a positive development in 2015. The Solar PV Index shows a similar pattern, but an overall less positive development.

In order to track the performance of RES assets on public markets, EurObserv'ER tracked, for the first time in this edition, the development of YieldCos in the EU. In 2014 and 2015, there were only eight YieldCos active in the EU, which overall performed rather well. However, it remains to be seen how the YieldCo concept develops in the EU and whether more YieldCos will emerge in subsequent years. □

RENEWABLE ENERGY COSTS, PRICES AND COST COMPETITIVENESS

RES-E

All mature technologies show large areas of competitiveness with reference electricity price

RES-H

Heat from solid biomass is very competitive regarding reference heat price

RES-T

LCoE for biofuels is just above the reference transport reference price

RENEWABLE ELECTRICITY

Among the technologies producing electricity from bioenergy (via biogas, liquid and solid biomass), the LCoE for technologies based on solid biomass seem the least expensive, and even in the same range as the reference electricity price. The LCoE for electricity from deep geothermal energy and hydropower are comparable. Commercial large scale PV shows a wide LCoE range, mostly as a result of the differences in solar yield across the Member States. Concentrating solar power has only been quantified for Southern Europe and results in a higher LCoE than Commercial solar PV.

Wind energy LCoE has not been broken down into onshore versus offshore. The underlying reason for this is the very fast decline of offshore wind bid prices in recent tenders (Denmark, Germany, the Netherlands), which demonstrate that in certain large scale cases offshore wind LCoE is undercutting onshore wind levels. Moreover, the LCoE range observed for onshore wind is already very wide, largely covering offshore wind as well. Solar PV in the residential sector is special in the sense that the reference electricity prices are relatively high, making this technology, albeit at high LCoE levels, competitive in many Member States.

One of the technologies not displayed in the figure is ocean energy (including wave and tidal energy), for which the assessment results in LCoE ranges between 400 and 600 EUR/MWh. As this is an outlying range the technology is not presented in the graph.

RENEWABLE HEAT

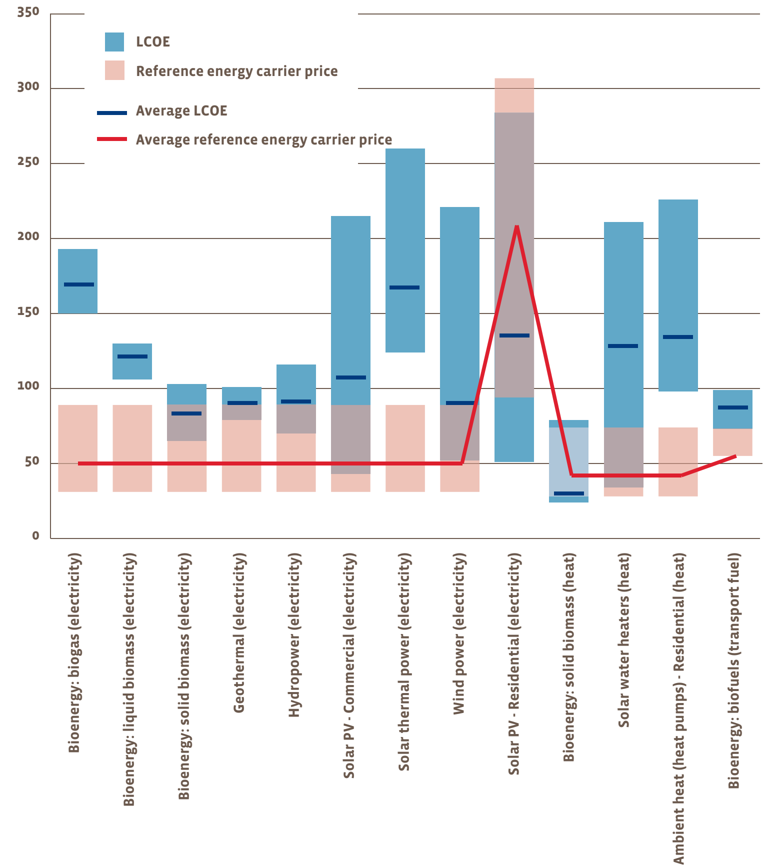
For the technologies producing heat, the LCoE for solid biomass is overlapping the reference heat range, indicating it is competitiveness in many countries. The LCoE range for solar water heaters is only partly overlapping the reference heat range, indicating that it is mainly competitive in selected countries (mostly in the Southern part of the European Union). Heat captured from ambient heat via heat pumps shows, according to the analysis, relatively high LCoE levels.

