

Climate Change and Electricity

European carbon factor
Benchmarking of
CO₂ emissions by Europe's
largest electricity utilities

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The carbon factor of Europe's largest electricity utilities is at its lowest level since 2001

In 2015, the electricity generated by the 20 utilities in our selection declined by 26 TWh, or 1.3% year on year, to 1,972 TWh from 1,998 TWh in 2014. This is the sixth consecutive year that electricity output has fallen for our selection of utilities despite a more favourable economic climate in Europe in 2015, and weather conditions that were conducive to greater electricity consumption (colder winter and warmer summer).

The decrease in the electricity production of the utilities in our selection was accompanied by a more pronounced 2.4% reduction in CO₂ emissions from 627 million tonnes of CO₂ (Mt CO₂) in 2014 to 612 Mt CO₂ in 2015. The greater reduction in CO₂ emissions compared to electricity production can be explained by:

1. the decline in electricity output in Europe;
2. a decrease in the proportion of high-carbon non-renewable energy sources in the energy mix.

Europe's carbon factor fell by 1.1% to 311 kg CO₂/MWh in 2015, its lowest level since this study began in 2001.

In our analysis, this decrease reflects a less carbon-intensive non-renewable energy mix rather than a significant increase in the use of renewable energies within our selection. The proportion of renewable energies in electricity production held steady at around 22% in 2015. The carbon content of non-renewable energy sources declined for the fourth consecutive year.

The 1.1% fall in the carbon factor recorded in 2015 is in line with the decarbonisation rate of the European economy, which stood at 0.7% in 2015, but is below both the global decarbonisation rate, which declined by 2.8% from 2014 to 2015, and the theoretical average global decarbonisation rate of 6.5% that is required until 2100 in order to keep the Earth's temperature from rising by more than 2°C (see 2016 PwC study "The Paris agreement: a turning point?").

The 20 utilities in our selection generated over 50% of the CO₂ emissions in Europe's electricity and heating sector (28 countries).

The most significant decreases in emissions in Mt CO₂ between 2014 and 2015 were recorded by:

- **E.ON:** after cutting its emissions by 15.9 Mt CO₂, or 25% year on year, E.ON moved down from fifth to sixth place among the largest emitters in our selection. This performance is largely attributable to the 14% year-on-year decline in production, as well as changes in its energy mix. Although the proportion of renewable sources in E.ON's energy mix remained relatively stable (down 1 TWh) and nuclear energy production declined by 4.4 TWh, the proportion of coal and gas fell sharply by 7.7 TWh and 5.8 TWh, respectively. This explains the noticeably larger decrease in emissions than in production.
- **EDF:** in 2015, Europe's largest producer of electricity reduced its emissions by 5.4 Mt CO₂, or 9% year on year. As with E.ON, the reduction is less attributable to the use of renewable energies, which fell slightly by 1.1 points to 9% of the energy mix, than it is to a shift away from coal (down 0.9 points to 6%) in favour of nuclear energy (up 1.4 points to 76%).
- **DEI:** the reduction in lignite-based electricity generation (down 3.3 TWh) was partly offset by an increase in hydropower output (up 1.5 TWh), which was 20% greater than the past 15 year average.

- **Drax:** the producer with the fourth highest carbon factor in our selection continued the overhaul of its energy mix that began in 2014, reducing the proportion of coal (down 3.5 TWh) in favour of electricity generated from biomass (up 3.6 TWh). Its on-site CO₂ emissions decreased by 3.5 Mt in 2015.

The largest increases in emissions in Mt CO₂ between 2014 and 2015 were recorded by:

- **EDP:** emissions increased by 4.6 Mt CO₂ in 2015, as a 6 TWh decline in hydropower production was offset by increases in coal- and gas-fired production (up 4 TWh and 2.5 TWh, respectively).
- **RWE:** the largest emitter in our selection since 2002 expanded its use of coal, lignite and fuel oil. Consequently, its CO₂ emissions grew by 6%, or 11 Mt.

The proportion of electricity generated from renewable sources held steady at 22%

Between 2014 and 2015, the proportion of renewable sources in the energy mix of the 20 utilities in our selection stabilised at around 22% following three consecutive years of growth. The annual output derived from renewable energy sources by the utilities in our selection declined slightly by 7 TWh to 431 TWh. This trend should be viewed in the context of the pronounced decrease in production of electricity from non-renewable energy sources (down 24 TWh year on year and 236 TWh during the past five years). Electricity produced from non-renewable energy sources by the utilities in our selection decreased by 3.5% on average for the fourth consecutive year. Output from coal-fired and nuclear power plants fell in 2015, while that from natural gas-fired plants increased.

Hydropower remained the most prevalent renewable energy used in Europe although production declined in 2015 as a result of unfavourable weather conditions in the Iberian peninsula and France. Wind power retained its second place, while biomass, the third-placed source of renewable energy for the utilities in our selection, made gains over the year. Other renewable energies, such as geothermal energy and photovoltaic power, do not have a meaningful presence in our selection's energy mix, even though certain companies have made a significant effort to increase their use of renewable energies.

Top five emitters

- RWE (DE, UK): 141 Mt CO₂, up 4%
- Vattenfall (DE, SE, FI): 84 Mt CO₂, up 2%
- ENEL (IT, ES, PT, SK): 68 Mt CO₂, up 2%
- EDF (FR, UK, IT, BE, PL): 52 Mt CO₂, down 9%
- Engie (FR, BE, NL, LU, DE): 50 Mt CO₂, up 5%

Five lowest carbon factors

- Statkraft (NO): 4 kg CO₂/MWh, down 4%
- Fortum (FI): 21 kg CO₂/MWh, down 47%
- Verbund (AT): 55 kg CO₂/MWh, up 6%
- EDF (FR, UK, IT, BE, PL): 81 kg CO₂/MWh, down 9%
- PVO (FI, SE): 84 kg CO₂/MWh, down 40%

Five highest carbon factors

- DEI (GR): 1,006 kg CO₂/MWh, down 9%
- RWE (DE, UK): 721 kg CO₂/MWh, down 3%
- EDP (ES, PT): 520 kg CO₂/MWh, up 26%
- Drax (UK): 491 kg CO₂/MWh, down 16%
- Vattenfall (DE, SE, FI): 484 kg CO₂/MWh, up 2%

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1. Context, purpose and limits of the study

1.1. In 2015, the carbon factor fell to its lowest level since 2001

2015 was a year of climate commitments for the world and for the European Union in particular, with the 21st Conference of the Parties to the United Nations Framework Convention on Climate Change (COP21) held in Paris during the year. The EU confirmed its commitment to addressing climate change by pledging to reduce its greenhouse gas emissions by 40% by 2030 from 1990 levels. This commitment expands and amplifies the 2020 objective¹ set by the EU and will require a meaningful decarbonisation of the European economy. Measured against expected growth in GDP, if the EU is to meet its Paris Agreement commitments, its carbon intensity² will have to contract by 3.1% each year until 2030³.

In 2015, the EU's combined carbon intensity fell by 0.7%, with mixed results among its members, ranging from decreases of 6% in the UK, 1.1% in Germany and 0.2% in France to a 4.7% increase in Italy. By comparison, the world's two largest greenhouse gas emitters, China and the United States, sharply reduced their carbon intensity in 2015. China's carbon intensity declined by 6.4% during the year, which is nine times more than the improvement in the EU. However, China's carbon intensity is still 2.6 times greater than Europe's. The United States, whose carbon intensity is 1.7 times higher than the EU's, achieved a reduction of 4.7% in 2015⁴.

Against a backdrop of gradual economic recovery in Europe, the region's main utilities produced less electricity than in previous years. The decrease in electricity output by the utilities in our selection (down 1.3%) helped to further reduce CO₂ emissions in 2015 by 2.4%. The proportion of renewable energies in the mix also increased, contributing to the reduction in CO₂ emitted by the utilities in our selection and, consequently, the European carbon factor (see Section 3.5).

1.2. Purpose of the study

The purpose of this study is to identify, consolidate, standardise and present comprehensive information on CO₂ emissions by the largest European electricity utilities and to analyse the main trends between 2001 and 2015.

1.3. Limits of the study

We do not provide comments or opinions on energy prices or the impact of CO₂ in the assessment of the companies included in this study.

1: Reduce greenhouse gas emissions by 20% from 1990 levels, increase the proportion of energy consumption produced from renewable sources to 20% and improve energy efficiency by 20%.

2: Carbon intensity is defined as emissions from the energy sector (emissions produced from energy production, including electricity production and emissions from transport) in relation to GDP.

3: Source "The Paris Agreement: A turning point? Low Carbon Economy Index 2016", November 2016, PwC.

4: idem.

2. Methodology and sources

2.1. Data collection in Europe

Most of the companies in our selection have posted data directly on their websites or in their Annual Reports and/or Environment/Sustainable Development reports.

The level of transparency of the disclosed data did not improve significantly from previous years.

While some companies publish a detailed geographic breakdown of CO₂ emissions from electricity generation, along with the related carbon factor, this information is more difficult to come by for others who publish aggregate data and do not distinguish between emissions attributable to heating (not included in the scope of this study) and emissions attributable to electricity production. Moreover, very few utilities provide explanations for changes in emissions figures.

For companies producing both electricity and steam, aggregate CO₂ emissions have been allocated to electricity in proportion to the percentage of electricity in total energy output.

We are aware that some data may be approximate, particularly in cases where data have been extrapolated. However, we believe that the margin of error regarding direct greenhouse gas emissions does not exceed 10%.

2.2. Coverage

In 2015, electricity production in Europe for the 34 countries⁵ of the ENTSO-E (European Network of Transmission System Operators for Electricity) totalled 3,278 TWh⁶, up 1.4% compared to 2014. The companies in our selection therefore account for 1,972 TWh, or 60%, of all electricity generated (and 38% of electricity generated from renewable energies) in Europe.

