Charged or static

Which European electric utilities are prepared for a low carbon transition?

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Authors: Drew Fryer, Luke Fletcher, Tom Crocker and James Smyth

Contents

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Authors:
Drew Fryer, CFA
Luke Fletcher
Tom Crocker
James Smyth

Acknowledgments:
Dr. Paul Griffin
John Hekman
Rick Stathers
Esther Stoakes

Linking emissions-related metrics to earnings for European electric utilities

This report updates CDP's research and League Table for European electric utilities, first published in May 2015. It ranks 14 of the largest publicly listed power generators in Europe on readiness for a low carbon transition.

Electric utilities are among the largest contributors to global greenhouse gas emissions, and as an energy supply sector are key to other sectors' ability to decarbonize. Deep decarbonization and near zero net emissions are required from EU utilities by 2050 to achieve below 2°C of warming.

There are four key areas assessed in the League Table, which have been aligned with topic area recommendations for company reporting from the G20 Financial Stability Board's Task Force on Climate-related Financial Disclosures (TCFD):

Transition risks: We assess companies' current share of generation from fossil fuels, their emissions profiles and current carbon costs under the EU ETS, and introduce a model to measure locked-in emissions between 2015-2050 from current fossil fuel assets against companies' implied carbon budgets to achieve a 2°C transition.

Physical risks: We map facility-specific water stress risks for today and for 2030 using WRI's Aqueduct Water Risk Atlas, and compare this with companies' water risk management measures.

Transition opportunities: We assess companies' progress and strategy in shifting towards renewable energy assets, as well as smart energy solutions, and assess their CAPEX plans and capital flexibility.

Climate governance and strategy: We assess emissions reduction targets, identify alignment of governance and remuneration structures with low carbon objectives, and actions taken in supporting or opposing policies to achieve a low carbon transition.

Key findings

- Though progress is being made in decarbonizing EU power generation, significant additional actions will be required to keep the sector in line with the objectives of the Paris Agreement. The companies in this report are estimated to exceed their implied 2°C carbon budget by 14% or 1.3 billion tonnes CO_2e in aggregate between 2015 and 2050. This raises concerns that accelerated retirement of existing assets could be required. Figure 2 overleaf illustrates the locked-in emissions analysis from which these results are sourced.

- Renewable energy and other new business models involving energy services are gaining ground, but some companies have been much faster to exploit these opportunities while others risk being left behind. The share of non-hydro renewable generation ranges between 1% and 34% among companies assessed. The percentage of planned future CAPEX allocated to renewables ranges from 0% to 54%.

- By 2030, 51% of company thermal generation capacity is projected to be in high or extremely high water stress areas, creating risks to continuity of operations.

- Boards could improve climate governance structures and further incentivize executives to manage climate-related risks. Only a minority of EU utilities have disclosed specific targets for climate change in CEO remuneration, or have identified board-level climate experts.

- Highest ranked companies overall are Verbund, Iberdrola, Fortum and Enel.

- Lowest ranked companies are RWE, CEZ, Endesa and EnBW.

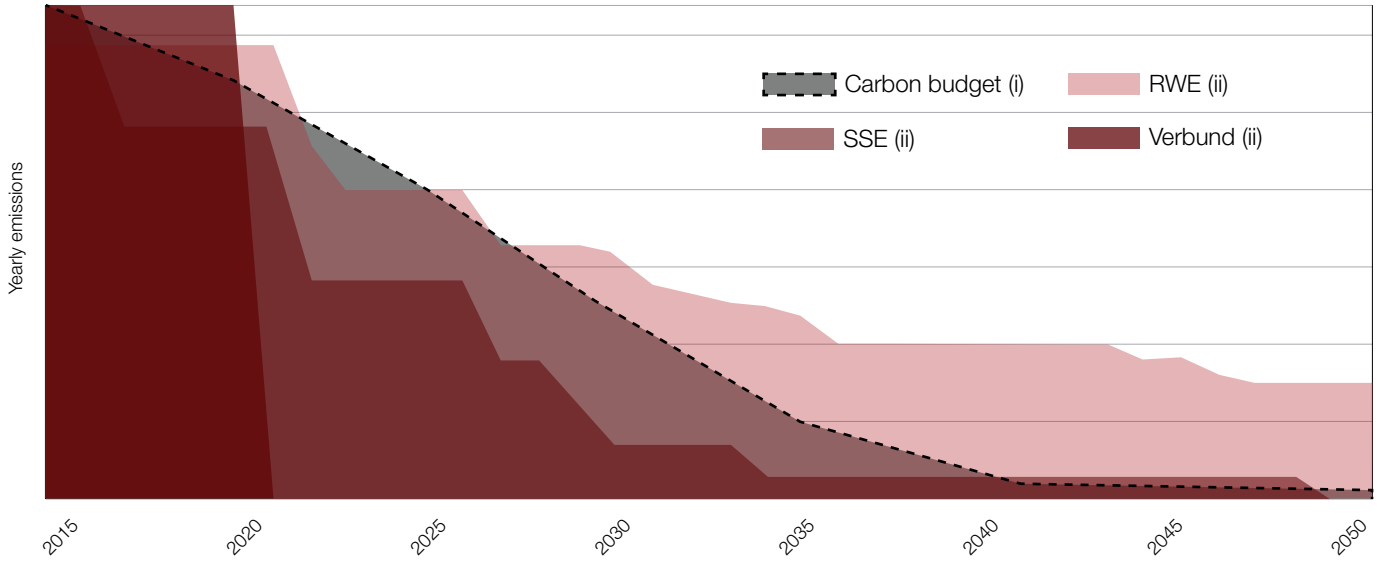
The summary League Table below presents headline company findings. It is based on detailed analysis across a range of carbon and water-related indicators which could have a material impact on company performance. The League Table is designed to serve as a proxy for business readiness in an industry which will undergo significant change as governments increase efforts to implement the Paris Agreement. Companies placed towards the bottom are deemed less prepared for a low carbon transition.

Figure 1: League Table summary

League Table rank	2015 League Table rank	Company	Country	Average market cap 2016 (€bn)	European market share in 2015 (i)	League Table score	Managing transition risks	Managing physical risks	Transition opportunities	Climate governance & strategy
1	3	Verbund	Austria	5	1.0%	3.78	A	A	A	B
2	1	Iberdrola	Spain	40	2.4%	5.35	B	E	A	A
3	7	Fortum	Finland	13	1.5%	6.45	B	B	B	D
4	4	Enel[ii]	Italy	37	3.9%	6.48	C	E	A	B
5	11	SSE	UK	20	0.9%	6.51	C	B	C	C
6	2	Centrica	UK	15	0.6%	6.65	B	C	D	C
7	6	EDF	France	23	18.4%	6.68	B	C	E	B
8	5	EDP	Portugal	11	1.4%	6.72	D	D	A	B
9	9	E.ON[ii]	Germany	17	2.7%	7.13	C	C	B	C
10	8	ENGIE	France	34	4.0%	7.98	C	C	D	C
11	12	EnBW	Germany	6	1.7%	8.22	E	C	C	C
12	10	Endesa	Spain	20	2.4%	8.66	D	D	C	D
13	-	CEZ	Czech Republic	9	1.9%	9.44	D	D	D	E
14	13	RWE[ii]	Germany	7	6.5%	10.89	E	C	E	E
Weighting for each key area							**35%**	**10%**	**30%**	**25%**

(i) Relative to total gross electricity generation (GWh) for EU.
(ii) E.ON analysis includes 46.65% share of Uniper, RWE analysis includes 76.8% share of Innogy, Enel analysis includes 70.14% share of Endesa
Source: CDP

Figure 2: Estimated locked-in emissions vs. implied carbon budget for selected companies



(i) Carbon budgets are calculated based on company specific convergence pathways necessary for the decarbonization of the EU electric utility sector, in accordance with the IEA 2DS scenario.
(ii) Vertical axis scaled for visual comparison - see all 14 company locked-in emissions trajectories in Appendix II on page 44.
Source: CDP, GlobalData, IEA 2DS scenario, company reports

Accessing the full report

The full report is available only to CDP investor signatories. Signatories can access the full report from https://www.cdp.net/en/dashboards/investor. Please contact your CDP account manager or investor@cdp.net if you are not able to log in.

Thematic highlights

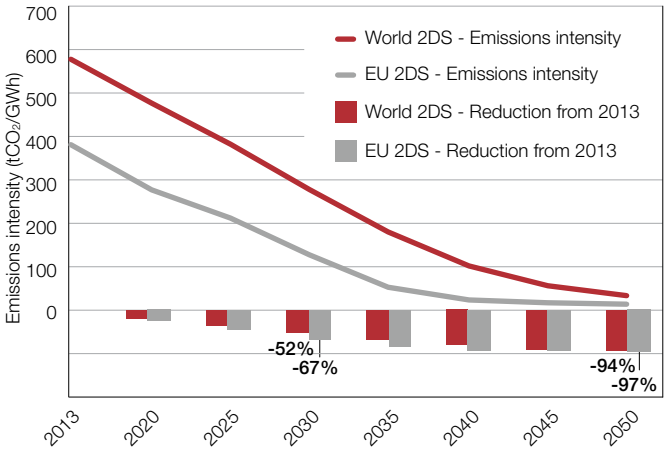
- **Deep decarbonization is required of EU utilities to fulfil their part in achieving well below 2°C of warming.** The IEA's 2°C scenario implies a need for a 67% reduction in the greenhouse gas emissions intensity of EU power generation by 2030, and 97% reduction by 2050, relative to 2013 levels (Figure 3). Greater transparency and evidence of forward looking transition planning is needed sector-wide to demonstrate preparedness for a low carbon transition, and to address recent recommendations from the TCFD.

- **Many utilities have significant 'locked-in emissions' from existing fossil fuel power assets, posing a significant threat to achieving below 2°C** of warming, given asset lifetimes of up to half a century from commissioning. In this report, CDP adopts a methodology for measuring locked-in emissions developed with ADEME.[1] We find the majority of utilities assessed will break their implied carbon budgets for 2015-2050 based on current and announced fossil fuel power plants, unless significant additional actions are taken. Only three of the 14 utilities are likely to remain within their 2015-2050 carbon budgets. Collectively the 14 companies are set to exceed their cumulative carbon budgets by 14%, equating to 1.3 billion tonnes of CO_2e by 2050. This could mean accelerated retirement of existing assets and associated valuation write-downs.

- **Underlying this finding, many utilities remain heavily dependent on fossil fuel generation.** Half the utilities assessed still produce more than 20% of electricity from coal, and RWE generates 57% of power from coal. Progress in decommissioning coal assets is limited to date and needs to accelerate to achieve below 2°C warming. RWE and E.ON have separated renewable and fossil fuel assets into new separate companies in the past year, indicative of the divergence in their prospects going forward. With shares of fossil fuel assets varying considerably between companies, emissions intensities are also highly variable. In our sample, the most coal focused utilities have emissions more than ten times higher per unit of power generated compared to utilities with the highest share of renewables.

- **Though the price of carbon in the EU ETS has settled at relatively low levels, this still implies significant costs and impacts on earnings** for utilities with significant fossil fuel generation assets. Estimated carbon costs ranged from €6 million–€1.1 billion in 2015, implying cuts in EBITDA in the range of 0.3%-13.7%. Reforms to the EU ETS such as the market stability reserve create risks of higher carbon prices going forward. At a carbon price of €30 and assuming no change in sources or volumes of power generation, carbon costs rise to up to 38% of EBITDA.

Figure 3: Utilities industry 2°C scenario



Source: IEA Energy Technology Perspectives 2016

- **Minimal progress is being made by EU utilities on carbon capture and storage.** CCS is viewed by some stakeholders as critical to a low carbon transition, and is central to many published scenarios for achieving below 2°C warming. Utilities commented to CDP that carbon prices today are not high enough to make CCS a high priority, and other low carbon technologies are more cost competitive. Regulatory signals are also weak, with Germany having an effective ban on CCS, and the UK cancelling planned £1 billion CCS funding. Given many utilities will break their carbon budgets in years to come based on existing fossil fuel assets, technologies like CCS may become vital if existing assets are to continue to operate under ambitions to limit warming below 2°C. Slow progress today could mean CCS becomes commercially available too late to contribute to effective mitigation, or not at all.