RENEWABLE TRANSPORT

Graph 7 provides an overview of the LCoE ranges for the assessed technologies on EU level. The ranges reflect the different energy prices observed in the EU Member States. Overall, the cost-competitiveness of RE technologies varies per technology per Member State depending on the renewable energy resource characteristics and the cost of capital. Furthermore, cost-competitiveness varies with differences in reference energy prices in Member States. Mature technologies such as hydro, geothermal and solid biomass can provide low-cost power that is comparable to the reference electricity prices. 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 reference heat prices mostly in Northern parts of the EU. □

Graph. n° 7

LCoE and reference energy carrier (€/MWh) EU Overview



Note: Overview of the LCoE assessment on a European Union level; ranges derive from the Member State differentiation. The graph also presents the ranges of reference electricity, reference heat and reference transport fuel prices, all excluding taxes and levies. An exception is the reference price for Solar PV (household electricity prices), where taxes and levies are included. Data refer to 2015

Source: EurObserv'ER 2016

€ 87 billion

Avoided expenses in EU-28 through renewables 2015

€ 40.5 billion

Avoided fossil fuel costs by renewable electricity in 2015

€ 38.6 billion

Avoided fossil fuel costs by renewable heat in 2015

€ 8.3 billion

Avoided fossil fuel costs by renewable transport fuels in 2015

302 Mtoe

Avoided fossil fuel use by renewable energy

AVOIDED FOSSIL FUEL USE AND RESULTING AVOIDED COSTS

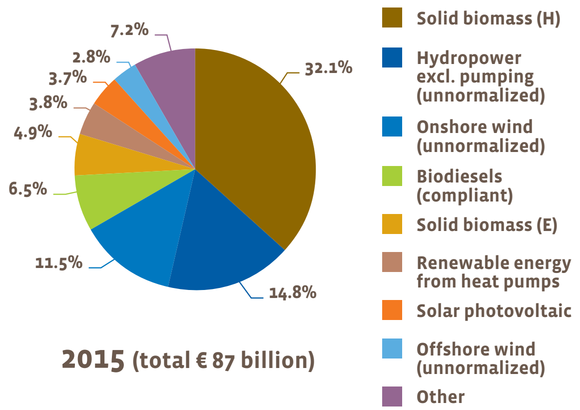
In 2014 and 2015 renewable energy substituted around 292 Mtoe and 302 Mtoe of fossil fuels respectively. The use of renewable electricity contributed to 64% of the total avoided fossil fuels. This is followed by renewables in the heating and cooling sector contributing to approximately 32% of the total avoided fossil fuels and the remaining 4% was substituted through renewable transport fuels (mainly compliant with the Directive 2009/28/EC are included) both in 2014 and 2015.

The largest share of avoided fossil fuels comes from solid fuels (mainly coal, 44% for both years 2014 and 2015), followed by natural gas (30% for both years). Next are oil products, with a contribution of 19% in 2014 and 20% in 2015. The remaining fuels (transport fuels and non-renewable waste) cover the remaining 7%. At member state level, the avoided fossil fuel use is displayed in graph 8.