The emissions analysed in this report total 612 Mt CO₂/year, representing 50% of the European (EU-28 plus Norway) energy sector's total emissions, estimated at 1,225 Mt CO₂/year⁷.

5:EU countries (excluding Malta) plus Switzerland, Norway, Iceland and the Balkan countries (excluding Albania).

6:Source "Electricity in Europe 2015: Synthetic overview of electric system consumption, generation and exchanges in the ENTSO-E area", June 2016, www.rte-france.com/sites/default/files/entsoe_electricity_in_europe_2015.pdf

7:CITL EU28 sector data "20 Combustion of fuels", available at <http://www.eea.europa.eu/data-and-maps/data/european-union-emissions-trading-scheme-eu-ets-data-from-citl-8>

2.3. Scope

To make the results of the study as relevant as possible, our scope included only:

- European emissions⁸;
- emissions attributable to electricity generation (i.e., excluding emissions from subsidiaries in other sectors).

Wherever possible, emissions attributable to heat production were also eliminated.

When consolidated emissions data were unavailable, the figures from recent acquisitions were added using the control approach rather than the equity share approach in accordance with the recommendations of the GHG Protocol⁹.

EDF Energies Nouvelles, as well as different subsidiaries such as Dalkia and TIRU, were included in the selection for 2014 and 2015 as part of the EDF group.

Wherever possible, historical data for companies included in this study were restated for the 2002-2014 period in order to highlight trends on a comparable scope basis.

Details on consolidation are provided in Appendix B.

8:Excluding emissions from entities outside Europe.

9:For more information, see: www.ghgprotocol.org

2.4. Published information

2.4.1. European analysis (20 companies)

We analysed the 20 leading European electricity utilities based on the following criteria:

- production (in TWh). We took into account electricity generated as opposed to electricity sold, which also factors in trading activities;
- emissions (in t CO₂/year), corresponding to electricity generated;
- carbon factor (in kg CO₂/MWh produced);
- percentage of energy produced from renewable sources¹⁰;
- main trends in the carbon factor, CO₂ emissions and the renewable energy ratio.

2.4.2. Recalculation of historical data

We updated and recalculated historical production and emissions data for certain companies to take into account recently published data.

¹⁰:Renewable energy is energy that comes from natural resources such as wind, sunlight, water and biomass and can be naturally replenished.

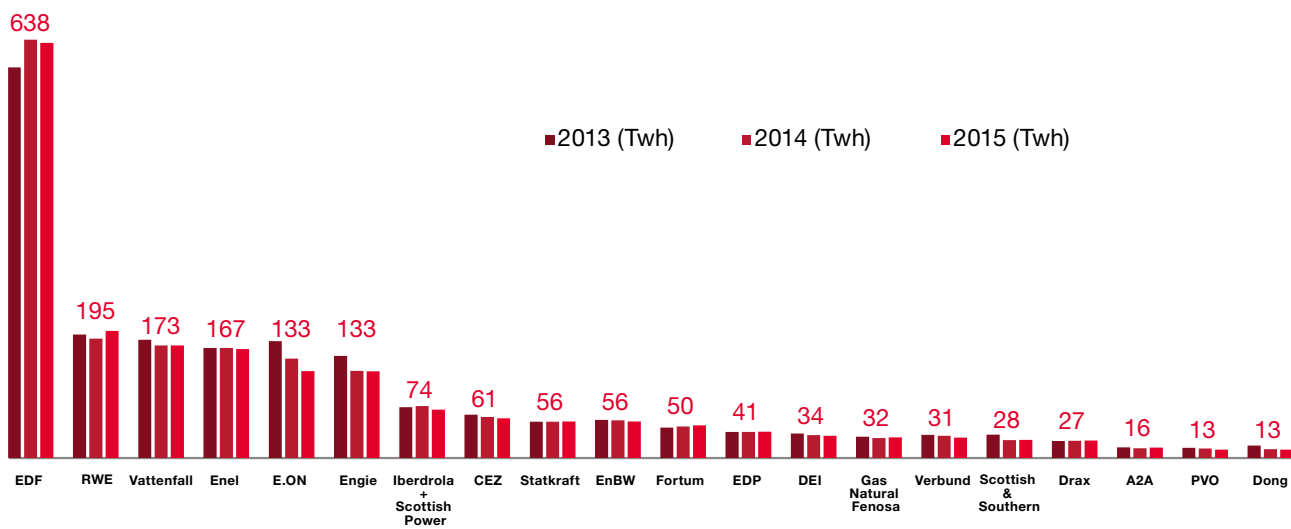
3. Results for 2002-2015

3.1. Production – 2015 data

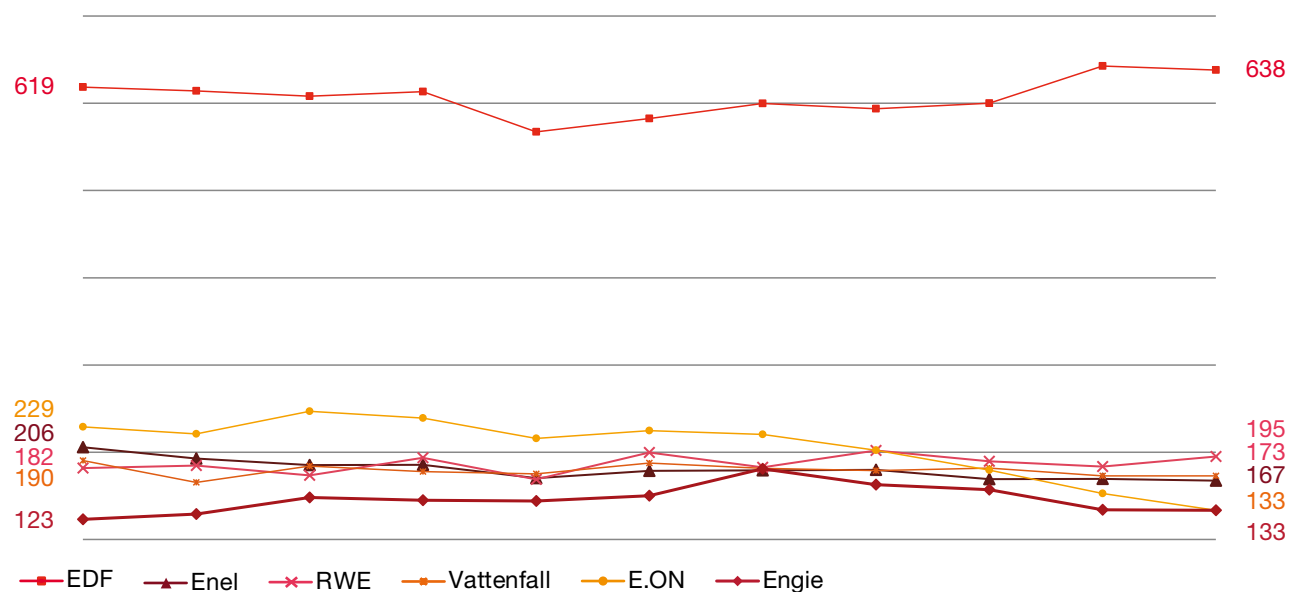
Electricity generated by the companies in our selection declined slightly by 26 TWh, or 1.3 %, between 2014 and 2015. One utility reduced its electricity production by at least 10 TWh (E. ON, down 19 TWh), while RWE (up 12 TWh) was the only company to increase its production by more than 10 TWh.

EDF was again the largest producer of electricity by far in Europe. RWE remained in second place.

Electricity production in Europe 2013-2015 in TWh/year (for the 20 companies in our selection)



Electricity production in Europe 2005-2015 in TWh (top six producers)





Unlike in previous years, the economic environment in Europe was no longer the leading cause of the decrease in electricity production, as GDP for the EU-28 increased by 1.4% in both 2014 and 2015. Similarly, the weather conditions (a slightly colder winter than the previous year and a warmer summer) were conducive to greater electricity consumption. However, technological progress and changes in consumer behaviour most likely led to improved energy efficiency in buildings, lighting and appliances, even if it is difficult to accurately measure this trend's contribution to lower electricity production.

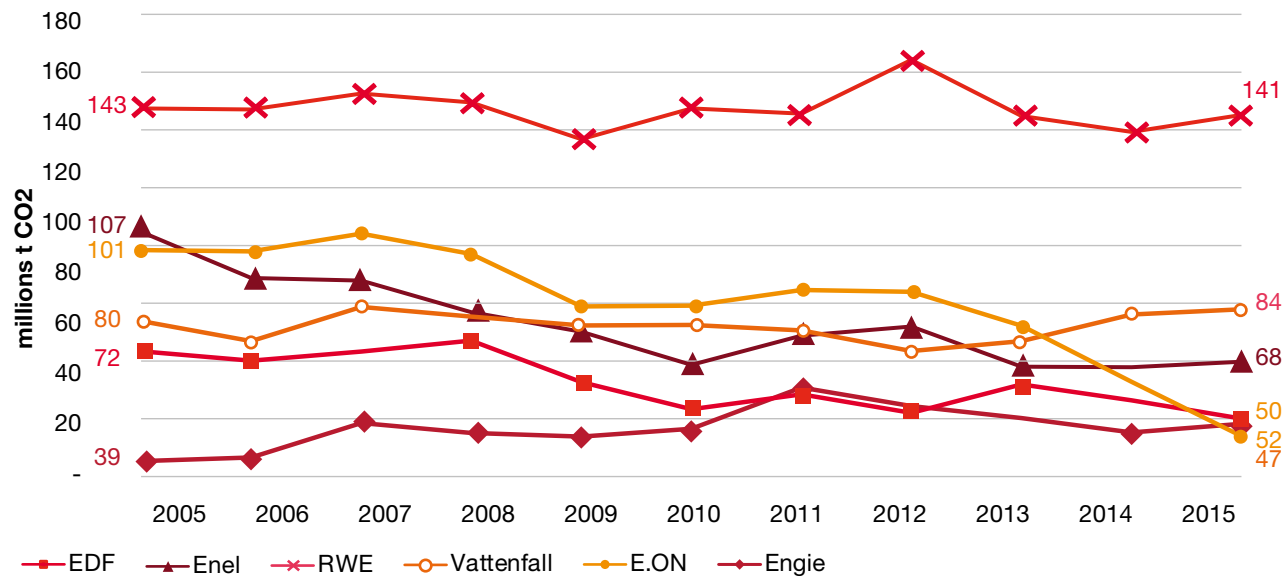
The top five of European electricity producers in 2015 included a sixth, as Engie climbed to fifth-equal with E.ON.