- **Faster, but uneven, progress is being made in deployment of renewable power.** Renewable share of capacity for the 14 companies increased from 25% in 2010 to 32% in 2016, and for our sample (representing 50% of total EU electricity generation) 20% of electricity generated in 2016 was from renewables. However, much progress is needed to meet the EU's target of at least 45% of electricity generated from renewables by 2030. Wind and solar are becoming progressively competitive at utility scale. Global average levelized cost of electricity (LCOE) for both solar PV and onshore wind has significantly decreased since 2010, and by 2025 is forecast to fall a further 59% for solar PV and 26% for onshore wind.[2]

1. Methodology developed as part of the Assessing low-Carbon Transition (ACT) pilot project, an initiative led by CDP and ADEME, the French Environment and Energy Management Agency, partnering with the 2° Investing Initiative, European Investment Bank and ClimateCHECK.
2. Source: IRENA "The Power to Change: Solar and Wind Cost Reduction Potential to 2025", June 2016

- **Low carbon nuclear power makes a significant contribution to EU climate change mitigation but has limited growth prospects.** Mandated early decommissioning of nuclear power in Germany, together with high cost and community opposition to new nuclear is causing it to grow slowly compared to renewables. Companies that focus on nuclear at the expense of investment in renewables may limit their growth opportunities going forward.

- **Utilities' business models are in significant transition, with a need to innovate** and be prepared for a more connected and personalized customer relationship with more complex end-user demands. With the share of variable renewable energy increasing, energy distribution grids are shifting from unidirectional centralized power systems towards more distributed, dynamic and digitized networks. Companies are targeting a new market of services and technologies such as: the Internet of Things (IoT), distributed energy resources (DER), and smart data management. New demands from customers in energy services are transforming market dynamics and utilities are now in direct competition with other sectors, all looking to establish a footprint in the value chain and improve their market position.

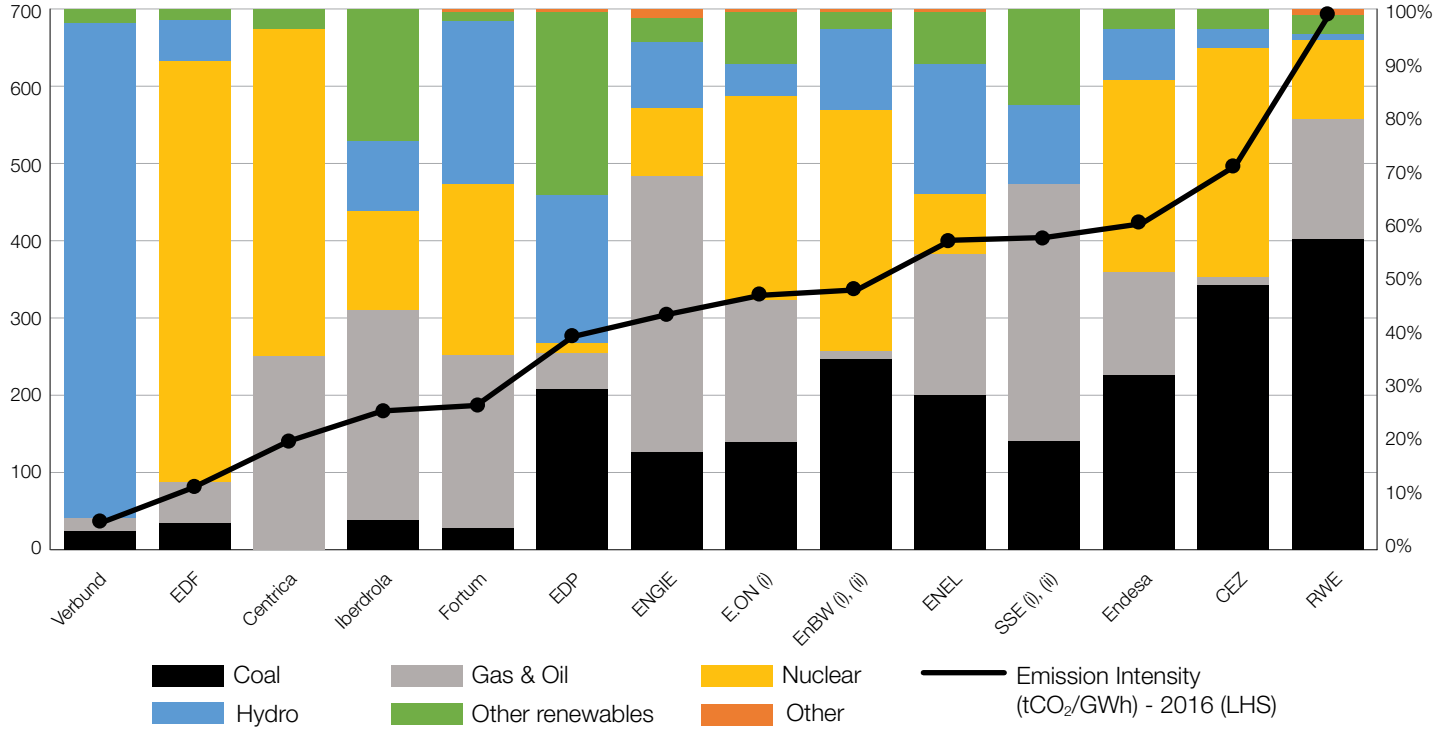
- **All EU utilities assessed have emissions reduction targets, but only 3 have been externally validated[3] as compatible with limiting warming to 2°C.** The most proactive targets extend as far as 2050 and imply complete decarbonization of electricity supplies. Most notably, Verbund is targeting 100% renewable generation by 2020. Others have targets that imply emissions trajectories significantly higher than required for convergence to the sectoral decarbonization pathway for 2°C, and will need to take significant additional action.

- **Exposure to water stress risks are projected to increase sharply by 2030.** Using WRI's Aqueduct tool, CDP found that in 2016, 2% of company thermal generation capacity is situated in high or extremely high water stress areas. By 2030, exposure to high and extremely high water stress regions increases to 51% with 20% of total capacity located in extremely high water risk regions, for assets expected to remain online.

- **More needs to be done to align governance and remuneration structures with the need for low carbon transition.** Only one out of 14 companies have climate-linked performance metrics in their CEOs' long term remuneration plans. Only four of the 14 companies have individuals with identified climate change expertise on their boards. Most EU utilities assessed are however applying internal carbon prices as an input to capital investment decisions, with proactive companies applying a significant shadow carbon price, and stress testing investment options versus a number of carbon price scenarios.

- **InfluenceMap analysis finds utilities remain opposed to a number of strands of climate policy,** in particular to national-level legislation such as the UK Carbon Price Floor and renewable energy subsidies, such as feed-in-tariffs. However, there has been a significant increase in support for, and engagement with, low carbon polices by EU utilities following the Paris Agreement in late 2015.

Figure 4: Generation by resource type – Average 2015-2016 (RHS); Emission intensity (tCO_2/GWh) - 2016 (LHS)



(i) Generation: EnBW and SSE average for 2015 - H1 2016, E.ON - 2015 only but accounting for 47% ownership of Uniper.
(ii) Emissions intensity for 2015 for EnBW and SSE.
Source: CDP, company reports

3. by the Science Based Targets Initiative

Company highlights

#1 Verbund. The company is targeting a 100% renewable energy generation portfolio by 2020, and decommissioning all remaining fossil fuel assets. Thus, Verbund has a locked-in emissions ratio estimated at only 32% of its implied carbon budget. Today it already has the lowest share of fossil fuels and the highest share of renewables with a focus on hydro power, and has increased its wind power operations in recent years. Verbund also ranks first on water resilience; it is the only company to have a lower overall water stress risk in 2030 compared with 2016.

#2 Iberdrola. The company is making fast progress in reducing its emissions intensity, driven by deployment of new renewable energy assets. Its targets imply a 59% renewable share of capacity by 2020 and carbon neutrality by 2050, with some offsetting of residual emissions. Iberdrola has made the fastest recent progress in reducing reliance on coal, including closing its largest coal facility in 2016, giving it the third lowest share of coal. However, in the projected lock-in emissions model, Iberdrola is still likely to exceed its implied carbon budget with an estimated locked-in emissions ratio of 118% by 2050. Its investment in clean energy sees 33% of CAPEX (2016-2020) planned for renewables, and 70% of CAPEX is growth oriented. Its executive remuneration has climate-linked KPIs, and its board includes directors with identified climate expertise. Iberdrola's thermal and hydro assets have significant exposure to high water stress regions, but it also has a comprehensive, forward looking water risk management plan.

#3 Fortum. Fortum has the third lowest share of generation from coal and a significant portion of generation from hydro. It has low current generation from other renewables but increasing investments in wind and solar. Fortum has a focus on sustainable city solutions such as waste to energy, heating and cooling. Its R&D expense as a proportion of sales is the highest for our sample of companies showing a commitment to innovation. Fortum has the greatest capital flexibility (lowest economic net debt/EBITDA).

#4 Enel. Enel has an above average current emissions intensity, but ranks consistently high across transition opportunities metrics. It targets an increase in its share of renewable capacity from 45% in 2016 to 52% by 2019. It has set a target to be carbon neutral in 2050 and has had its target validated by the Science-Based Targets Initiative as compatible with limiting warming below 2°C. Its 2017-2019 strategy outlines strong investment in smart solutions with 23% of planned CAPEX focused on digitalization. The company has been a leader in the roll out of smart meters and has a clear strategic direction with its "Open Power" concept. It has recently demonstrated greater support of ambitious low carbon policies, a positive shift from its previous stance. Enel ranks last on water resilience, with high exposure to water scarcity and an average water risk management plan. 71% of its thermal capacity is likely to be exposed to high or extremely high water stress risk by 2030.

#5 SSE. SSE is demonstrating rapid improvement. It decommissioned a key coal power asset in 2016, and decommissioning of fossil fuel assets reaching their technical lifetimes going forward is expected to significantly reduce its currently high emissions. With an estimated locked-in emissions ratio of only 71%, the company is expected to remain well within its implied carbon budget by 2050. It has the third highest share of other renewables. Its emissions reduction target also implies the sharpest downward trajectory in emissions intensity going forward. It has low exposure to water stress, with all its hydro sites located in water abundant regions. It is the strongest supporter of low carbon policies and has advocated for more ambitious EU climate targets to support the Paris Agreement.

#6 Centrica. Centrica has a low emissions intensity, and is the only company assessed to have no coal in its generation portfolio, showing a marked improvement in emissions performance from 2009-2016. However, a reliance on natural gas in the coming years will likely result in an emissions lock-in ratio of 120% of its projected carbon budget. Centrica has shifted strategy away from generation, focusing on end-consumer services. This led to the decision to sell off its wind capacity, which causes it to rank poorly on our analysis of transition opportunities, but Centrica states it will continue to buy renewable electricity through power purchase agreements. Centrica is making significant investments (£1.2 billion over 2016-2020) in smart solutions such as the connected home and distributed energy, and recently established Centrica Innovations (£100 million over 5 years) to help accelerate new technologies.

#7 EDF. EDF has among the lowest emissions intensities, driven by a large nuclear power fleet. It also has growing renewable power operations, with a target to increase total renewable capacity to 50GW in 2030 from 29GW in 2016, but this is only a low share of overall generation. Its R&D expense as a proportion of sales is the second highest for our sample of companies. EDF is also one of a small number of companies assessed with identified board-level climate expertise. However, due to its large nuclear asset base, it has less capital flexibility than competitors, highlighted by a high economic net debt/EBITDA and a low share of CAPEX allocated to growth activities.

#8 EDP. EDP has a strong emissions reduction target, recently approved by the Science-Based Targets Initiative as compatible with limiting warming below 2°C. EDP has the highest share of other renewables and second highest total renewables in its generation portfolio and is a global leader in wind power. It aims to have at least 76% renewable capacity by 2020 (72% in 2016). Its 2016-2020 strategy has 54% of investment going to renewables. However, EDP has the second highest locked-in emissions ratio. Many of its fossil fuel sites were commissioned post 2002. With typical technical lifetimes of between 30-50 years, the company is likely to exceed its implied carbon budget before 2050, with an estimated locked-in emissions ratio of 132%. Also, with relatively high economic net debt/EBITDA, the company has less capital flexibility than most and is seeking to deleverage over coming years.

#9 E.ON. E.ON has undertaken a partial sale of its fossil fuel power assets, retaining a 47% share of the newly formed Uniper entity. The decision to split the company illustrates a shifting strategy to concentrate on renewables, distribution and customer solutions. Its recent growth in other renewables and future targets are strong versus peers. CDP's analysis is on an equity share basis to represent E.ON investors' remaining exposure to assets and means fossil fuel power generation is still a significant portion of the company's asset portfolio. However, E.ON has indicated that it intends to sell its remaining stake in Uniper over the medium-term, and future CAPEX strategy is centered around the new E.ON business model.