In monetary terms, renewable sources of energy avoided fuel costs for the EU-28 worth € 87 billion, with € 40.5 billion stemming from the electricity sector in 2015. Second, renewable heat contributed to avoided costs reaching € 44.4 billion in 2014. In 2015 this fell to € 38.6 billion. Third is renewable transport fuels which contributed to avoided costs of € 10.4 billion in 2014 and € 8.3 billion in 2015. Although the penetration of renewable energy expanded by approximately 3% in 2015, the cumulative effect of the avoided fossil fuel costs is lower than in 2014. The underlying reason for this decline are decreasing fossil fuel prices in 2015 compared to 2014. Among the RES technologies, solid biomass avoided the purchase of fossil fuels at an amount of € 32.1 billion in 2015. Next, hydropower has been responsible for € 14.8 billion in 2015 Onshore wind is third in the row with € 11.5 billion in 2015. Broken down by countries Germany avoided fossil fuel imports worth € 12.7 billion, followed by France (€ 10.9 billion), and Italy (€ 10.8 billion). Nine Member States, however, experienced a decreasing trend in avoided fossil fuels due to decreased RE deployment in 2015 compared to 2014. These countries are Spain, Italy, Portugal, Croatia, Slovenia, Romania, France, Austria and Belgium.

Graph. n° 9

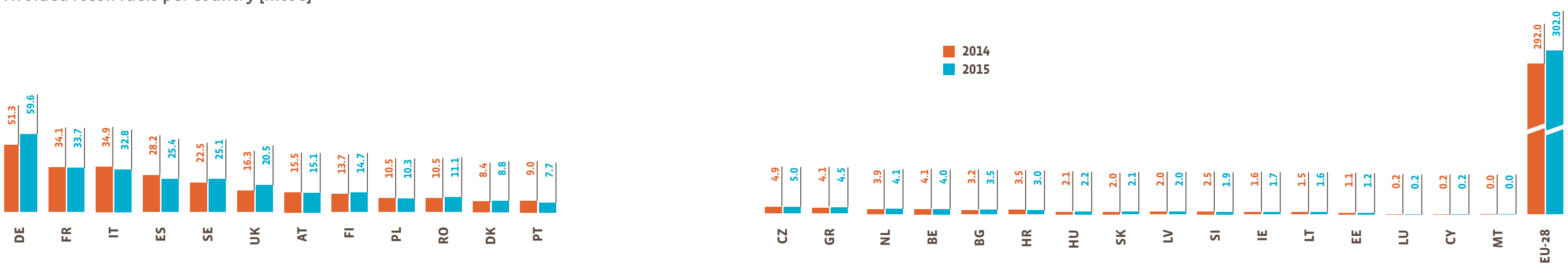
Avoided expenses in EU 28 through renewables in 2015. Share by country



Source: EurObserv'ER 2016

Graph. n° 8

Avoided fossil fuels per country [Mtoe]



Source: EurObserv'ER based on EEA data

€ 546 million

R&D Expenditures in RES in 2015 in the EU 28

64.3

Patents per € trillion GDP in 2012 in solar energy in the EU-28

20.64 %

Share of EU in global exports of renewable energy technologies in 2015

€ 2 368 million

Value of EU net exports (all RES) in 2015

The Energy Union strives to provide a secure, sustainable, affordable energy supply. RET, patent applications reflecting the output of R&D efforts and finally trade shares in RET displaying how competitive a country is in RET products.

PUBLIC R&D INVESTMENTS

It can be stated that many countries have specialized in certain technology fields within RET technologies. In solar energy, the EU28 scores first above the U.S. Within Europe, especially Germany, the Netherlands and Denmark have the largest public R&D investments. In hydro energy, which is a comparably small field with regard to public R&D investment, Canada ranks first, which can be explained by its hydro power resources. Here, also Norway and Switzerland (Finland) have comparably large amounts of public R&D spending.. In biofuels, it is clearly the U.S. with the largest investment with nearly € 500 million in 2015. In wind energy, Japan scores first with regard to public R&D spending, followed by the EU28 (Denmark, Germany, UK, Spain). Germany, the Netherlands and Denmark are the countries that have significant public R&D