3.2. Emissions – 2015 data

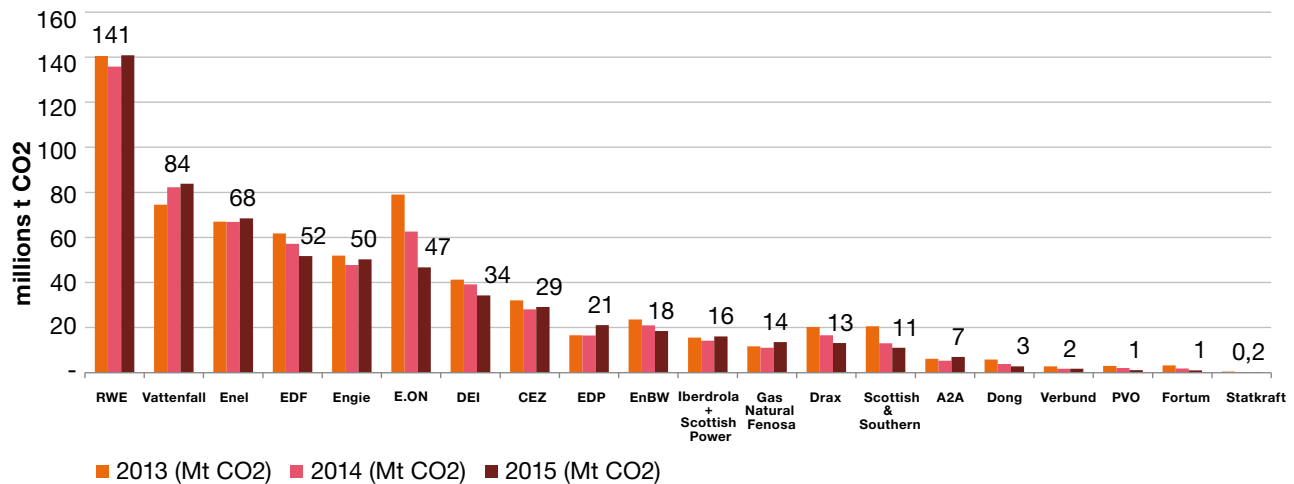
Pro forma emissions by the companies in our selection contracted by 15 Mt CO₂, or 2.4%, between 2014 and 2015. RWE remained the largest emitter in Europe, a position that it has held since 2002, with 141 Mt CO₂ in 2015, up 5 Mt CO₂ year on year. RWE accounts for nearly 23% of total emissions by the companies in our selection.

The top five emitters in our selection of companies changed slightly. RWE, Vattenfall and Enel remain in the top three places, while Engie moved into fifth place (due to strong production levels from its coal-fired power plants and the temporary shutdown of its nuclear plants in Belgium). E.ON dropped from fourth to sixth in 2015, following a considerable 25% reduction in emissions (15.9 Mt CO₂) that was similar to the reduction observed between 2013 and 2014.

CO₂ emissions in Europe 2005-2015 (top six emitters)



CO₂ emissions in Europe 2013-2015 (for the 20 companies in our selection)



3.3. Major changes in CO₂ emissions for 2014-2015

Changes in CO₂ emissions for the companies in our selection are attributable to both structural and temporary factors. Unlike in 2014, when all the companies in our selection reduced their emissions, trends varied between 2014 and 2015, with emissions up for nine companies and down for the other eleven.

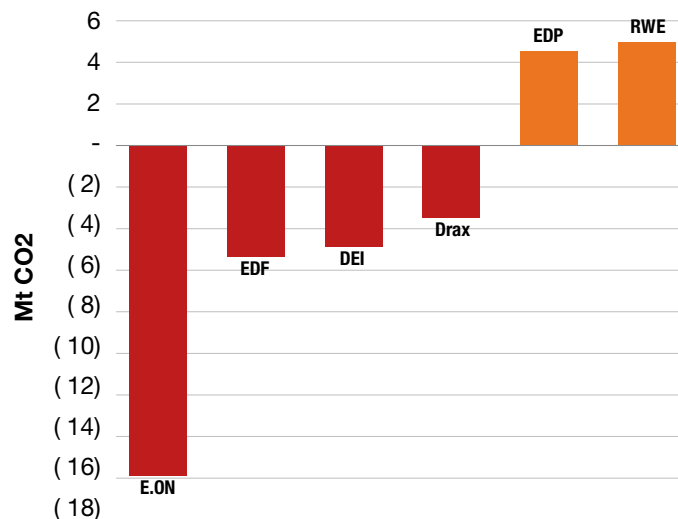
The most significant decreases in emissions in Mt CO₂ between 2014 and 2015 were recorded by:

- **E.ON:** after cutting its emissions by 15.9 Mt CO₂, or 25% year on year, E.ON moved down from fifth to sixth place among the largest emitters in our selection. This performance is largely attributable to the 14% year-on-year decline in production, as well as changes in its energy mix. Although the proportion of renewable sources in E.ON's energy mix remained relatively stable (down 1 TWh) and nuclear energy production declined by 4.4 TWh, the proportion of coal and gas fell sharply by 7.7 TWh and 5.8 TWh, respectively. This explains the noticeably larger decrease in emissions than in production
- **EDF:** in 2015, Europe's largest producer of electricity reduced its emissions by 5.4 Mt CO₂, or 9% year on year. As with E.ON, the reduction is less attributable to the use of renewable energies, which fell slightly by 1.1 points to 9% of the energy mix, than it is to a shift away from coal (down 0.9 points to 6%) to nuclear energy (up 1.4 points to 76%).
- **DEI:** the reduction in lignite-based electricity generation (down 3.3 TWh) was partly offset by an increase in hydropower output (up 1.5 TWh), which was 20% greater than the past 15 year average.
- **Drax:** the producer with the fourth highest carbon factor in our selection continued the overhaul of its energy mix that began in 2014, reducing the proportion of coal (down 3.5 TWh) in favour of electricity generated from biomass (up 3.6 TWh). Its on-site CO₂ emissions decreased by 3.5 Mt in 2015.

The largest increases in emissions in Mt CO₂ between 2014 and 2015 were recorded by:

- **EDP:** emissions increased by 4.6 Mt CO₂ in 2015, as a 6 TWh decline in hydropower production was offset by increases in coal- and gas-fired production (up 4 TWh and 2.5 TWh, respectively).
- **RWE:** the largest emitter in our selection since 2002 expanded its use of coal, lignite and fuel oil. Consequently, its CO₂ emissions grew by 6%, or 11 Mt.

Major changes in CO₂ emissions between 2014 and 2015



3.4. Carbon factor

Europe's carbon factor is at its lowest level since 2001, and following a peak in 2007 of 377kg CO₂/MWh, the carbon factor for the utilities in our selection has also reduced each year since 2012. The average European carbon factor for our selection declined by 3kg CO₂/MWh, or 1.1% year on year, to 311kg CO₂/MWh from 314kg CO₂/MWh in 2014. Of this decrease, 75% was attributable to the improved carbon factor from non-renewable sources (399kg CO₂/MWh in 2015 compared with 402kg CO₂/MWh in 2014) and 25% to the larger proportion of renewable energy sources in the selection's electricity production (virtually stable at 22% in 2014 and 2015). Improvements in the carbon factor as a whole are highly dependent on changes in the carbon factor from non-renewable sources, as was already the case in 2013 and 2014. The decrease in our selection's carbon factor therefore reflects a lower-carbon non-renewable energy mix rather than any real effort to increase the output from renewable energies.

2015 saw contrasting trends in the carbon factors of the companies in our selection, with increases of between 15% and 30% in the case of five companies with operations mainly in southern Europe, and decreases of between 14% and 50% in the case of six companies operating in northern and central Europe. Lastly, we would like to highlight EDF's contribution to maintaining the average European carbon factor at a relatively low level. Without EDF, the European carbon factor for our selection would be 35% higher at 420kg CO₂/MWh. This reflects the scale of EDF's operations in Europe (the company generates three times more electricity than runner-up RWE) and the considerable proportion of nuclear energy (76%) and hydropower (7%) in its energy mix.