#10 ENGIE. The company has recently announced the disposal or closure of a number of its most carbon intensive assets. This improves its positioning on our locked-in emissions analysis, though its estimated locked-in ratio of 112% is still above its carbon budget. Its future CAPEX strategy (2016–2018), which includes a €15bn portfolio rotation program shows increasing focus on renewables and customer solutions as well as digitalization and technology. However, its 2010-2016 change in installed capacity of other renewables lagged behind peers and its renewable target for a 25% share of capacity by 2025 lacks ambition relative to peers. It has two board members identified as climate experts.

#11 ENBW. With a high proportion of coal assets and limited expected decommissioning of plants between 2025 to 2050, EnBW is set to exceed its implied carbon budget, with an estimated locked-in emissions ratio of 125%. It is the only company not to apply an internal carbon price. Other renewables are still a relatively small share of company generation; however, EnBW has been growing its renewable portfolio focusing on both onshore and offshore wind and beat domestic market growth over the 2010-2015 period. It has a reasonably ambitious target to increase total renewable capacity share to 40% by 2020 (2015 was 28%) and its 2016-2018 CAPEX strategy is focused on renewables and smart energy solutions. This future CAPEX plan also has the highest share allocated to growth CAPEX.

#12 Endesa. Endesa has a high current share of coal and fossil fuel assets. However, it bought the remaining 60% of Enel Green Power España from its parent company Enel in 2016, and now plans to expand its presence in the renewables sector in Iberia. It has multiple emissions reduction targets including one of complete decarbonization by 2050, though its near-term targets imply only slow progress in the near term. Its locked-in emissions ratio, estimated at 95%, is strong relative to peers. It is also a leader in smart meter deployment and it has good capital flexibility relative to peers. The company's thermal and hydro capacity is exposed to the highest and second highest respective water stress risk with a high proportion of capacity located in extremely high risk regions by 2030, though it demonstrates strong water risk management.

#13 CEZ. CEZ has a high emissions intensity and the second highest share of coal fired generation, including recently built coal assets. Its emissions reduction target is weak relative to peers and CEZ currently has a low share of renewables. However, over the 2010-2016 period it significantly increased its share of other renewables and outperformed the trend in its domestic market. The company has the ambition to become a major European player in renewables and relative to its current portfolio it has the fourth most ambitious renewable energy target. However, this ambition is not reflected in its 2016–2020 CAPEX strategy and it lags behind in other areas such as smart metering. CEZ ranks last on strategy and governance due to a lack of disclosure of many key metrics. The company did not respond to CDP's 2016 water questionnaire request and shows little evidence of water risk management other than adherence to national water regulation.

#14 RWE. RWE has the highest emissions intensity in the sample, with over three-quarters of generation capacity from fossil fuels. It has the highest proportion of coal and the second lowest proportion of renewable generation, leading to an emissions intensity more than ten times as high as that of the top ranked company, and a locked-in emission ratio that is 134% of its implied 2°C carbon budget for 2015-2050. It sold shares in a newly formed entity, Innogy, holding its renewable power, grid and retail business assets in 2016, though retains a 76.8% stake. We assess RWE with Innogy on an equity-share basis to reflect RWE investors' remaining exposure to Innogy assets. RWE's emissions reduction target is significantly weaker than the 2°C transition pathway, and it is least supportive of low carbon policies of our sample, opposing many domestic low carbon policies. The company continues to struggle with the German Energiewende, highlighted by a decision to scrap the 2016 dividend, and capital flexibility is somewhat limited by nuclear decommissioning obligations. The company is lagging behind on smart meter roll-out; however, it does offer other smart solutions such as Innogy SmartHome. It has climate-linked KPIs in its CEO's remuneration package, though their weighting was reduced in 2016.

Company selection

Companies were selected from the largest publicly listed electric utilities in Europe, based on 2016 market capitalization and those that responded to CDP's 2016 climate change information request. All 13 companies included in CDP's earlier report on electric utilities are included again.

CEZ, a previous non-responder, answered the 2016 climate change information request and as a result has also been included. A number of other EU power generators that respond to CDP but have lower market capitalizations are omitted. Public Power Corporation, which commenced responding to CDP since the previous report, is among those omitted due to lower market capitalization.

The following companies were omitted because electricity generation is not their primary business and they could not be compared adequately on a number of the metrics evaluated:

- Grid operators: National Grid, Terna and Red Electrica.
- Waste management and recovery service providers: Suez and VEOLIA.
- DONG Energy has significant oil and gas production operations as well as power generation, though in November 2016 it announced an intention to divest its oil and gas and the company may be included in future updates of this report.

Non-responding companies

We highlight the following companies as non-responders to CDP's 2016 climate change questionnaire and are therefore not included in this report. We encourage investors to raise this lack of transparency in discussions with company management.

Figure 5: Non-responders to CDP

Organisation	Country	Market cap 2016 (€bn)	First year approached by CDP	Public disclosure of carbon emissions
PGE	Poland	5.0	2010	Partial
Alpiq	Switzerland	2.4	2010	No
BKW	Switzerland	1.7	2006	Yes
Hafslund	Norway	1.6	2006	Yes
Drax	UK	1.6	2007	Yes
TAURON	Poland	1.2	2010	Yes
ENEA	Poland	1.2	2010	Yes

Source: CDP

Linking our findings to investment choices

We recognize that investment decisions are based on a multitude of different factors and that some of these can be misaligned with emissions-reduction efforts. Our League Table identifies company readiness for the transition to a low carbon economy and the physical impacts of global warming. We would flag that companies towards the bottom of our League Table are possibly higher risk investments from a climate change perspective than those towards the top.

Figure 6: A summary of key areas, associated metrics and relative weighting within the League Table

Key area in League Table	Focus area	Metrics	Metric weighting within key area	Key area weighting
Transition risks	High carbon asset exposure & carbon price risk	i) Emissions intensity performance - level and trend (tCO_2e/GWh) ii) Fossil fuel generation - share and trend iii) Locked in emissions from generation fleet vs 2°C scenario iv) Carbon cover	25% 25% 30% 20%	35%
Physical risks	Water scarcity risks and management	i) Thermal asset water stress exposure ii) Hydro asset water stress exposure iii) Water risk management	45% 25% 30%	10%
Transition opportunities	Renewables, smart services and technologies	i) Generation from renewables ii) Change in renewable capacity iii) Renewable targets iv) Smart services & Innovation v) Capital flexibility & CAPEX strategy	25% 15% 15% 15% 30%	30%
Climate governance and strategy	Quality of climate governance	i) Emissions reduction targets ii) Board climate responsibility iii) Climate-related remuneration iv) Low carbon strategy v) Use of an internal carbon price vi) CDP score vii) Carbon regulation supportiveness	35% 10% 10% 10% 10% 10% 15%	25%

Source: CDP

Methodology

We score each company based on a number of metrics which are ranked and then weighted within each key area (see Figure 6 above for metric weightings within each key area). We then grade each area from A to E based on these weighted ranks. We calculate the overall League Table score by collating the weighted ranks for each key area.

Each of the key areas has a separate chapter within this report. We disclose the precise methodology for how we rank each metric in an appendix.

For further study

Areas for further research include:

- Utilities based in other geographies
- CC(U)S and net zero emission timeframe analysis
- High and low carbon price scenarios that incorporate utilities' ability to vary their generation mix
- Enhanced analysis of decentralised power generation, smart grid and other opportunities
- Impact of water scarcity on generating capacity
- Natural gas distribution and Scope 3 emissions
- Analysis of renewable-based heating and heat networks

Transition risks

- Only three companies - Verbund, SSE and Endesa - are likely to remain within their implied carbon budgets by 2050. Collectively the 14 companies assessed are set to exceed their cumulative carbon budgets by 14%, equating to 1.3 billion tonnes of CO_2e by 2050, demonstrating the need for a halt in building new fossil fuel assets and accelerated retirement of existing fossil fuel assets.

- Verbund ranks first overall. The company has the lowest emissions intensity, lowest percentage of fossil fuel assets and is set to generate electricity from 100% renewable sources by 2020, resulting in a locked-in emissions ratio estimated at only 32%; well below its implied carbon budget and equivalent to emissions savings of 19.9 million tonnes of CO_2e.

- RWE ranks last on each transition risk metric. The company is reliant on coal for over 50% of its generating capacity and with a locked-in emissions ratio estimated at 134%, exceeds its implied carbon budget by 595 million tonnes CO_2e.

Overview

The electricity generation sector contributes around 25% of annual global greenhouse gas emissions[4]. According to the International Energy Agency 2-Degree Scenario (IEA 2DS), European utilities require a 67% reduction in greenhouse gas emissions intensity by 2030, and a 97% reduction by 2050 relative to 2013 levels, to ensure that the energy system's emissions trajectory is consistent with at least a 50% chance of limiting the average global temperature increase to 2°C[5]. Maintaining a business as usual approach is untenable. Climate action pressures from international bodies and national governments, as well as investor concerns over stranded assets and the impacts of climate change on portfolio return, drive the need for electric utilities to adapt their electricity production portfolio for a well below 2°C future.

The current EU carbon price has resulted in an operating environment where carbon-based power generation is still viable in the short term, yet changes in government legislation to achieve increasingly stringent emissions reduction targets underlines the need to move away from fossil fuels. Following the ratification of the Paris Agreement in October 2016, European states are likely to impose increasingly stringent emissions reduction targets and policies. For instance, the European Commission has committed to cut greenhouse-gas-emissions (GHGs) by at least 40% by 2030 (compared with 1990 levels)[6] and has set out regulation changes to the EU electricity capacity market in its "Clean Energy for all Europeans" package[7]. The U.K. government has introduced a carbon floor price and is set to force the closure of all coal-fired power stations by 2025, while Sweden aims to become entirely carbon neutral by 2040.

In 2015 European utilities were forced to write off a record amount of value from their assets. Utilities can shift their generation portfolios to zero emitting power sources following any decommissioning of high carbon assets, minimizing risks of future asset impairment while maintaining production output.

In this chapter, we apply a model of 'locked-in emissions' to estimate a likely future emissions pathway for each company. Assessment is based on the difference between a company's estimated locked-in emissions from installed and planned fossil fuel generation to 2050 and the company's implied carbon budget based on convergence with the industry's science-based decarbonization pathway. The model assigns a carbon budget for the sector from 2015-2050 in accordance with the IEA 2DS scenario. Using the Sectoral Decarbonization Approach (SDA), the model determines individual convergence pathways which each company must align with by 2050 in order to remain consistent with the 2DS scenario (around 20 tCO_2e/GWh by 2050). Where a company exceeds it's 2°C aligned carbon budget, it will face greater risks from policies that could result in reduced output or closure of high emitting power plants before their technical lifetimes are complete, resulting in stranded assets. Alternatively, it may require the potentially costly addition of CCS, should the technology become widely available.

We also assess companies' current emissions performance, trends in operational emissions intensity from electricity generation from 2009-2016 and the share of fossil fuels in each companies' generation portfolio.

4. IPCC, Working Group III - "Climate Change 2014: Mitigation of Climate Change", Summary for Policymakers
5. IEA Energy Technology Perspectives 2016
6. European Commission - 2030 Energy Strategy: https://ec.europa.eu/energy/en/topics/energy-strategy/2030-energy-strategy
7. European Commission Press Release Database - Clean Energy for All Europeans – unlocking Europe's growth potential: http://europa.eu/rapid/press-release_IP-16-4009_en.htm. On 30 November 2016, the European Commission published its "Clean Energy for All Europeans" package, more commonly referred to as the "Winter Package", consisting of numerous legislative proposals aimed at establishing a common power market design across the Union, promoting the better integration of renewable sources into the market and advancing energy efficiency.

- **Metric 1) Emissions performance:** This metric identifies the companies with the lowest current power generating emissions intensity (per GWh) and determines the extent to which companies have reduced their emissions intensity over the period 2009-2016.

- **Metric 2) Share of fossil fuel generation:** expressed as a percentage of a company's total electricity generation average for 2015 and 2016. A higher ranked company will produce a lower percentage of its electricity from fossil fuels. Coal production is given a greater weighting than total fossil fuels because coal is roughly twice as emissions intensive as natural gas.

- **Metric 3) Locked-in emissions:** Using the locked-in emissions model, companies are ranked according to their locked in emissions percentage, determined by comparing estimated cumulative net emissions against their total carbon budget. This gives insight into companies' asset value at risk and gives an indication as to those that are most prepared for a well-below 2°C future.

  Note: Companies' estimated locked-in emissions are calculated from asset level data supplied from a data provider GlobalData[8]. Estimates of locked-in emissions could be sensitive to incompleteness or inaccuracies in these datasets, for example in capturing all relevant generation sites, and identifying all commissioning and decommissioning dates. CDP sent each company assessed a copy of the site data it sourced from GlobalData and asked them to validate its accuracy and completeness or provide corrections. Not all companies provided feedback to this request. Where companies did not, CDP also sought to identify other disclosures made by the companies on its generation assets and make corrections where there were inconsistencies.