Tab. n° 2

ALL RES

	Public R&D expenditure (in mln. €)		Share of Public R&D Exp. by GDP	
	2014	2015	2014	2015
EU 28				
France	176.8		0.0083%	
United Kingdom	94.2		0.0042%	
Sweden	62.8		0.0145%	
Belgium	26.8		0.0067%	
Romania	4.4		0.0029%	
Denmark		67.9		0.0250%
Netherlands		97.8		0.0145%
Total EU	781.6	377.5	0.0056%	0.0026%
Other Countries				
USA	671.5	755.4	0.0051%	0.0046%
Korea	123.7	106.2	0.0116%	0.0085%
Canada	79.0	63.3	0.0059%	0.0045%

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.

Tab. n° 3

Share on global exports in renewable energy technologies (in %)

	Share on global exports in renewable energy technologies		Net exports in € Mio.	
	2014	2015	2014	2015
EU 28				
Germany	8.33%	8.20%	1342	2206
Denmark	5.69%	4.79%	2772	2845
Spain	2.58%	2.27%	1140	1267
Netherlands	1.77%	1.20%	-265	-106
Poland	0.73%	0.62%	-361	-467
France	0.67%	0.62%	-353	-325
Italy	0.56%	0.69%	-191	-102
Belgium	0.50%	0.41%	-289	-52
Austria	0.48%	0.46%	10	-34
Czech Republic	0.48%	0.34%	-2	-9
United Kingdom	0.37%	0.27%	-2101	-2123
Slovenia	0.14%	0.11%	38	27
Portugal	0.10%	0.09%	-50	-19
Greece	0.09%	0.02%	-38	-134
Sweden	0.09%	0.07%	-166	-179
Slovakia	0.09%	0.07%	2	-11
Ireland	0.07%	0.04%	4	3
Lithuania	0.06%	0.06%	0,2	13
Hungary	0.06%	0.05%	-113	-147
Finland	0.06%	0.04%	-126	-124
Estonia	0.05%	0.05%	13	22
Luxemburg	0.04%	0.05%	-6	-6
Croatia	0.03%	0.04%	-15	-30
Romania	0.03%	0.02%	-234	-112
Bulgaria	0.02%	0.03%	-28	-9
Latvia	0.01%	0.02%	-11	-10
Malta	0.00%	0.00%	-11	-10
Cyprus	0.00%	0.00%	-14	-10
Total EU	23.09%	20.64%	946	2368

investment in nearly all RET fields. Especially for Denmark and the Netherlands this also translates to rather high shares of public R&D spending on GDP.

PATENT FILINGS

The technological performance of countries or innovation systems in general is commonly measured by patent filings . Countries with a high output of patents are assumed to have a strong technological competitiveness, which might be translated into an overall macroeconomic competitiveness. Europe takes a middle position between the Asian countries and the U.S. when it comes to the patenting activities in absolute and relative (GDP) numbers. Within the EU 28, it is mostly Germany that files the largest number of patents.

INTERNATIONAL TRADE

With regard to the export shares, China has a rather dominant position. After China, large export shares can be found for Germany, Japan, Denmark, the U.S. and Spain. From these countries, however, only Germany could keep up stable shares between 2014 and 2015. These trends, however, can be qualified when looking at the trade balances. This indicator reveals that China has a very positive trade balance, originating from its strong position on the PV market. The only other countries with a positive trade balance in RET are Denmark, Germany and Spain, thanks to their position in the wind power market. These countries are exporting more RET goods than they are importing. The coun-tries with the most negative trade balances are the U.S., the UK, Japan and India. □

RESULTS AND INTERPRETATIONS

Balancing of electricity supply and load is nothing new as conventional resources may fail unexpectedly and demand cannot be perfectly forecasted. However, increasing volatile renewable energy shares e.g. wind and solar power make successful balancing more difficult. Unexpected changes within one country could either be compensated by adjusting the generation side, or by cross-border transfers or demand side adjustments. Thus, flexibility can be provided not only by the supply side but also by the demand side and by transmission infrastructure between countries and markets. To account for the complexity of the system a set of flexibility indicators is applied: the capacity and transmission flexibility.