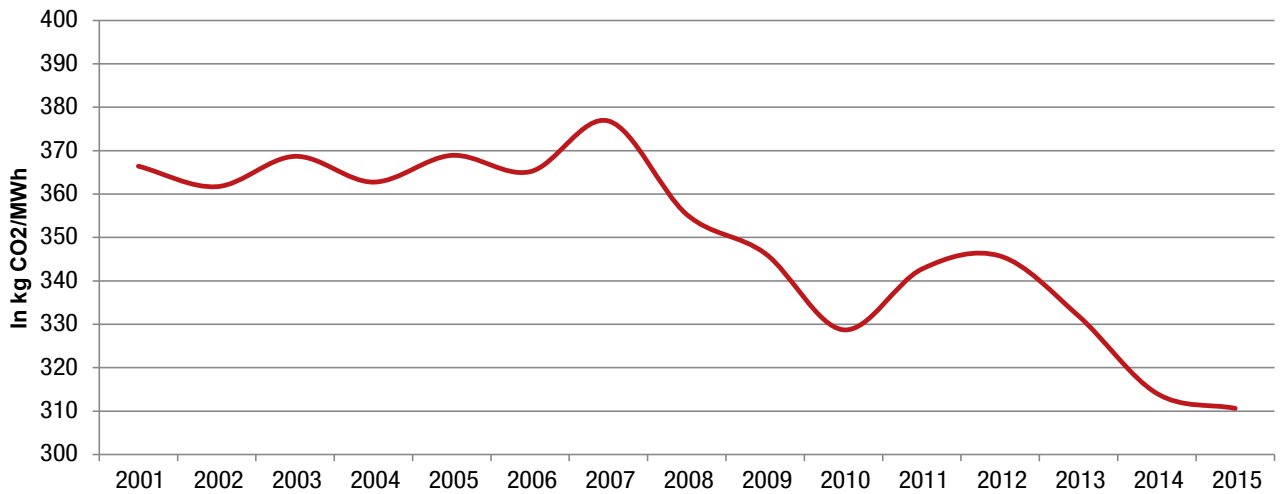
Main increases in the carbon factor in 2015 versus 2014:

- **EDP:** its carbon factor rose from 413 kg CO₂/MWh to 520 kg CO₂/MWh (up 26%) due to one-third of hydropower production being transferred to coal- and gas-fired power plants.
- **Iberdrola – Scottish Power:** its carbon factor rose from 178 kg CO₂/MWh to 217 kg CO₂/MWh (up 22%) due to a reduction in hydropower and nuclear generation and an increase in production from gas-fired power plants.
- **A2A:** its carbon factor rose from 358 kg CO₂/MWh to 436 kg CO₂/MWh (up 22%) due to an increase in production from fossil fuel thermal power plants and a reduction in hydropower.
- **Gas Natural Fenosa:** its carbon factor rose from 363 kg CO₂/MWh to 431 kg CO₂/MWh (up 18%) due to a reduction in hydropower in favour of coal.

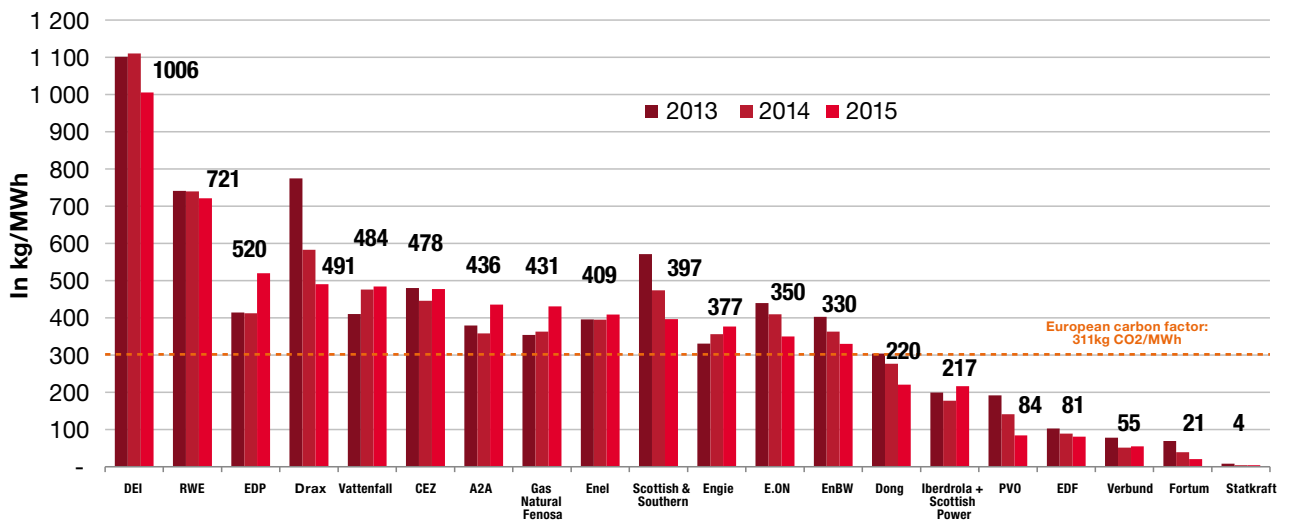
Main decreases in the carbon factor in 2015 versus 2014:

- **Fortum:** its carbon factor fell from 39 kg CO₂/MWh to 21 kg CO₂/MWh (down 47%) due to the growth in hydropower, and despite a decrease in nuclear energy output. 97% of Fortum's energy mix is derived from low-carbon energy sources, divided nearly equally between nuclear energy and hydropower.
- **PVO:** its carbon factor fell from 141 kg CO₂/MWh to 84 kg CO₂/MWh (down 40%) by taking advantage of weather conditions that were favourable to hydropower generation. Against a backdrop of a decrease in production, the company reduced its output from non-renewable energies, particularly coal
- **Dong:** its carbon factor fell from 277 kg CO₂/MWh to 220 kg CO₂/MWh (down 20%), thanks to higher output from wind power and significant cutbacks in its use of natural gas.
- **Scottish & Southern:** its carbon factor fell from 474 kg CO₂/MWh to 397 kg CO₂/MWh (down 16%), thanks to a significant reduction in its use of coal in favour of natural gas.
- **Drax:** its carbon factor fell from 583 kg CO₂/MWh to 491 kg CO₂/MWh (down 16%), thanks to its continued efforts to reduce the proportion of coal in favour of electricity generated from biomass, which in 2015 represented 43% of the company's electricity production.
- **E.ON:** its carbon factor fell from 410 kg CO₂/MWh to 350 kg CO₂/MWh (down 15%), against a backdrop of an around 12% decrease in production following the closure of coal-fired power plants, the sale of gas-fired power plants in Italy and Spain, and cutbacks on coal in the UK and Germany. Output from renewable energy sources and nuclear power also declined, following the closure of nuclear power plants in Germany and Sweden and the disposal of certain assets.

Change in the carbon factor (for the 20 companies in our selection)



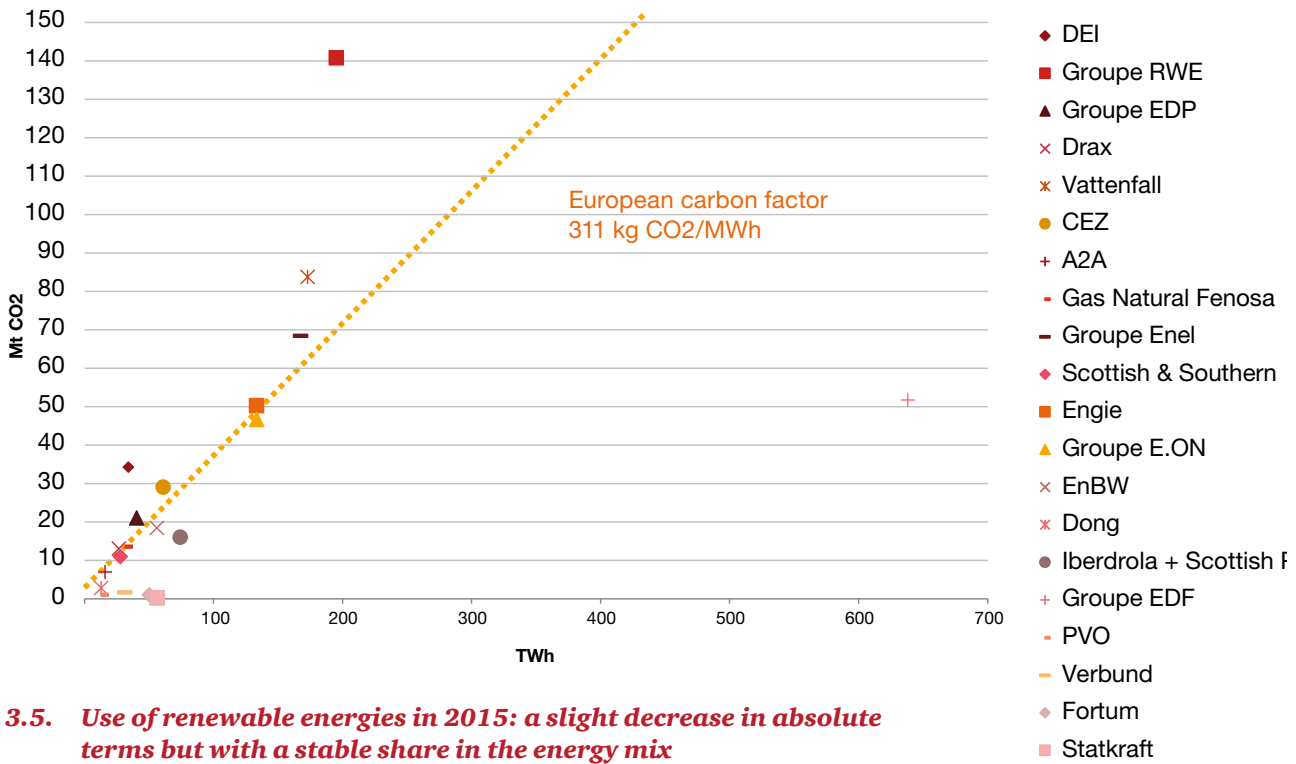
2015 carbon factor by company (for the 20 companies in our selection)



The ranking of European utilities by carbon factor has changed little since 2013, particularly among the top two and bottom seven companies on the scale of carbon emitters. Changes are more pronounced among the middle-ranked companies. In addition, three of the seven companies with a European carbon factor below our selection's overall average are among the top ten producers (EDF, Iberdrola and Statkraft, ranked first, seventh and ninth, respectively).