- **Metric 4) Carbon cover:** Measures the ratio of company EBITDA to estimated costs of purchasing EU Allowances (EUAs) needed to emit CO_2 under the EU ETS, less any free allowances received in 2015.

Highlights

Emissions performance

- Verbund and EDF lead on emissions intensity and Verbund ranks first for emissions performance. They are the only two companies with emissions intensities below 100 tCO_2e/GWh (Figure 8) due respectively to high percentages of hydro and nuclear production facilities in their generation portfolios.

- Centrica ranks second for emissions performance. The company has no coal within its generation mix and shows a marked decrease in emissions intensity from 2009-2016, reducing its emissions intensity by 14.3% p.a (see Figure 9).

- RWE and SSE rank last and second from last respectively for current emissions performance. RWE has the highest emissions intensity with over three-quarters of its generating capacity from fossil fuel sources.

- EnBW has had a significant increase in its emissions intensity since 2009. Most other companies have reduced their emissions intensities since 2009, but EDP, SSE, ENGIE, Endesa have also failed to reduce emissions intensities on a cumulative basis, according to our proprietary function that eliminates outliers and considers aggregate emissions over the period, not just start and end values.

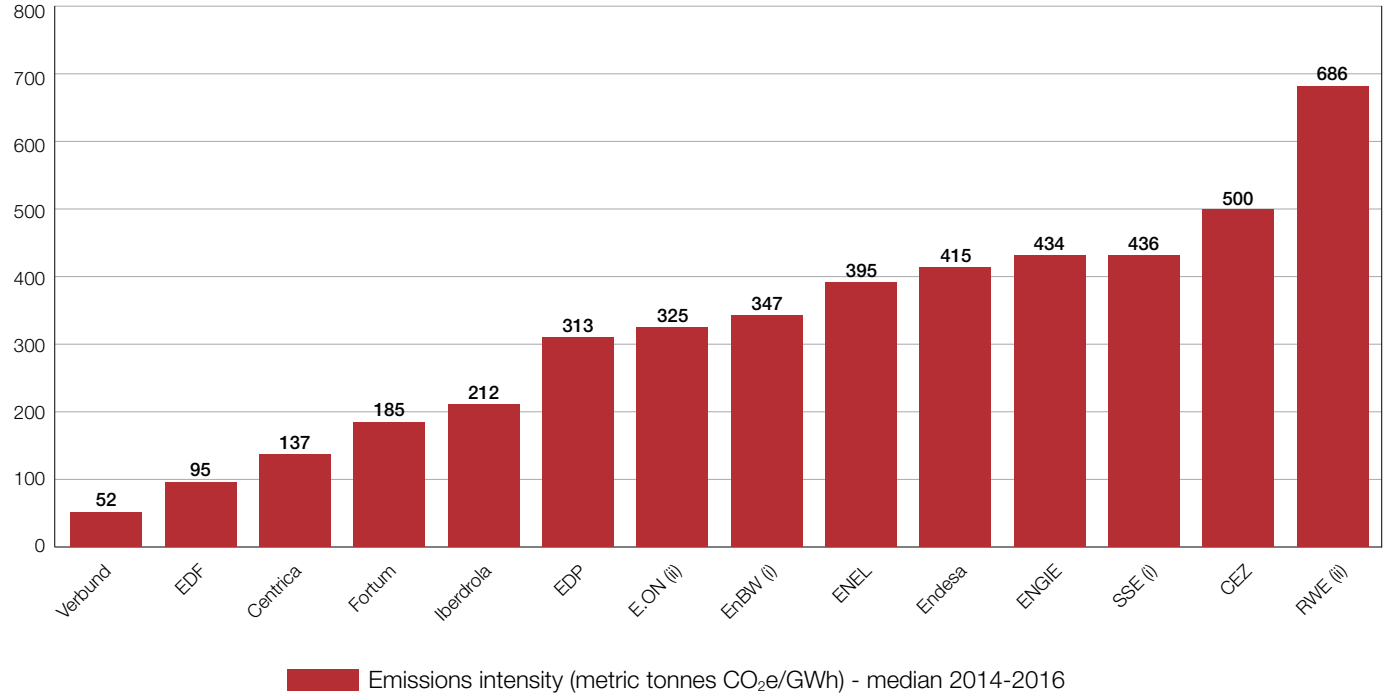
Figure 7: Transition risks summary

Company	Emissions performance	Share of fossil fuels	Locked-in emissions	Carbon cover	Overall weighted rank	Transition risks rank	Transition risks grade
Verbund	1	2	1	4	1.9	1	A
Centrica	2	1	11	1	4.6	2	B
EDF	3	3	8	5	4.9	3	B
Iberdrola	4	4	9	2	5.3	4	B
Fortum	5	5	10	3	6.0	5	B
SSE	13	8	2	6	6.7	6	C
E.ON	6	6	7	10	7.5	7	C
Enel	8	11	4	9	7.8	8	C
ENGIE	12	9	6	7	8.3	9	C
Endesa	10	13	3	13	9.0	10	D
EDP	7	7	13	8	9.1	11	D
CEZ	10	12	5	11	9.1	12	D
EnBW	9	10	12	12	10.8	13	E
RWE	14	14	14	14	13.4	14	E
Weighting	**25%**	**25%**	**30%**	**20%**			

Note: In calculating the weighted rank in this table, we use the weighted ranks for each area (where relevant).
We display non-weighted ranks in this summary for simplicity only
Source: CDP

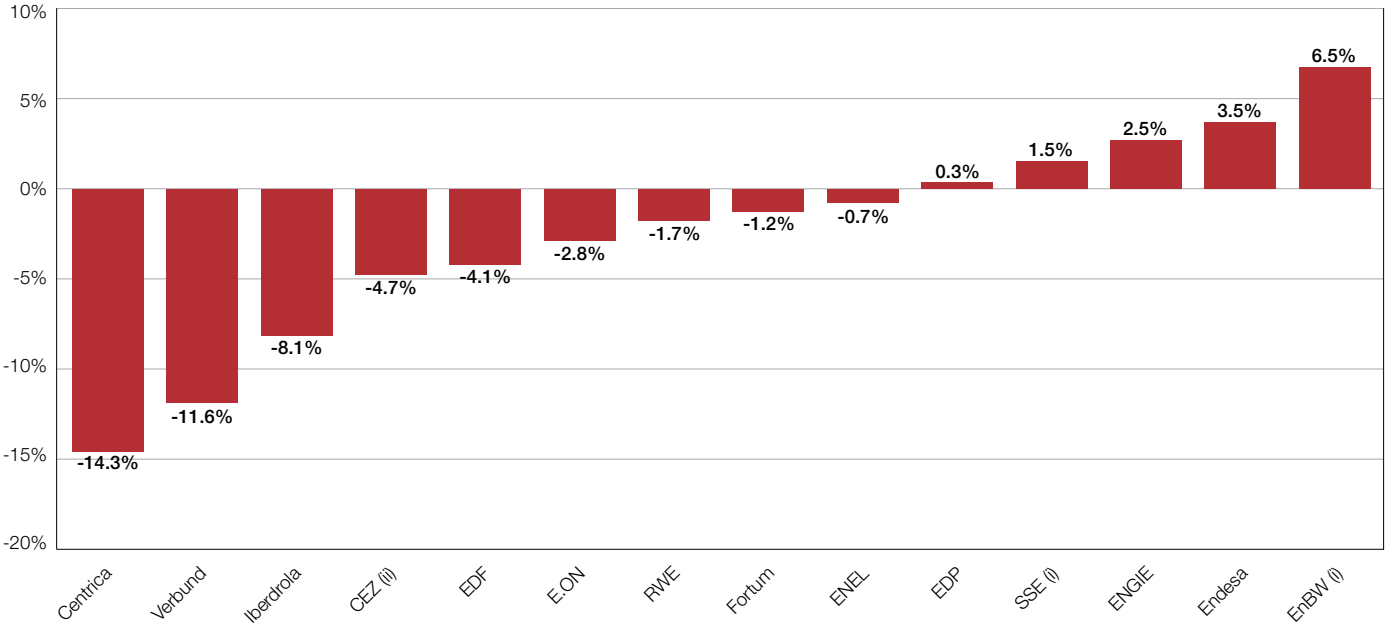
8. GlobalData is a provider of asset level data of plants and facilities for high emitting sectors such as oil and gas and electric utilities. Details at: https://globaldata.com/

Figure 8: Emissions intensity of electricity generation



(i) For 2014-2015 only. 2016 data was not released by some companies in time for this report's publication.
(ii) For 2016 only given change in company structure. E.ON's figure based on 47% share of Uniper and assumption that 2016 emissions from Russia segment of Uniper same as 2015.
Source: CDP, company reports

Figure 9: Implied change in emissions intensity



(i) 2009-2015
(ii) 2010-2016
Note: See Methodology and Limitations for details of the implied change calculation
Source: CDP, company reports

Current fossil fuel assets and locked-in emissions[9]

- Excluding Verbund and EDF, over 35% of all companies' generation portfolios are attributed to fossil fuel sources. For six companies, fossil-fuel based generation contributes over 50% or more of the production share, emphasizing their dependence on high carbon fuels for electricity generation (Figure 10).

- Many utilities also remain reliant on coal. Half the utilities assessed still produce more than 20% of electricity from coal, a highly carbon intensive resource. Enel and RWE have increased their capacity share of coal since 2010.

- Verbund has the lowest high carbon asset exposure and ranks first for locked-in emissions. The company is projected to generate all electricity using renewable sources by 2020 and has a locked-in emissions ratio of 32%; well below its implied carbon budget and equivalent to emissions savings of 19.9 million tonnes of CO_2e.

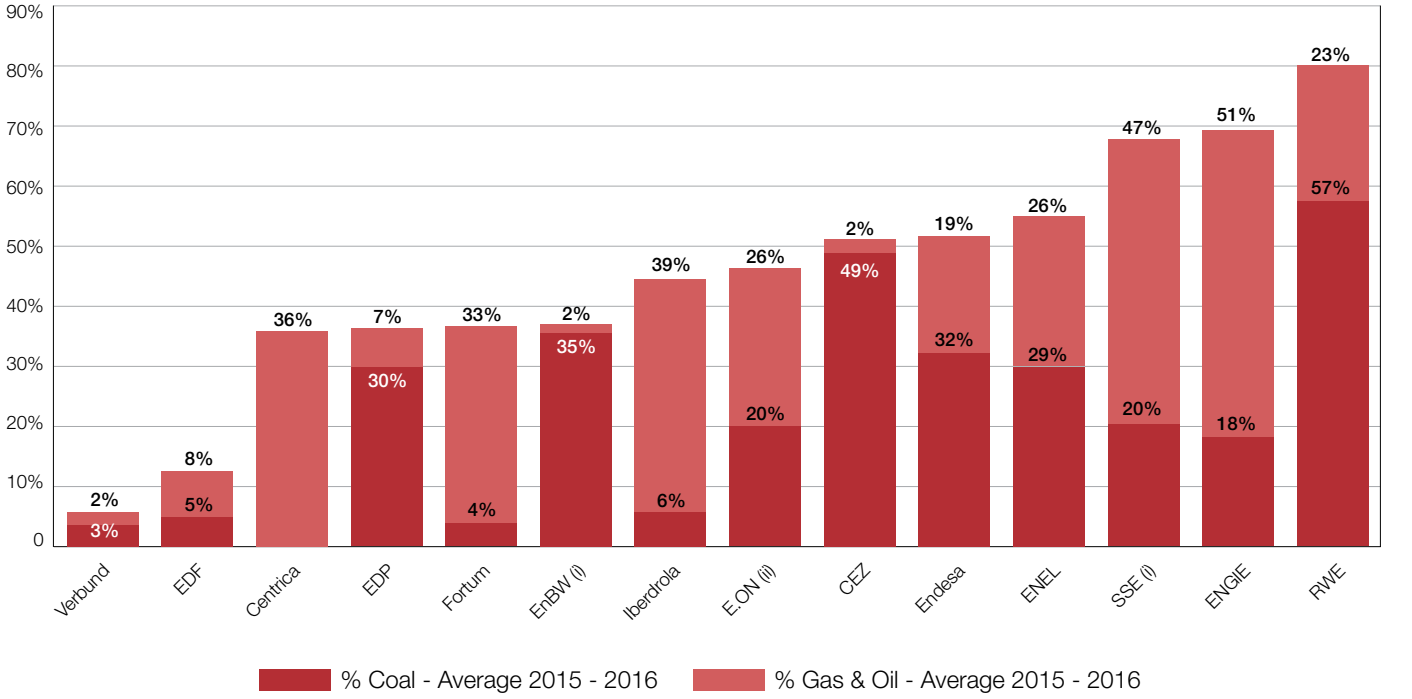
- RWE ranks last on both metrics. The company is reliant on fossil fuels for over 79% of its generating capabilities, 57% of which derives from coal (see Figure 10). RWE has a locked-in emissions ratio of 134%, exceeding its estimated carbon budget by 595 million tonnes. EDP has the second highest locked-in emissions ratio. The majority of its thermal sites were commissioned post 2002, and with typical technical lifetimes of between 30-50 years, the company is likely to exceed its allocated carbon budget by 94.6 million tonnes of CO_2e.