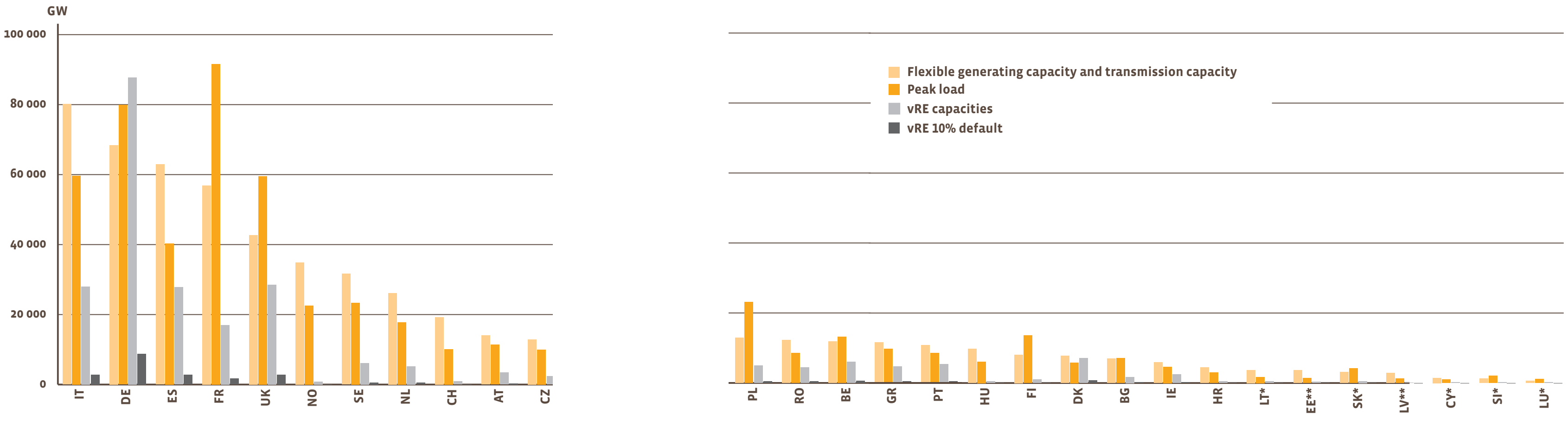
The flexible generation capacity per peak load signalizes which share is flexible, i.e. can be balanced in case of sudden changes in generation, e.g. due to volatile capacities under peak load conditions. The transmission capacities show which capacities might be available from adjacent countries in case of a bottleneck. Both capacities, generation and transmission capacities, show the flexible capacity at the supply side.

Any flexible capacity larger than peak load and volatile RE capacities (10%) shows that the flexible generation and transmission capacities cover not only peak demand but could at the same time compensate potential defaults e.g. a 10% default of vRE.

Overall, the flexibility of the electricity system, which is based on flexible generating capacities and transmission, is highly sufficient for all Member States. Graph no 10 depicts the overall flexibility as a sum of generating and transmission flexibility and compares this value to the load, vRE capacity share and the vRE 10% default, which is here depicted as a critical threshold for a system's flexibility. Regarding the components of the flexibility capacity, the capacity flexibility is sufficient for all Member States.
However, the cross-border transmission capacity is still low such that some neighbouring countries could only rely to a small degree on flexible capacities in adjacent countries. The transfer capacities might become a constraint, if some countries significantly increase their vRE shares and might rely on flexible capacities in neighbouring countries. □

Graph. n° 10

Flexibility capacities in comparison to load, vRE capacities and the critical threshold at vRE 10% default rate



Source: EurObserv'ER 2016

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