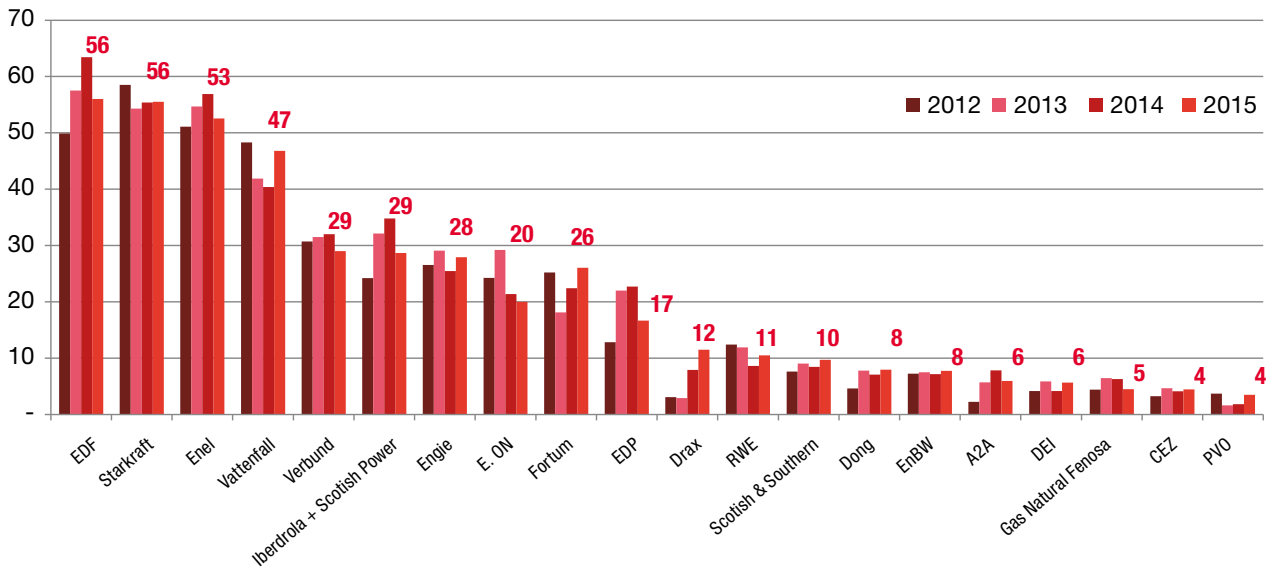
The four utilities with the highest carbon factors reported contrasting results. DEI's carbon factor decreased by 105 kg CO₂/MWh, RWE's remained relatively stable, down 19 kg CO₂/MWh or 2%, and EDP's increased sharply by 108 kg CO₂/MWh. Drax's carbon factor continued to decline (down 92 kg CO₂/MWh for scope 1 site emissions) thanks to an energy mix more reliant on biomass.

Position of the top 20 companies in relation to the European carbon factor



3.5. Use of renewable energies in 2015: a slight decrease in absolute terms but with a stable share in the energy mix

Electricity generated from renewable energy sources in Europe 2012-2015 in TWh (for the 20 companies in our selection)



3.5.1. Slight decrease in electricity generated from renewable sources

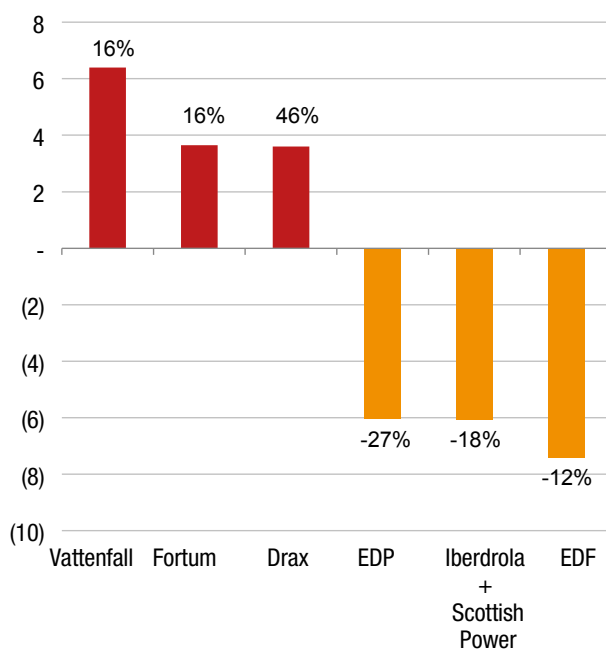
Our analysis of the 20 utilities in our selection shows that electricity generated from renewable sources decreased slightly year on year to around 430 TWh. However, over the past five years the proportion of electricity generated from renewable sources has increased by around 21%.

Despite this slight contraction, the proportion of renewable energies in our selection's energy mix is relatively stable, down to 21.8% from 21.9%. During 2011-2015, the proportion of renewable energies in our selection's energy mix trended upward, increasing by 5% per year, from 16.7% in 2011.

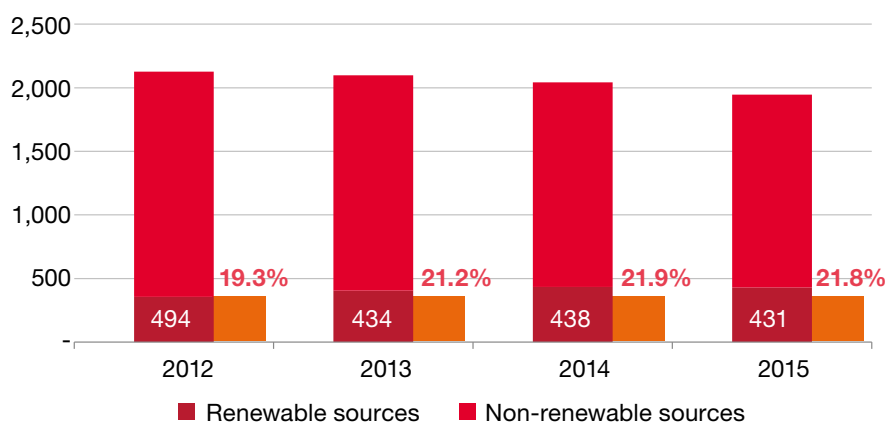
Vattenfall increased its proportion of electricity generated from renewable sources due to its hydroelectric production (up 5.2 TWh) and wind power (up 1.7 TWh), while Fortum's dams and Drax's biomass helped them to increase their proportion of renewables.

The three companies that showed the most significant reductions in electricity generated from renewable sources between 2014 and 2015 (EDP, EDF and Iberdrola) all saw their hydroelectric plants in south-western Europe impacted by unfavourable weather conditions.

Main changes in electricity generated from renewable energy sources in TWh



Main changes in electricity generated from renewable energy sources (changes in % between 2014 and 2015)



The data supplied by the utilities in our selection shows that Europe is on the right track to meeting its objective of lifting the proportion of renewable energies in final energy consumption to 27% by 2030.

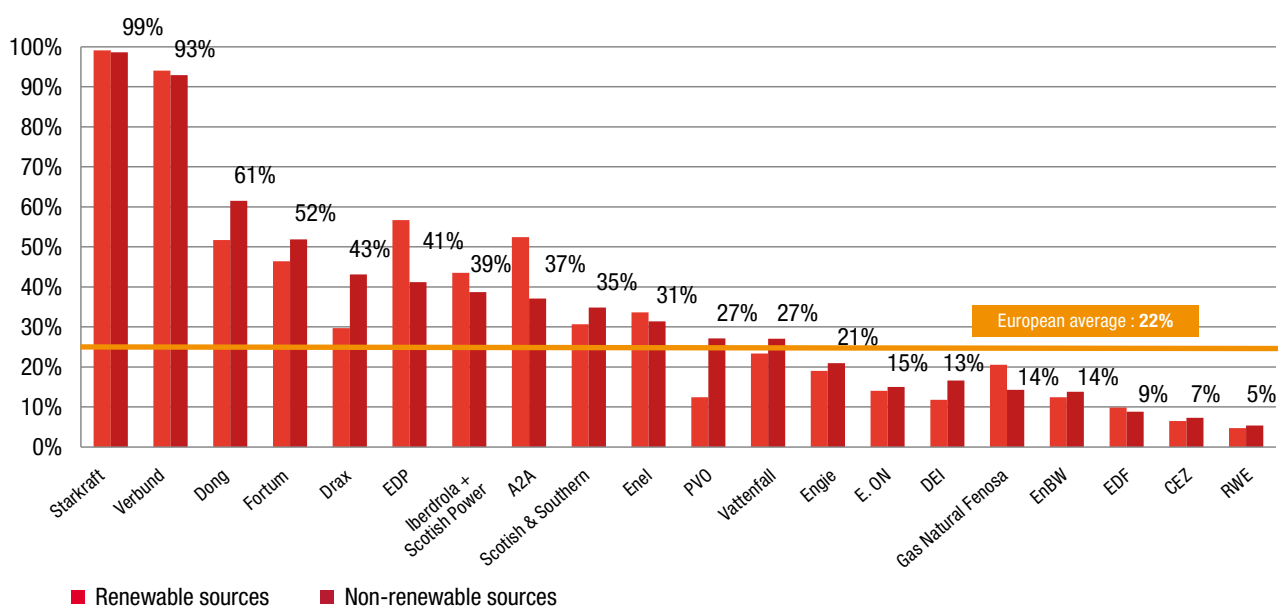
The utilities in our selection have reaffirmed the goal set by Directive 2001/77/EC calling for 21% of electricity to be generated from renewable sources beginning in 2010.