- Despite ranking in the bottom two for its current emissions performance, SSE is projected to remain well within its implied carbon budget. It decommissioned a key coal power asset in 2016 and by 2021, SSE's largest remaining coal-fired power station is projected to have reached the end of its technical lifetime (alongside other coal plants in 2022), significantly reducing SSE's estimated cumulative emissions, which continue to fall over time.

- CEZ shows a marked increase in estimated emissions between 2015-2017 due to the opening of a major coal-fired plant in 2016. This plant is likely to remain active until 2066, driving CEZ to exceed its implied carbon budget, despite the decommissioning of the majority of its existing coal and gas plants. Similarly, despite the decommissioning of a large number of plants between 2015-2025, EnBW is likely to continue operating coal and gas plants from 2025-2050 and is therefore estimated to be unable to remain within its implied carbon budget. Both companies produce virtually all of their fossil fuel based electricity from coal sources.

- Iberdrola and Fortum are estimated to only begin substantive decommissioning of plants around 2035 and 2045 respectively, at which time emissions are reduced rapidly. Cumulative emissions over time imply total emission lock-in ratios of 115% and 118% by 2050 respectively.

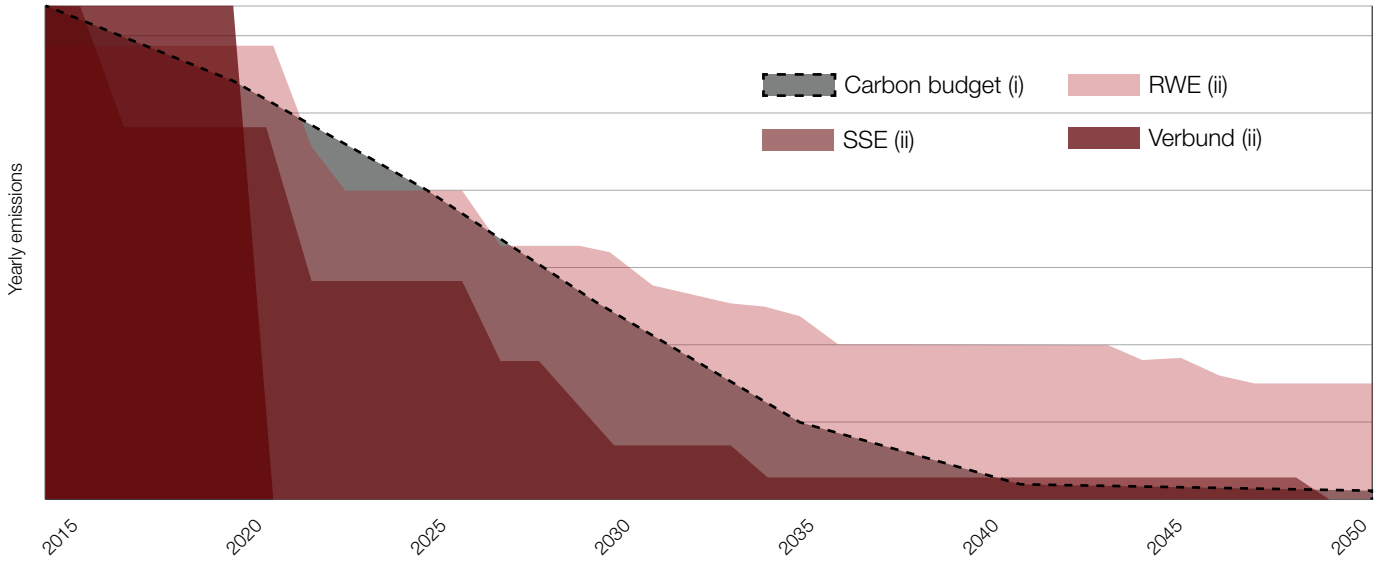
Figure 10: Generation from fossil fuels



(i) Average of 2015 and H1 2016
(ii) 2015 only but accounting for 47% ownership of Uniper
Source: CDP, company reports

9. Company specific locked-in emissions graphs are presented in Appendix II.

Figure 11: Estimated locked-in emissions trajectory vs. implied carbon budget for selected companies



(i) Carbon budgets are calculated based on company specific convergence pathways necessary for the decarbonization of the EU electric utility sector, in accordance with the IEA 2DS scenario.
(ii) Vertical axis scaled for visual comparison - see all 14 company locked-in emissions trajectories in Appendix II on page 44.
Source: CDP, GlobalData, IEA 2DS scenario, company reports

ACT: Assessing low-Carbon Transition

In 2016, CDP collaborated with ADEME, the French Environment and Energy Management Agency, and other partners to launch the ACT initiative, developing ways to assess how ready organizations are to transition to a low carbon world.

The ACT pilot project developed methodologies for the Electric Utilities, Auto Manufacturing and Retail Sectors, combining quantitative and qualitative information on a company's past, present and projected future to reveal its alignment with the low carbon transition. The ACT methodologies are sector specific because the contributions sectors make to global emissions differ greatly, and therefore differing actions will be required to align with a low carbon future.

For the electric utilities sector, a particular emphasis is placed on electricity production capacity and existing and planned power production technologies, as well as current production assets; locked-in emissions from these assets and production technology changes such as the deployment of renewables and/or carbon capture and storage (CCS).

The ACT pilot phase results find that immediate strong transition plans are needed that encompass a long-term vision, and lay out a step-by-step trajectory to replace fossil-dominated generation capacity with renewable energy. Without diversification of generation type and investment in low carbon technologies the industry will be unable to align with a low carbon economy.

This report utilizes the "locked-in emissions model" developed for the ACT electric utilities methodology to assess the high carbon asset exposure of the sampled companies. The concept of locked-in emissions allows a judgement to be made about the company's outlook in further time periods. Analyzing a company's locked-in emissions alongside science-based budgets also introduces the means to scrutinize the potential cost of inaction, including the probability of stranded assets. Examining absolute emissions, along with recent and short-term emissions intensity trends, forms part of a holistic view of company emissions performance in the past, present, and future.

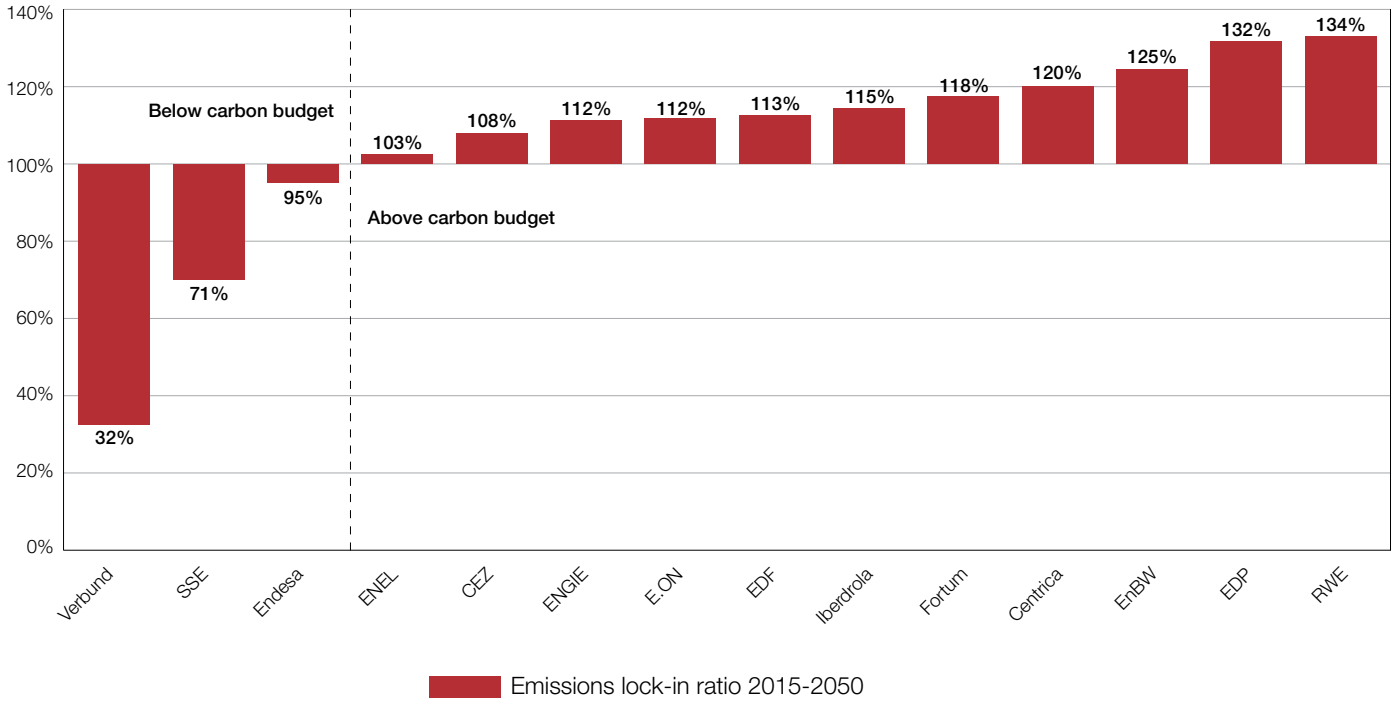
The ACT initiative will continue to develop new methodologies for more sectors in future and adapt the assessment methods to new contexts including SME companies and developing economies. For more information visit actproject.net.

The Carbon Pricing Corridors initiative

CDP, on behalf of the We Mean Business coalition, recently convened a panel of utilities and investment leaders from across the G20 under the Carbon Pricing Corridors initiative. The panel of experts are to project a range (corridor) of carbon prices, over time, that will likely enable the world to meet the emissions reduction goals outlined by the Paris Agreement.

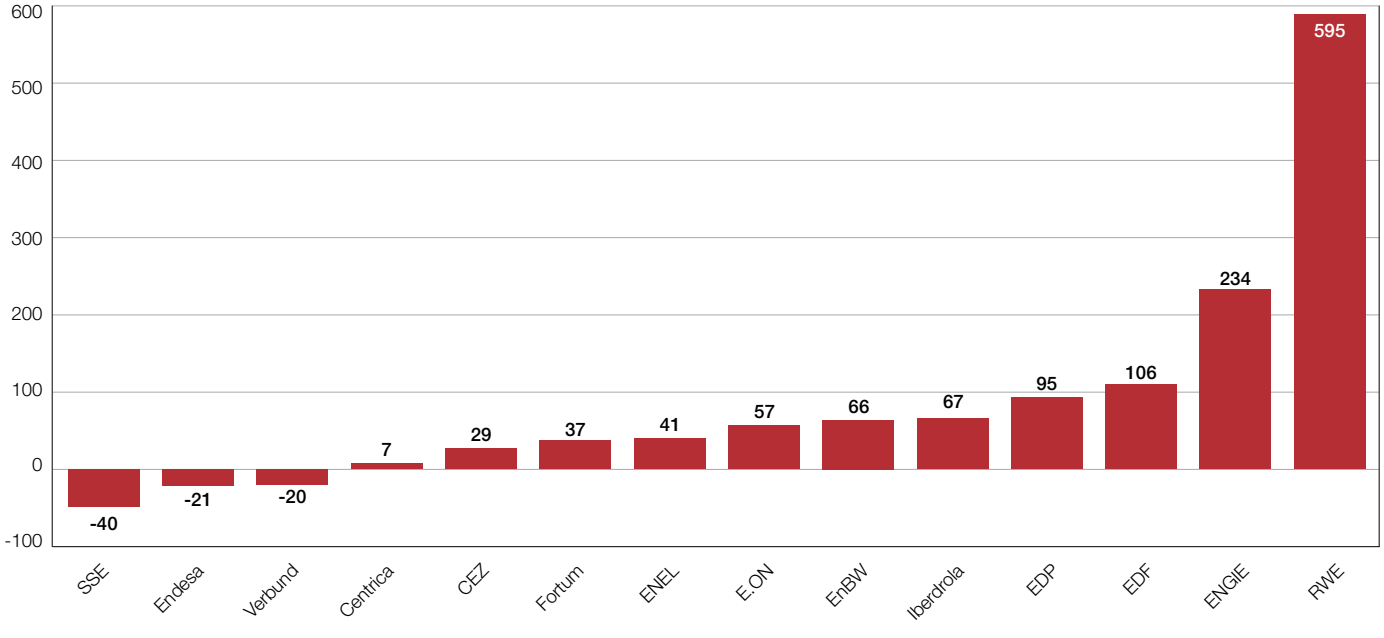
The focus of the first inquiry process and a subsequent publication will be on the power sector in order to determine a carbon pricing corridor that enables decarbonization of electricity generation through 2020, 2025 and 2030. The group will report on initial projections for credible carbon price ranges in Spring 2017.