3.5.2. The proportion of renewable energies in the energy mix is stable at 22%

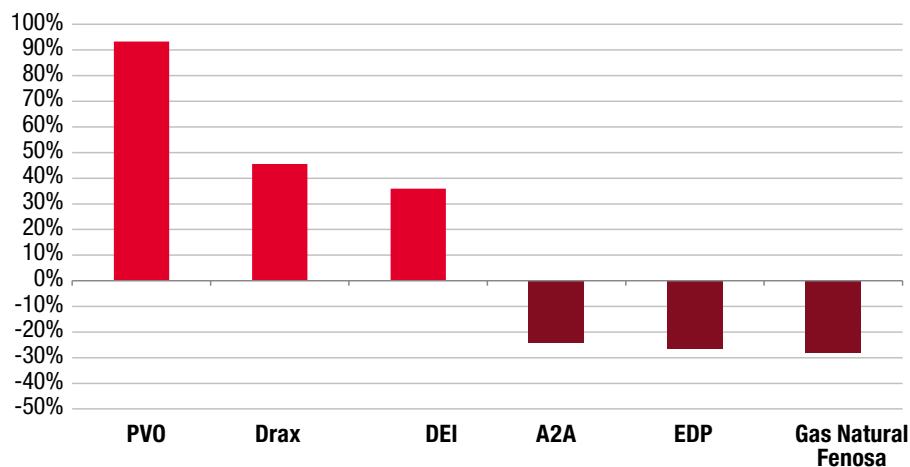
The energy mix of the companies in our selection varied significantly. Trailing Statkraft and Verbund, which had an energy mix comprising more than 90% renewables thanks to conditions favourable to hydroelectricity in Scandinavia and the Alps, seven companies (Dong, Fortum, Drax, EDP, Iberdrola, A2A and Scottish & Southern) managed to increase the proportion of renewables in their mix to more than 33%.

The accompanying charts reveal that the companies that produce the largest amounts of electricity from renewable energies in Europe do not necessarily have the highest proportion of renewable sources in their energy mix. EDF, for example, is the largest producer of renewable energy in our selection, yet it is one of the three companies that derives less than 10% of its total output from renewable sources. It even reduced its production from renewables in 2015. A2A, on the other hand, generates more than 35% of its electricity from renewable sources but ranks sixteenth in renewable energy production.

Percentage of renewable energy in the mix (for the 20 companies in our selection)



Main changes in electricity generated from renewable energy sources in TWh (and changes in % between 2014 and 2015)



Of the three companies that saw the proportion of renewables increase the most, two of them (PVO and DEI) benefited from weather conditions conducive to hydroelectric power generation. The third, Drax, has stepped up its use of biomass.

The three companies that saw the proportion of renewables decrease the most are located in the Iberian peninsula and, unlike PVO and DEI, were unable to operate their hydroelectric plants at full capacity due to limited rainfall.

4. Change in the energy mix – focus on renewable energy sources

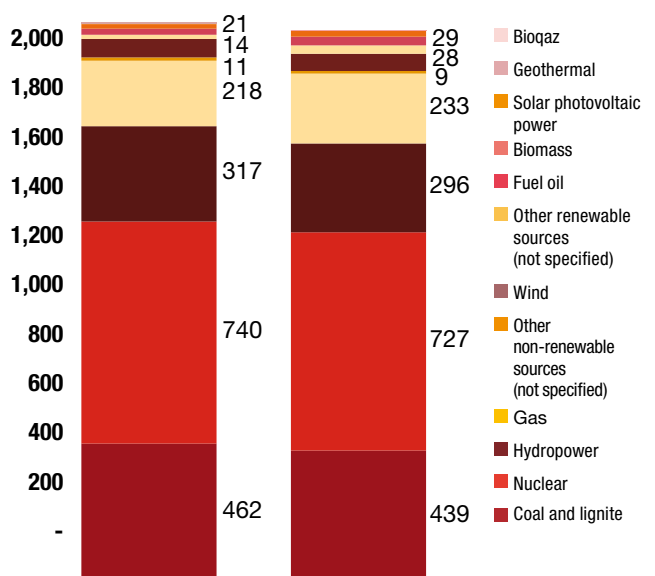
Our analysis of changes in the energy mix reveals that hydropower remains by far the primary source of renewable energy used by the 20 companies in our selection, accounting for 16% of their energy mix. Hydropower output declined sharply in 2015 among the companies in our selection (down 22 TWh, or 7%), but with 296 TWh, hydropower still represents the third source of energy, after nuclear and coal but ahead of gas. Statkraft and EDF alone account for nearly one-third of all hydropower produced by the utilities in our selection, and that proportion reaches almost 50% with the addition of Vattenfall. Despite certain regional variations, 2015 was generally unfavourable for hydroelectric generation, particularly in Spain and Portugal where rainfall was low.

Wind power is still the second source of renewable energy for our selection, representing a stable 3.1% of total output. Wind power accounts for more than 10% of the European energy mix for three companies in our selection, all of which are strongly established along the North Sea, where weather conditions are ideal. They include Dong (45% of the mix), Iberdrola, via its subsidiary Scottish Power (20%), and Scottish & Southern (19%). Dong continued to pursue its offshore wind power strategy with the commissioning of the Westermost Rough and Borkum Riffgrund wind farms in the United Kingdom and Denmark.

The other renewable energies represent less than 2% of the energy mix for the companies in our selection. Biomass was up 0.7 points to 1% of the total energy mix. Several companies, such as EDF, Enel and Vattenfall, reduced their biomass output while Drax, which strengthened its leadership in this category by increasing its output by 2 TWh, and Dong rely on biomass for more than 15% of their energy mix. Next comes solar power, which failed again to take off with an unchanged 0.1% of the energy mix. RWE is the only energy company with a solar energy output of more than 0.5 TWh despite a slight 0.4 TWh contraction in 2015. It should be noted, however, that electricity generated from solar power in Europe rose 6 TWh¹¹ in 2015, thanks in particular to medium-sized companies and homeowners.

The most significant change in fossil fuels has been the continued decline in the proportion of coal in the total European energy mix since 2014 (down 1 point to 24% in 2015). The reduction in emissions and the improvement in the European carbon factor is therefore explained by the 23 TWh decrease in electricity generated from coal and lignite by the companies in our selection, particularly in Germany (E. ON, EnBW and Vattenfall). Conditions that were exceptionally favourable to coal-fired power plants in 2013 have deteriorated since with the price of coal rising to \$50/metric ton due to declining shale gas production in the United States and the carbon price in Europe bouncing back to around \$7/metric ton. The decline in electricity generated from coal lifted production levels for natural gas (up 15 TWh), which represented 13% of our selection's energy mix. Nevertheless, the price of carbon would need to reach €35/t CO₂ in order for natural gas to gain any sort of competitive edge¹². Nuclear energy is still the leading source of energy in Europe (40% of the energy mix of the utilities in our selection despite the gradual withdrawal of German energy companies from nuclear), even though production declined in Germany (E. ON and Vattenfall registered a 12 TWh decrease) and the Czech Republic (CEZ, down 3.5 TWh), partly offset by an increase in production for EDF in France (up 5 TWh).

Changes in the energy mix in TWh between 2014 and 2015



The breakdown in this chart only concerns electricity producers for whom we were able to calculate or estimate the energy mix, i.e., all companies except Engie in 2014. Consumption of this group is hence not included in this graph.

11 : ENTSO-E Statistical Factsheet, <https://www.entsoe.eu/publications/statistics/statistical-factsheet/Pages/default.aspx>

12 : Source Tendances Carbone, I4CE, November 2015, http://www.i4ce.org/wp-core/wp-content/uploads/2015/12/TC107_FR1.pdf

A. Company data

Country	Company	2015			2014			2013		
		Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh	Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh	Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh
FR/GB/IT/BE	EDF	638	51,780,757	81	643	57,145,900	89	600	61,794,856	103
IT	A2A	16	6,973,298	436	15	5,336,172	358	16	6,177,596	380
DE	EnBW	56	18,471,090	330	58	20,973,414	363	59	23,600,000	403
DE/GB/BE/NL/Eastern Europe	RWE	195	140,800,000	721	184	135,800,000	740	190	140,500,000	741
Europe	E.ON	133	46,700,000	350	153	62,600,000	410	180	79,000,000	440
Europe	Vattenfall	173	83,800,000	484	173	82,300,000	476	182	74,515,007	410
Europe	Engie	133	50,265,088	377	134	47,721,565	356	157	51,947,848	331
IT/ES/BG/FR/GR/SK/RO	Enel	167	68,455,966	409	169,3	66,869,550	395	169	67,023,792	396
PT/ES	EDP	41	21,075,000	520	40	16,521,500	413	40	16,599,200	414
CZ/PL/BG/RO	CEZ	61	29,097,000	478	63	28,141,103	446	67	32,027,023	480
FI	Fortum	50	1,048,386	21	48	1,900,000	39	47	3,251,000	70
GR	DEI	34	34,300,000	1,006	35	39,200,000	1,110	38	41,300,000	1,101
NO	Statkraft	56	241,000	4	56	249,300	4	56	460,900	8
AT/BG	Verbund	31	1,718,145	55	34	1,761,000	52	36	2,777,000	78
ES	Gas Natural Fenosa	32	13,600,734	431	31	11,099,776	363	33	11,641,515	354
GB	Drax	27	13,101,000	491	27	16,595,000	583	26	20,300,000	775
GB	Scottish & Southern	28	11,021,000	397	28	13,079,000	474	36	20,548,000	571
FI	PVO	13	1,083,600	84	15	2,058,600	141	16	2,995,200	192
DK	Dong	13	2,843,028	220	14	3,788,206	277	19	5,805,727	304
GB/ES	Iberdrola + Scottish Power	74	16,061,000	217	80	14,214,106	178	78	15,571,013	200
TOTAL		1,972	612,436,092	311	1,998	627,354,192	314	2,042	677,835,677	332