Figure 12: Estimated locked-in emissions relative to 2°C carbon budget (%)



Source: CDP, GlobalData, IEA 2DS scenario, company reports

Figure 13: Aggregate estimated emissions above/below carbon budgets 2015-2050



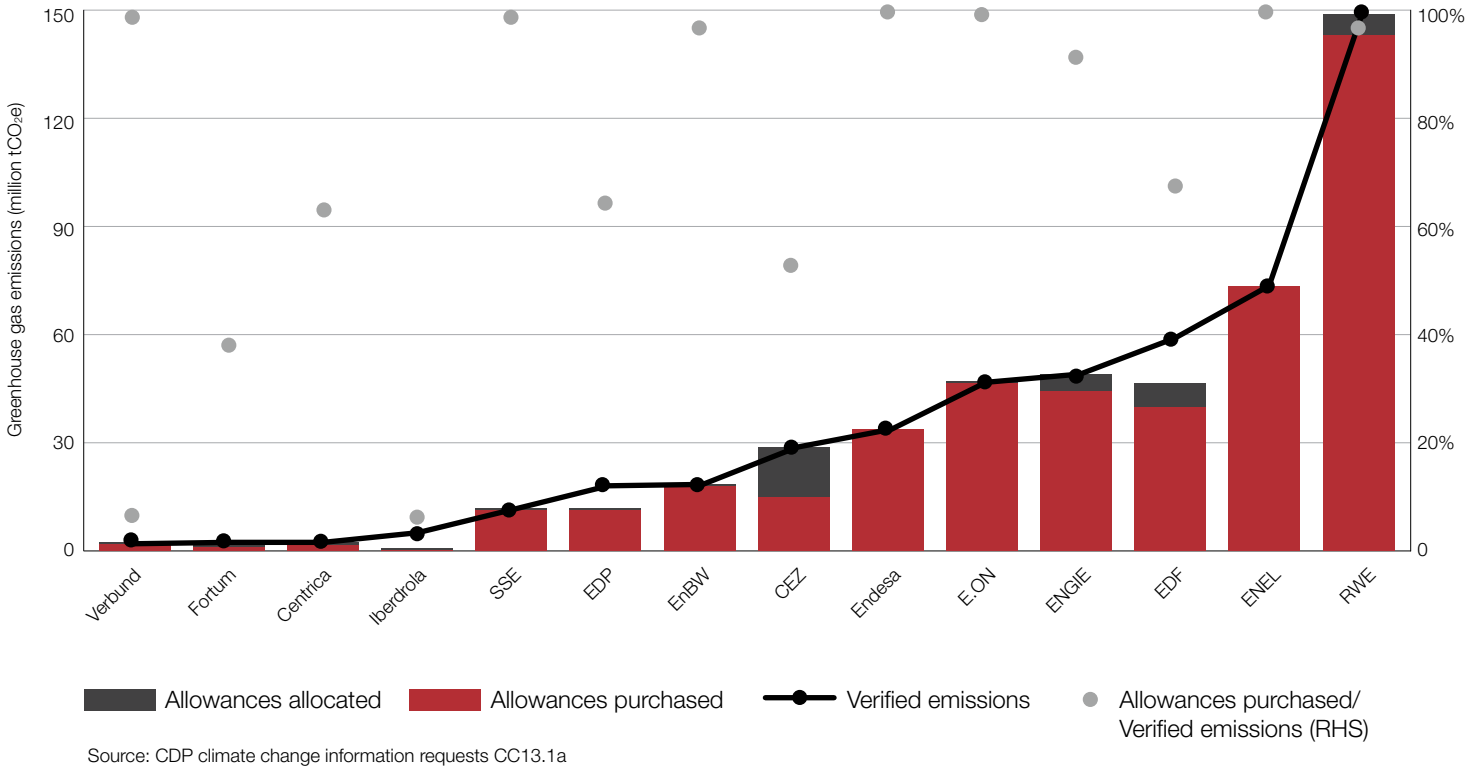
Source: CDP, GlobalData, IEA 2DS scenario, company reports

Carbon price exposure

- Carbon price obligations, represented by EU Allowance (EUA) costs under the EU ETS, vary considerably across utilities assessed. At a 2015 average traded market price of €7.70, the 14 utilities assessed face estimated total carbon costs of €3.6 billion. RWE's carbon costs account for €1.1 billion of that sum, and its EBITDA is reduced by an estimated 13.7%. Other companies with significant carbon price exposures include Endesa, with an estimated cut to EBITDA of 7.8%, and EnBW with an estimated 6.1% of EBITDA in 2015. At the other end of the spectrum, Centrica, Iberdrola and Fortum have exposures of less than 1% of EBITDA at 2015 price levels.

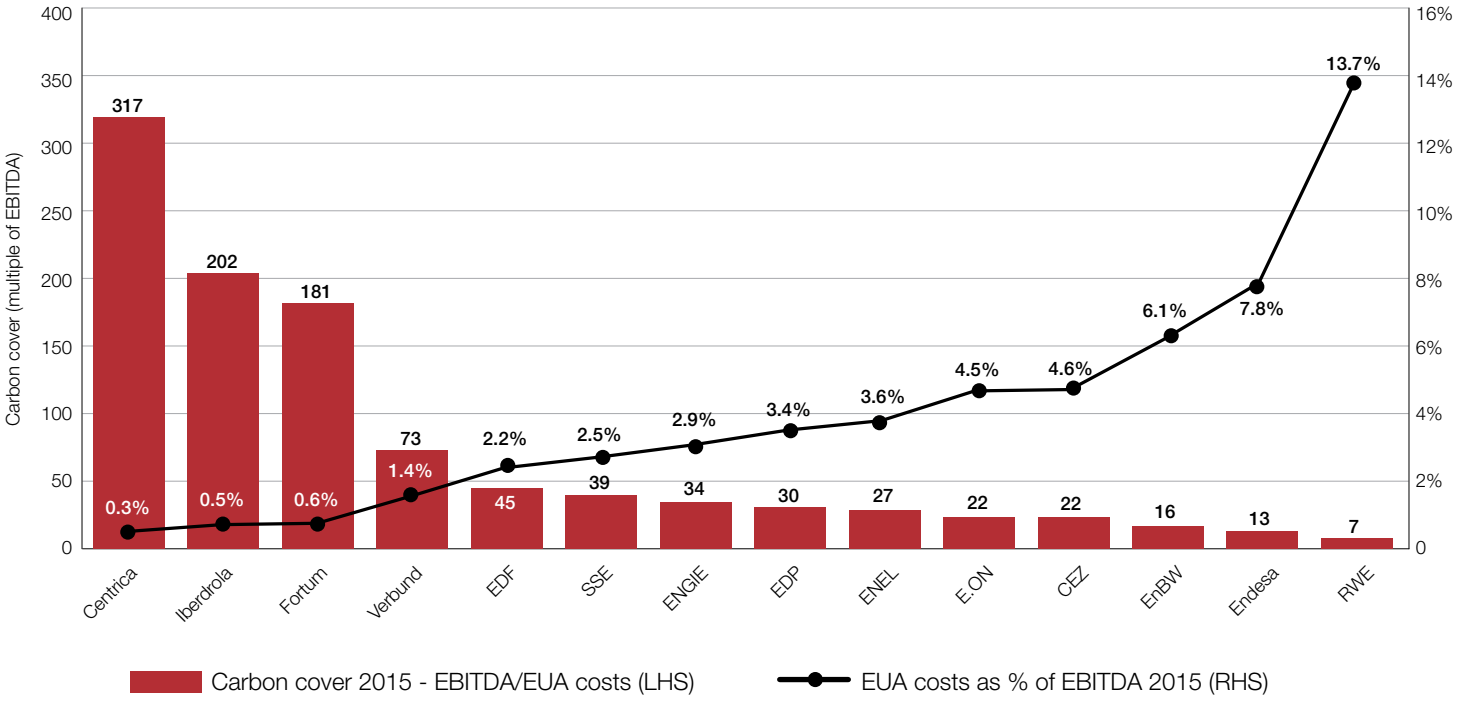
- At a hypothetical carbon price of €30 and assuming no change in sources or volumes of power generation, carbon costs could rise to an estimated 1.2%-38.3% of EBITDA, and total costs across 14 companies of €14 billion.

Figure 14: EU ETS emissions allowances – allocations and purchases 2015



Source: CDP climate change information requests CC13.1a

Figure 15: Carbon cover 2015



Source: CDP, company reports, Bloomberg, Quandl, Intercontinental Exchange (ICE)

Climate policies affecting European electric utilities

EU and national policy are significant drivers of the low carbon transition for EU utilities. In responses to CDP, utilities cite a range of regulations that generate risks and opportunities. Figure 17 shows the frequency with which risk or opportunity categories were cited and the perception of their magnitude by the 14 utilities assessed. A selection of key policy drivers are also outlined below.

EU climate policy: The EU has an overarching target to reduce GHG emissions by 80-95% below 1990 levels by 2050. Underlying it are a number of medium term targets and supporting policies:

- 2020 targets to reduce emissions by 20% below 1990, increase renewable energy to 20%, and improve energy efficiency by 20%.
- The 2030 climate and energy framework targets at least a 40% cut in GHG emissions from 1990 levels, at least a 27% improvement in energy efficiency, and at least a 27% share for renewable energy in overall energy consumption, including at least 45% of electricity generated from renewables.

EU ETS: The EU's emission trading scheme is its key lever of climate policy. It works on the cap and trade principle where a cap is set on the total amount of GHG that can be emitted by those in the system and this cap is reduced over time. Companies buy or receive emission allowances which can be traded with one another. Allowances are now fully auctioned for power generators except in countries that entered the EU since 2004.
The surplus of emission allowances that has built up since 2009 was reduced in 2016 by "back-loading", where the auctioning of 300 million allowances from 2015 was postponed until 2019-2020. Another fundamental change is the introduction of The Market Stability Reserve, which will start operating in 2021. It will address a surplus by automatically adjusting the supply of allowances to be auctioned.

Renewable energy policies: The EU Renewable Energy Directive has transparent targets for adoption of renewable energy. By 2020, the target is a 20% share of energy from renewable sources and a 10% share of energy from renewable sources in transport energy consumption, including binding national targets. A range of policy instruments are being used to achieve these targets at national level, including feed-in tariffs, feed-in premiums, quota obligations, and competitive auctions.

EU-wide innovation programs: The EU supports the development of low carbon technologies with the NER300 programme providing funding for renewable energy and CCS and the Horizon 2020 scheme providing nearly €80 billion of funding for research and innovation.

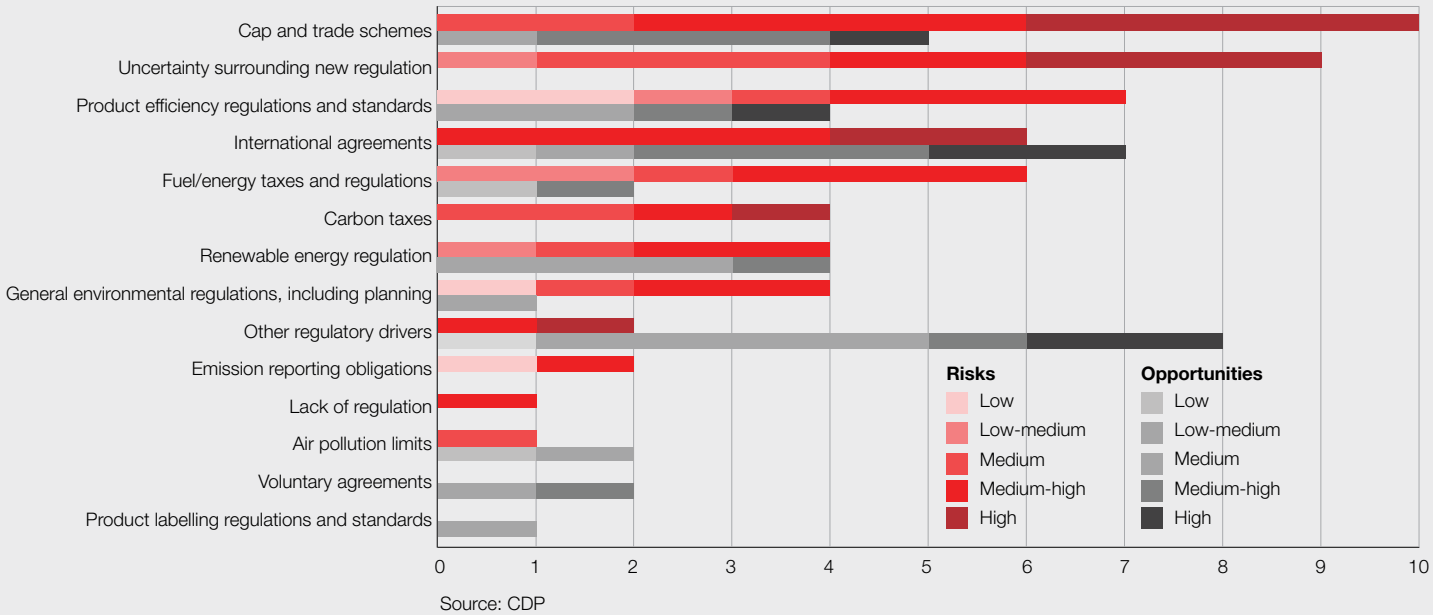
German climate policy: Energiewende ("energy transition") represents a shift away from fossil fuels and nuclear energy to a more efficient and renewables focused energy future in Germany. It targets a reduction in GHG emissions of 80-95% by 2050 relative to 1990 and renewable energy to represent 60% of the energy mix by 2050. Adding to the challenges in achieving emissions reductions, Germany's nuclear energy is to be completely phased out by 2022.

UK climate policy: The UK's Climate Change Act requires an 80% reduction in GHG emissions by 2050 from 1990 levels. The carbon price floor (CPF) is a UK policy to support the EU ETS with the aim of underpinning the price of carbon at a level that drives low carbon investment. The CPF puts a minimum price on how much power generators in the UK must pay to pollute. It was doubled from £9 to £18/tCO_2 in April 2015 and has been a major factor in the decreasing use of coal in the UK energy mix. It will remain at £18/tCO2 until at least 2021. The UK also plans to phase out coal fired power stations by 2025.

Figure 16: EUA December 2017 contract price

Source: Quandl, Intercontinental Exchange

Figure 17: Climate change-related risks & opportunities cited by EU utilities



Source: CDP

Limited progress on carbon capture and storage

Little apparent progress is being made by EU utilities on carbon capture and storage. CCS is a technology viewed by many stakeholders as critical to a low carbon transition, and is central to many published scenarios for achieving below 2°C warming. The IEA's 450 scenario and its Energy Technology Perspectives 2 degrees scenario (2DS) both rely on CCS as a technological solution to limiting atmospheric greenhouse gas emissions.

Figure 18 illustrates that in the 2DS scenario CCS delivers 12% (94 Gt CO_2) of cumulative emissions reductions through to 2050. This includes negative emissions from bioenergy with CCS (BECCS) which is likely to become increasingly important in order to achieve net zero emissions and the Paris Agreement's more ambitious target of keeping global warming to 1.5°C above pre-industrial levels.

The importance of CCS was highlighted in the IPCC 5th Assessment Report (AR5) which stated that many climate models could not achieve concentration levels of 450ppm CO_2e in the atmosphere by 2100 without key technologies such CCS and its combination with bioenergy[10]. In addition, other than CCS there are few options for deep emissions reductions across industrial processes such as the manufacture of steel and cement.

Demonstration of CCS technology is not new. CCS operations at Sleipner in Norway started over 20 years ago and according to the global CCS Institute there are now 21 large-scale CCS projects in operation or under construction throughout the world and a considerable number of smaller-scale projects. The world's largest CCS project Petra Nova in the US recently came into service and was both on time and on budget.

Figure 19 shows the predicted global electricity generation under the 2DS scenario with the relative contributions from each energy source. CCS is seen to make an increasing contribution and without it the IEA predicts an additional cost in the power sector of US$3.5 trillion in order to limit global warming to 2°C[11].

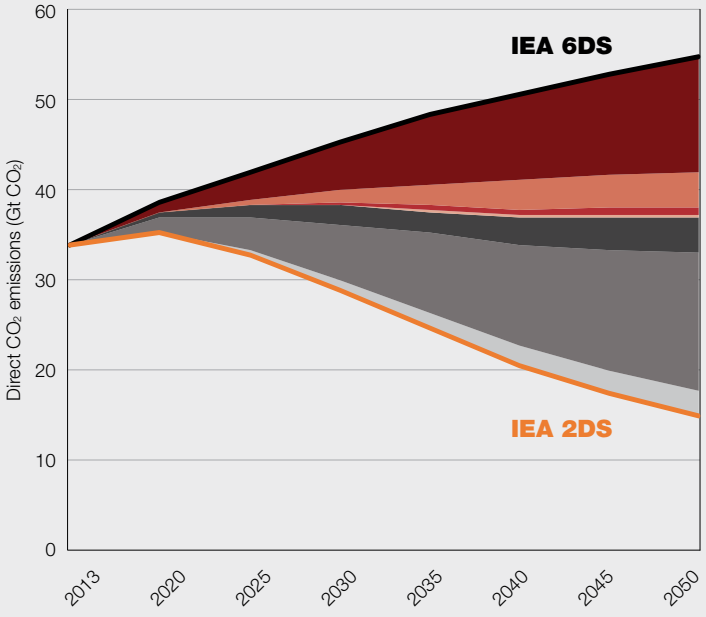
Our analysis shows that a number of companies in our sample will break their carbon budgets in years to come based on existing fossil fuel assets. Technologies like CCS might help to reverse the lock-in of emissions and potentially avoid stranded assets.

Utilities commented to CDP that carbon prices today are not high enough to make CCS commercially viable. Regulatory signals are also weak, with Germany having an effective ban on CCS, and the UK cancelling £1 billion in planned CCS funding.

Prior to COP15 in Copenhagen there was considerable optimism in CCS with more than US$30 billion in public funding announcements; however, only around US$ 2.8 billion was actually invested between 2007 and 2014.

Lack of regulatory support is particularly damaging for CCS compared to other clean energy solutions. Renewables supply electricity to customers and energy efficiency can reduce costs but the benefits of CCS are almost entirely related to emissions reduction. Hence stability in policy and financial support is vital in securing CCS investment.

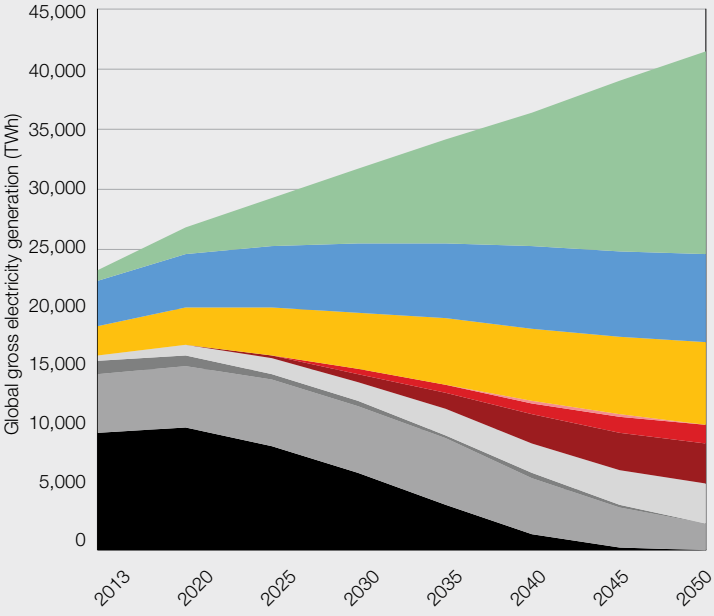
Figure 18: Contributions to emissions reductions



Renewables 32%
BECCS 2%
End-use fuel switching 10%
Nuclear 7%
CCS (Power & Industry) 10%
Power generation efficiency & fuel switching 1%
End-use efficiency 38%

Source: IEA Energy Technology Perspectives 2016.

Figure 19: Global electricity generation in IEA 2DS scenario



Coal
Oil
Coal with CCS
Biomass with CCS
Hydro
Natural gas
Biomass and waste
Natural gas with CCS
Nuclear
Other renewables

Source: IEA Energy Technology Perspectives 2016.

10. IPCC, Climate Change 2014: Mitigation of Climate Change
11. IEA, 20 years of Carbon Capture and Storage

Physical risks: Water resilience

- In 2016, 2% of company thermal generation capacity is situated in high or extremely high water stress areas. By 2030, exposure to high and extremely high water stress regions increases to 51% for assets expected to remain online, with 20% of total capacity located in extremely high water risk regions.
- Verbund is ranked first on water resilience. It is the only company to have lower thermal water stress risk in 2030 compared to 2016 and demonstrates substantial evidence of managing water risks.
- Companies with high water stress risk tend to have more effective risk management. Iberdrola and Endesa have high exposure to water stress risk, yet are the top two on water risk management. Similarly, companies with low exposure to current and future water stress risk often have the poorest water risk management (Figure 22).

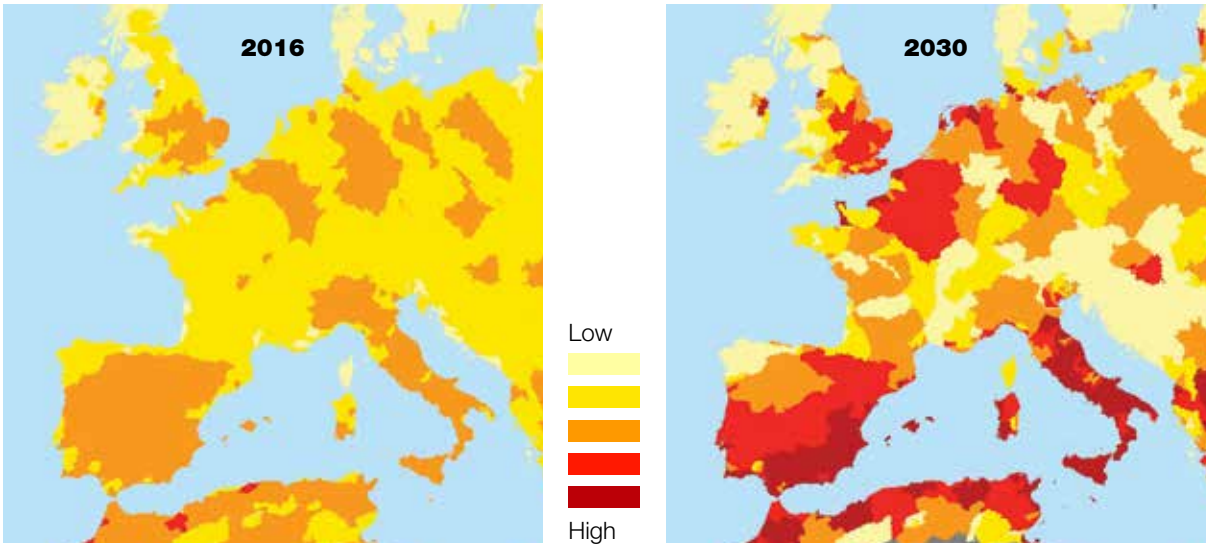
Overview

In 2016 the World Economic Forum identified water crises as the third greatest global risk by impact.[12] Growing competition between industry, agriculture, energy, and cities is likely to exacerbate water scarcity risk unless water use and management practices markedly shift in coming years. According to the IEA's World Energy Outlook, most of the weaknesses in the global energy system in relation to energy access, security and the detrimental environmental impacts incurred from energy use, will likely be exacerbated by changes in water availability and predictability.[13]

Electric utilities are reliant on significant quantities of water to operate. Nuclear power plants and thermal power plants using steam turbines to generate electricity, are reliant on sufficient and stable supplies of water for cooling, while hydro plants require natural water bodies or reservoirs to generate electricity. Though thermal power plants are designed to operate under diverse climatic conditions, decreasing volumes of available water and increasing water temperatures may lead to a reduction of operating capacities and temporary shutdowns. Increased water loss from declining rainfall levels and rising temperatures are also likely to affect the hydrologic cycle that underpins hydropower generation, resulting in a reduced or more intermittent ability to generate electricity.