Country	Company	2008			2007			2006		
		Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh	Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh	Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh
FR/GB/IT/BE	EDF	613	74,694,603	122	608	71,422,491	117	614	68,796,816	112
IT	A2A	24	12,129,886	514	24	12,775,117	531	25	13,477,806	542
DE	EnBW	67	16,967,200	254	74	17,713,500	241	75	18,050,900	241
DE/GB/BE/NL/Eastern Europe	RWE	194	144,460,000	747	173	147,060,000	848	185	142,400,000	771
Europe	E.ON	239	100,074,100	418	247	106,043,010	429	221	100,795,400	456
Europe	Vattenfall	178	81,717,000	459	184	84,502,500	459	165	74,500,000	450
Europe	Engie	145	47,575,442	327	148	50,520,233	341	129	40,403,000	314
IT/ES/BG/FR/GR/SK/RO	Enel	186	83,000,000	447	185	92,252,200	498	193	92,992,808	495
PT/ES	EDP	40	19,783,000	500	43	23,422,000	544	43	24,484,000	565
CZ/PL/BG/RO	CEZ	68	40,375,540	597	73	46,853,740	640	62	32,980,000	532
FI	Fortum	53	2,156,600	41	52	3,340,800	64	54	5,820,800	107
GR	DEI	52	52,200,000	996	54	53,040,000	984	52	50,483,000	969
NO	Statkraft	53	1,604,700	30	45	229,000	5	46		
AT/BG	Verbund	29	2,885,000	101	28	3,407,000	120	28	3,701,000	132
ES	Gas Natural Fenosa	18	7,263,102	398	34	18,203,375	535	31	15,822,000	514
GB	Drax	27	22,299,000	818	27	22,503,000	844	27	22,764,847	840
GB	Scottish & Southern	46	22,720,000	496	47	25,880,000	555	41	25,210,000	622
FI	PVO	22	2,916,788	131	17	4,250,000	250	18	4,731,278	264
DK	Dong	19	7,433,436	401	20	8,547,437	432	26	11,874,624	464
GB/ES	Iberdrola + Scottish Power	94	27,212,240	279	84	24,716,124	279	95	28,161,442	279
TOTAL		2,165.8	769,467,637.2	355	2,167.2	816,681,526.6	377	2,129.1	777,449,720.6	365

Country	Company	2001		
		Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh
FR/GB/IT/BE	EDF	587	47,057,472	80
IT	A2A	39	26,637,000	683
DE	EnBW	63	15,145,777	462
DE/GB/BE/NL/Eastern Europe	RWE	179	125,250,000	700
Europe	E.ON	199	90,859,421	457
Europe	Vattenfall	180	70,988,805	394
Europe	Engie	106	39,361,000	371
IT/ES/BG/FR/GR/SK/RO	Enel	257	135,000,000	526
PT/ES	EDP	41	23,255,101	573
CZ/PL/BG/RO	CEZ			
FI	Fortum	41	11,400,000	278
GR	DEI	48	52,086,200	1,084
NO	Statkraft	38	0	0
AT/BG	Verbund	28	3,146,000	111
ES	Gas Natural Fenosa	26	14,525,000	559
GB	Drax	22	18,735,000	852
GB	Scottish & Southern	23	11,854,800	525
FI	PVO	19	4,900,000	258
DK	Dong	29	17,829,897	615
GB/ES	Iberdrola + Scottish Power	77	25,185,390	327
TOTAL		2,001	733,216,863	366

2012			2011			2010			2009		
Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh	Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh	Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh	Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh
594	53,508,736	90	600	58,876,859	98	583	54,559,981	94	567	62,520,836	110
11	4,384,860	408	14	6,234,300	454	16	6,926,400	441	19	9,083,980	481
59	21,800,000	369	60	19,674,200	251	66	19,674,200	299	66	15,850,445	241
202	156,900,000	777	183	141,200,000	772	200	142,700,000	715	169	133,700,000	792
202	88,960,000	440	220	89,500,000	406	225	84,891,459	390	216	84,700,000	393
179	71,577,144	400	181	77,637,900	428	188	79,269,000	423	175	79,118,000	452
163	55,434,000	341	181	60,865,465	337	150	48,827,157	325	144	46,497,991	322
180	78,786,450	438	179	76,129,529	425	179	67,552,154	378	170	77,247,998	454
35	18,005,000	521	41	16,919,000	412	45	14,699,000	330	42	20,007,000	477
69	35,016,864	509	68	38,739,133	566	68	38,845,671	568	65	37,195,443	569
54	2,260,000	42	55	4,725,600	88	54	4,510,800	84	49	2,021,300	41
40	47,300,000	1,174	42	45,932,408	1,107	46	46,500,000	1,022	50	49,700,000	992
60	483,900	8	52	1,161,900	23	57	1,693,400	30	57	1,600,100	28
35	2,902,000	82	30	3,659,619	123	31	3,232,112	104	30	2,213,932	74
37	15,485,800	417	38	14,000,000	279	38	10,696,302	279	29	9,480,240	330
27	23,908,189	882	26	21,466,000	813	28	23,964,647	844	24	19,845,250	815
46	24,426,000	531	49	24,500,000	504	47	23,100,000	494	39	19,300,000	491
15	572,840	39	15	1,587,037	106	18	3,887,037	221	15	2,875,309	187
16	4,477,892	278	20	6,835,160	335	20	6,814,612	337	18	6,928,622	383
76	19,261,232	254	73	19,366,878	264	87	22,570,356	258	92	25,550,820	279
2,098	725,450,907	346	2,127	729,010,988.2	343	2,144	704,914,288.6	329	2,037	705,437,265.8	346

2005			2004			2003			2002		
Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh	Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh	Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh	Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh
619	71,537,878	116	616	68,751,628	112	645	68,589,136	106	634	65,431,511	103
23	11,382,050	539	25	14,909,800	587	21	13,994,100	657	21	14,547,900	683
74	17,811,200	242	73	19,229,245	263	75	20,858,100	277	65	16,766,516	488
182	142,700,000	784	183	139,100,000	761	179	140,500,000	787	184	135,500,000	738
229	101,174,880	442	245	101,385,062	413	186	93,828,200	504	216	91,778,921	425
190	80,417,500	422	174	69,971,000	403	160	71,471,000	448	166	68,282,636	411
123	39,361,000	319	125	40,825,000	327	130	41,587,000	320	115	44,481,000	387
206	106,523,438	528	222	111,917,253	514	232	115,506,560	499	228	120,400,000	529
42	28,255,000	677	39	23,893,710	614	43	23,249,000	536	39	26,899,200	690
60	33,300,000	555	62	35,706,546	575	61	34,000,000	557			
52	1,993,708	38	56	7,928,571	143	53	9,142,857	172	48	7,000,000	146
53	52,592,000	994	53	53,287,500	1,015	52	52,408,800	1,004	49	51,345,000	1,050
49	0	0	34	0	0	42	0	0	49	0	0
29	3,810,000	131	30	4,437,000	149	28	5,000,000	178	35	3,654,000	105
29	16,487,000	572	27	16,539,300	612	26	15,098,000	584	24	16,380,300	683
25	20,519,000	830	25	20,519,000	838	26	21,642,000	833	19	16,350,000	840
39	18,900,000	486	23	12,184,800	524	23	12,239,400	531	19	9,346,800	487
13	1,671,585	126	18	4,950,000	280	18	6,073,529	337	16	6,000,000	375
29	15,766,397	552	29	15,766,397	552	36	21,470,000	591	30	17,529,897	584
88	29,649,833	338	66	8,817,000	133	64	7,465,495	117	75	22,896,631	305
2,123.0	770,118,812.3	363	2,123.0	770,118,812.3	363	2,099.7	774,123,178	369	2,031	734,590,312	362

B. Consolidated results

Country	Company	2015			2014			2013		
		Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh	Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh	Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh
FR	EDF-France	498	14,049,307	28	503	16,605,000	33	474.4	16,919,000	36
Europe (excl. FR)	EDF Energies Nouvelles	2	59,000	25	2	53,000	23			
GB	EDF Energy	83	16,904,310	204	81	19,948,000	245	86.9	22,156,000	255
IT	Edison	24	7,079,068	290	23	6,238,500	269	18.4	6,689,356	363
PL	ERSA & Kogeneracja	20	12,252,739	612	21	12,875,400	619	14.0	14,457,500	1 030
BE	EDF Luminus	8	794,233	100	8	815,000	102	5.4	932,000	171
HU	BE ZRt & EDF Demasz	3	642,100	249	4	611,000	154	0.9	641,000	699
FR/GB/IT/BE	EDF	638	51,780,757	81	643	57,145,900	89	600	61,794,856	103
DE	RWE	122	102,200,000	839	120	103,000,000	850	125.0	106,200,000	850
GB	RWE UK	37	17,400,000	472	34	15,700,000	512	36.9	18,900,000	512
BE/NL	RWE Belgium Netherlands	22	14,800,000	664	17	12,300,000	601	13.3	8,900,000	601
Central/Eastern Europe	RWE Central/Eastern	5	6,400,000	1,208	6	6,500,000	1 161	5.6	6,500,000	1 161
Renew	Renew	9	-	-	7	-	-	7.3	0	0
DE/GB/BE/NL/Eastern Europe	RWE	195	140,800,000	721	184	135,800,000	740	190	140,500,000	741
Other EU countries	E.ON	48	11,400,000	239	n/a	14,000,000	n/a	0.0	0	0
GB	E.ON UK	19	8,100,000	430	n/a	12,900,000	530	0.0	0	0
IT	formerly Endesa Italia	6	2,300,000	380	n/a	5,400,000	470	0.0	0	0
ES	E.ON Espana	n/a	n/a	n/a	n/a	n/a	n/a	0.0	0	0
FR	E.ON France	6	4,600,000	760	n/a	2,800,000	710	0.0	0	0
DE	E.ON Germany	63	20,300,000	320	n/a	27,500,000	380	0.0	0	0
Europe	E.ON	133	46,700,000	350	153	62,600,000	410	180	79,000,000	440
IE	Ireland	-	n/a	n/a	-	n/a	n/a	0.0	n/a	n/a
PT	Formerly Endesa	-	n/a	n/a	-	n/a	n/a	0.0	n/a	n/a
IT	Enel Provezione	69	n/a	n/a	72	n/a	n/a	71.2	n/a	n/a
ES	Viesgo generacion (formerly Endesa)	77	n/a	n/a	74	n/a	n/a	73.2	n/a	n/a
BG	Maritza	0	n/a	n/a	0	n/a	n/a	0.1	n/a	n/a
FR	Enel France	-	n/a	n/a	0	n/a	n/a	0.4	n/a	n/a
GR	Elica + Endesa	1	n/a	n/a	0	n/a	n/a	0.6	n/a	n/a
SK	Enel Slovakia	18	n/a	n/a	21	n/a	n/a	21.3	n/a	n/a
Other Europe (RO)	RO	3	n/a	n/a	2	n/a	n/a	2.5	n/a	n/a
IT/ES/BG/FR/GR/SK/RO	Enel	167	68,455,966	409	169.3	66,869,550	395	169	67,023,792	396
CZ	CEZ CZ	57	26,028,918	460	58	24,736,722	424	62.3	26,996,663	465
PL	CEZ Poland	3	n/a	n/a	3	2,436,736	928	2.6	2,440,778	957
BG	CEZ Bulgaria	0	n/a	n/a	1	967,645	1 019	0.6	589,582	1 031
RO	CEZ Romania	1	n/a	n/a	1	-	-	1.3	0	0
CZ/PL/BG/RO	CEZ				63	28,141,103	446	67	32,027,023	480

2012			2011			2010			2009		
Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh	Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh	Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh	Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh
466.4	16,409,000	35	472	14,360,000	30	476	19,109,000	40	454	18,506,880	41
83.4	20,909,000	251	73	15,805,000	218	64	13,932,780	219	72	23,795,870	330
24.4	9,075,472	373	35	18,630,431	527	43	21,518,201	503	42	20,218,086	486
14.2	6,178,264	434	13	7,121,148	550						
5.4	n/a	n/a	7	2,960,280	442						
594	53,508,736	90	600	58,876,859	98	583	54,559,981	94	567	62,520,836	110
130.3	115,000,000	883	129	112,000,000	868	140	108,400,000	777	128	107,900,000	845
43.9	26,900,000	613	30	16,200,000	542	34	18,900,000	551	27	16,600,000	622
14.8	8,400,000	568	12	6,200,000	539	14	8,300,000	580	5	2,700,000	600
5.6	6,600,000	1,179	6	6,800,000	1,153	6	7,100,000	1,246	6	6,500,000	1,140
7.3	0	n/a	6	0	0	6	0	0			
202	156,900,000	777	183	141,200,000	772	200	142,700,000	715	169	133,700,000	792
n/a	n/a	n/a	55	14,400,000	260	na	13,658,514	270	na	na	na
n/a	n/a	n/a	30	18,730,000	620	27	17,765,553	660	37	19,500,000	530
n/a	n/a	n/a	17	7,590,000	450	18	7,199,175	410	17	7,500,000	450
n/a	n/a	n/a	11	5,980,000	550	11	5,672,077	510	13	6,500,000	520
n/a	n/a	n/a	6	4,600,000	710	na	na	na	na	na	na
n/a	n/a	n/a	101	38,200,000	380	na	na	na			
202	88,960,000	440	220	89,500,000	406	225	84,891,459	390	216	84,700,000	393
0.0	n/a	n/a	0	69,768	1,001	0	275,075	917			
40.9	n/a	n/a	2	1,664,982	783	1	706,000	783			
74.5	n/a	n/a	79	36,844,733	466	81	34,376,000	423	84	37,076,701	441
40.9	n/a	n/a	77	34,566,000	451	70	23,291,000	333	61	31,050,467	507
0.1	n/a	n/a	0	0	0	5	5,892,000	1,245	4	5,166,000	1,396
0.4	n/a	n/a	0	56	0	0	39	0			
0.5	n/a	n/a	0.35	0.00	0.00	0.31	0.00	0.00			
20.7	n/a	n/a	20	2,975,000	146	21	3,005,000	146			
1.8	n/a	n/a	0	8,990	68	0	7,040	68			
180	78,786,450	438	179	76,129,529	425	179	67,552,154	378	170	77,247,998	454
64.0	31,552,076	493	63	33,306,853	526	63	n/a				
2.3	1,884,205	834	2	2,321,555	1,125	2	n/a				
1.5	1,580,583	1,026	3	3,110,725	1,091	3	n/a				
1.0	0	0	0	0	0	0	n/a				
69	35,016,864	509	68	38,739,133	566	68	38,845,671	568	65	37,195,443	569

B. Consolidated results

Pays	Compagnie	2008			2007			2006		
		Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh	Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh	Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh
FR	EDF-France	484	18,436,590	38	483	20,523,250	43	491	19,632,000	40
Europe (excl. FR)	EDF Energies Nouvelles									
GB	EDF Energy	27	21,860,640	804	26	21,060,450	826	25	20,777,200	818
IT	Edison	50	26,228,973	523	41	22,015,791	531	39	21,407,916	542
PL	ERSA & Kogeneracja									
BE	EDF Luminus									
HU	BE ZRt & EDF Demasz									
FR/GB/IT/BE	Groupe EDF	613	74,694,603	122	608	71,422,491	117	614	68,796,816	112
Allemagne	RWE	180	141,000,000	785	176	158,000,000	897	148	117,700,000	794
UK	RWE UK	38	25,000,000	665	34	22,000,000	651	37	24,700,000	677
Belgium Netherlands	RWE Belgium Netherlands									
Central/Eastern	RWE Central/Eastern									
Renew	Renew									
DE/UK/BE/NL/Europe EST	Groupe RWE	194	144,460,000	747	173	147,060,000	848	185	142,400,000	771
Other UE countries	E.ON	139	54,200,000	390	136	57,100,000	420	132	54,000,000	410
UK	E.ON UK	44	25,700,000	580	41	30,000,000	730	36	25,500,000	710
Italie	ex Endesa Italia	22	11,707,170	530	22	11,707,170	530	25	13,307,240	530
Spain	E.ON Espana									
France	E.ON France	4	8,166,930	2,094	8	6,835,840	880	8	7,588,160	920
Germany	E.ON Germany									
Europe	Groupe E.ON	239	100,074,100	418	247	106,043,010	429	221	100,795,400	456
IE	Irlande									
PT	ex-Endesa									
IT	Enel Provisone	96	44,500,000	462	94	46,723,200	496	104	48,500,000	467
ES	Viesgo generacion (ex Endesa)	na	na	na	0	4,200,000	0	7	6,000,000	823
BG	Maritza	0	0	0	0	0	0	0	0	0
FR	Enel France									
GR	Elica + Endesa									
SK	Enel Slovakia									
Other Europe (RO)	Romania									
IT/ES/BG/FR/GR/SK/RO	Groupe Enel	186	83,000,000	447	185	92,252,200	498	193	92,992,808	495
CZ	CEZ CZ									
PL	CEZ Poland									
BG	CEZ Bulgaria									
RO	CEZ Romania									
CZ/PL/BG/RO	CEZ	68	40,375,540	597	73	46,853,740	640	62	32,980,000	532

2005			2004			2003			2002			2001		
Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh	Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh	Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh	Production (TWh)	Emissions (t CO ₂)	kg CO ₂ /MWh	Production (TWh)	"Emission (t CO ₂)"	kg CO ₂ /MWh
494	23,707,200	48	487	20,470,800	42	513	22,893,000	45	509	23,690,000	47	477	17,344,000	36
23	18,480,300	807	25	20,477,828	812	23	17,460,000	776	20	15,754,611	772	12	7,800,000	650
33	22,135,218	663	61	35,557,800	583	57	35,130,236	613	56	35,136,900	624	62	41,826,772	675
619	71,537,878	116	616	68,751,628	112	645	68,589,136	106	634	65,431,511	103	587	47,057,472	80
149	120,000,000	808	149	116,000,000	779	141	113,000,000	803	149	114,000,000	765	148	105,000,000	709
33	22,700,000	680	34	23,100,000	681	38	27,500,000	726	35	21,500,000	623	31	20,250,000	653
182	142,700,000	784	183	139,100,000	761	179	140,500,000	787	184	135,500,000	738	179	125,250,000	700
130	53,200,000	410	127	52,215,190	410	123	47,158,200	383	156	52,260,000	335	142	55,800,000	393
37	28,000,000	750	35	25,086,000	719	36	26,683,000	743	37	23,132,702	632	33	19,536,822	584
23.4	11,681,000	500	20.9	11,484,000	550	17.9	10,919,000.0	610.0	17.6	10,881,620.0	620.0	17.6	10,018,000.0	570.0
9	7,993,880	920	10	9,435,315	985	9	9,068,000	956	6	5,504,599	971	6	5,504,599	971
229	101,174,880	442	245	101,385,062	413	186	93,828,200	504	216	91,778,921	425	199	90,859,421	457
112	56,200,000	501	126	63,408,000	503	138	71,467,560	518	137	75,000,000	547	162	87,000,000	537
7	6,000,000	823	6	5,013,000	823	6	5,013,000	823	6	5,013,000	823	6	5,013,000	823
3	3,806,345	1266	3	4,069,000	1266									
206	106,523,438	528	222	111,917,253	514	232	115,506,560	499	228	120,400,000	529	257	135,000,000	526
60	33,300,000	555	62	35,706,546	575	61	34,000,000	557						

Bibliography

PwC's report *PwC Low Carbon Economy Index 2016 – The Paris Agreement: A turning point?*

can be downloaded from:

http://pwccn.com/home/eng/low_carbon_economy_nov2016.html

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