Institutional investors are increasingly turning their attention to mitigating exposure to the physical risks of climate change. Concerns over the impacts of water scarcity in valuation and stock selection may drive investors to build portfolios around companies that mitigate such risks to protect their investments in the long-term. Electric utility companies operate in a number of regions with growing water scarcity. Changing water

Figure 20: Water stress relative to the Electric Power sector in 2016 and 2030



12. World Economic Forum, Global Risks Report 2016
13. International Energy Agency, World Energy Outlook Report 2016

availability, rising capital expenditures for advanced, water-efficient technologies and changes in legislation affecting access to water permits, could significantly affect the continuity and costs of electricity generation in coming years, and lead to asset impairment.

The inter-dependencies between energy and water increase the need for water management. CDP's annual water information request seeks to gather insights about a company's water strategy to enable better understanding of water risks and mitigation, to the benefit of investors. Of the 14 companies assessed in our sample, nine responded to the questionnaire (64% response rate), though of the total 51 electric utilities companies targeted by CDP, only 17 responded (33% response rate). As investor awareness of the financial implications of water scarcity increase, there will be an increased demand for better disclosure, in order to facilitate integration of water risk analysis into the investment process.

In this chapter, we assess companies' water resilience based on publicly available resources and company responses to the CDP 2016 water information request, as well as asset level information from GlobalData. Companies are ranked based on their current and future (2030) water stress exposure, as well as their risk management strategy. Water stress is calculated using an index which determines relative water stress in 2016 and 2030 based on the percentage of capacity in each risk category.

- **Metric 1) Thermal asset water stress exposure:** We assess water stress on a plant by plant basis using the Aqueduct global water stress risk mapping tool, developed by the World Resource Institute (WRI)[14].The Aqueduct tool evaluates current and future localized water stress, weighting water stress indicators by relevance to the electric power industry. The tool measures several water stress factors including physical water quantity and quality (based on factors such as inter-annual and seasonal variability, flood occurrence, drought severity and land stress) as well as regulatory and reputational risks and assigns a risk category to the score.

- **Metric 2) Hydro asset water stress exposure:** Due to the fundamental difference in water usage between thermal power plants and hydro plants, water stress exposure is measured separately for hydropower.

  We analyze current water stress exposure on an asset level, weighting each site relative to generating capacity and overall company thermal and hydro capacity. Based on disclosed or estimated decommissioning years, we project future water stress exposure of remaining assets in 2030. Current and future water stress index scores are calculated based on relative capacities in each risk category which is used to rank companies' water stress exposure.

- **Metric 3) Water risk management:** We form a ranking based on a variety of metrics relating to companies' water risk assessment and management based on their response to the 2016 CDP water questionnaire and other company disclosures. The scorecard includes: Disclosure to CDP, water risk assessment, supply chain management, targets, governance, and evidence of internal management and external regulatory adherence including water stress risk testing. Low ranks indicate better water management.

Figure 21: Water resilience summary

Company	Thermal asset water stress	Hydro asset water stress	Water risk management	Overall weighted rank	Water resilience rank	Water resilience grade
Verbund	1	4	4	2.4	1	A
SSE	3	1	10	3.4	2	B
Fortum	5	2	8	3.8	3	B
EnBW	2	5	13	5.0	4	C
RWE	6	6	12	6.1	5	C
EDF	8	7	3	6.2	6	C
ENGIE	10	3	5	6.3	7	C
Centrica (i)	8	N/A	6	6.8	8	C
E.ON	7	9	11	7.1	9	C
CEZ	4	11	14	8.4	10	D
EDP	11	10	9	8.6	11	D
Endesa	14	8	1	8.8	12	D
Iberdrola	12	13	2	9.6	13	E
Enel	13	12	7	9.9	14	E
Weighting	**45%**	**25%**	**30%**			

Note: In calculating the weighted rank in this table, we use the weighted ranks for each area. We display non-weighted ranks in this summary for simplicity only.
(i) Centrica is weighted 70% thermal capacity, 30% risk management as it has no hydro assets.
Source: CDP

14. World Resource Institute Aqueduct tool: http://wri.org/our-work/project/aqueduct

Highlights

- From 2016-2030, hydro capacity exposed to high or extremely high water stress risk increases from 0% to 18%. However, the top six ranked companies have reduced hydro water stress in 2030 compared to 2016 (Figure 24).

- Verbund is ranked first on water resilience. Hydro contributes over 84% of the company's generating capacity yet all sites are in low water stress risk regions in 2016 and 2030 (Figure 24). Verbund's two thermal plants are located in low water stress regions and by 2030 are likely to be offline.

- SSE and Fortum rank second and third overall, largely due to their low exposure to water stressed regions. All of SSE's hydro sites are located in water abundant regions and by 2030 its water risk decreases. Fortum has low thermal water stress risk and no hydro capacity located in high water stress region in 2016 or by 2030.

- Endesa, EDF and Verbund all conduct comprehensive company-wide and forward-looking water risk assessments with risks considered six or more years into the future. Iberdrola has the most progressive water targets, evidence of supply chain management, and conducts internal water stress risk analysis. Each ranks in the top four for risk management (Figure 25).

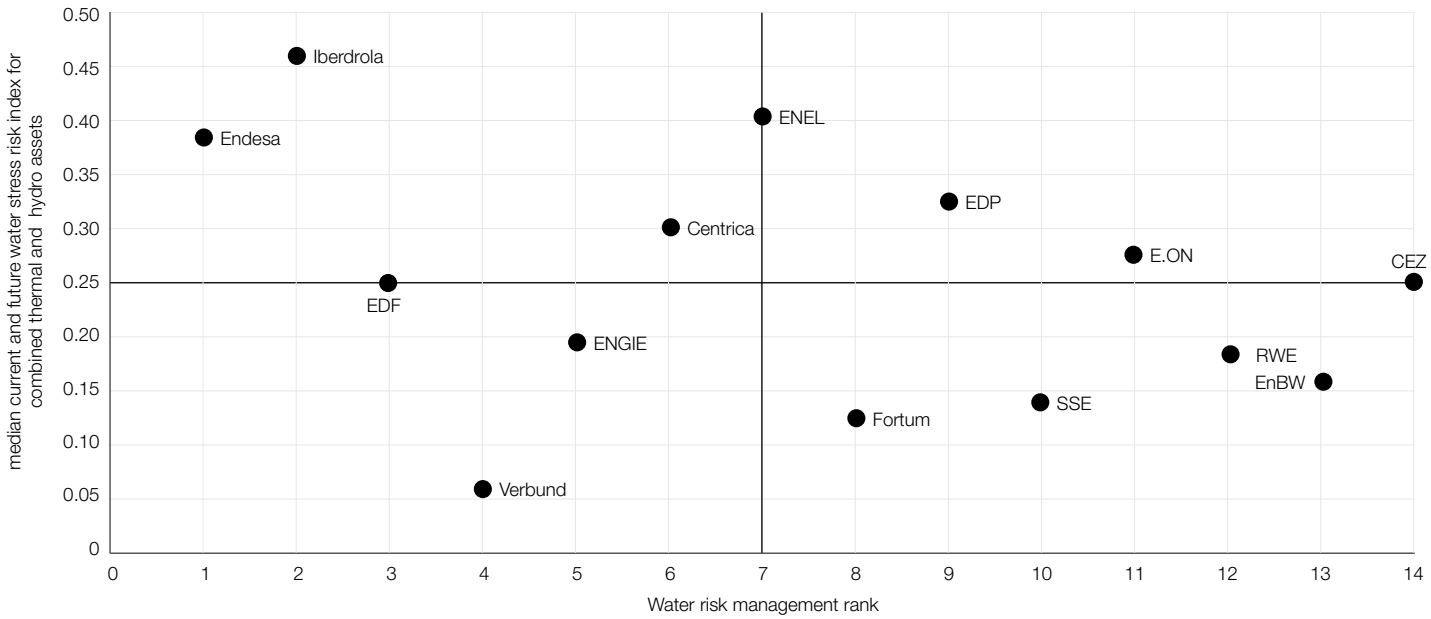
- EnBW is assessed on a narrower range of risk management metrics, but it scores poorly on water risk management due to a lack of any discernible publicly disclosed external water risk assessment or management strategy. RWE declined to participate in CDP's 2016 water questionnaire request yet in answers to questions sent by CDP as part of the production of this report shows some evidence of water risk management.

- CEZ did not respond to CDP's 2016 water information request and shows little evidence of water risk management other than adherence to national water regulations. It ranks well on thermal water risk exposure with none of its capacity exposed to high water stress in 2016, but poorly on hydro water stress with 85% of its remaining hydro capacity exposed to medium to high or high water stress by 2030.

- Iberdrola and Endesa rank poorly overall. By 2030 Iberdrola's hydro capacity has the highest exposure to extremely high water stress regions and 76% of its thermal capacity is likely to be exposed to high or extremely high water risk (Figures 23 and 24). Endesa has the highest thermal asset risk exposure with the majority of its assets located in extremely high risk regions by 2030. However, Endesa and Iberdrola rank first and second for water risk management, highlighting awareness and progress in managing water risk.

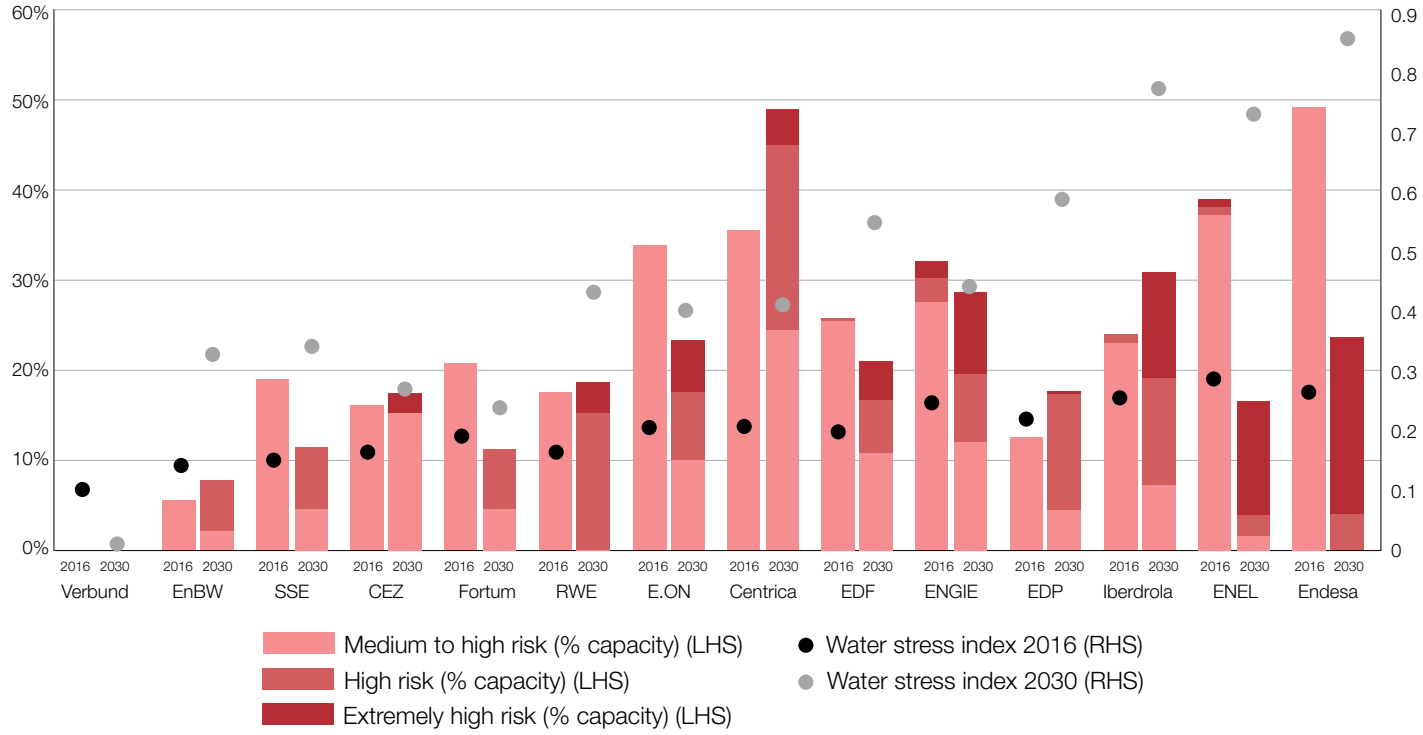
- Enel ranks last overall. 71% and 35% of its respective thermal and hydro capacity are likely to be exposed to high and extremely high water stress risk by 2030. Assets are particularly vulnerable in Spain and South America where water stress is likely to escalate in coming years. Enel's water risk management plan is not as robust as other companies though it shows evidence of internal water stress analysis and targets focused on water stewardship.

Figure 22: Combined thermal & hydro asset water stress risk vs. risk management rank



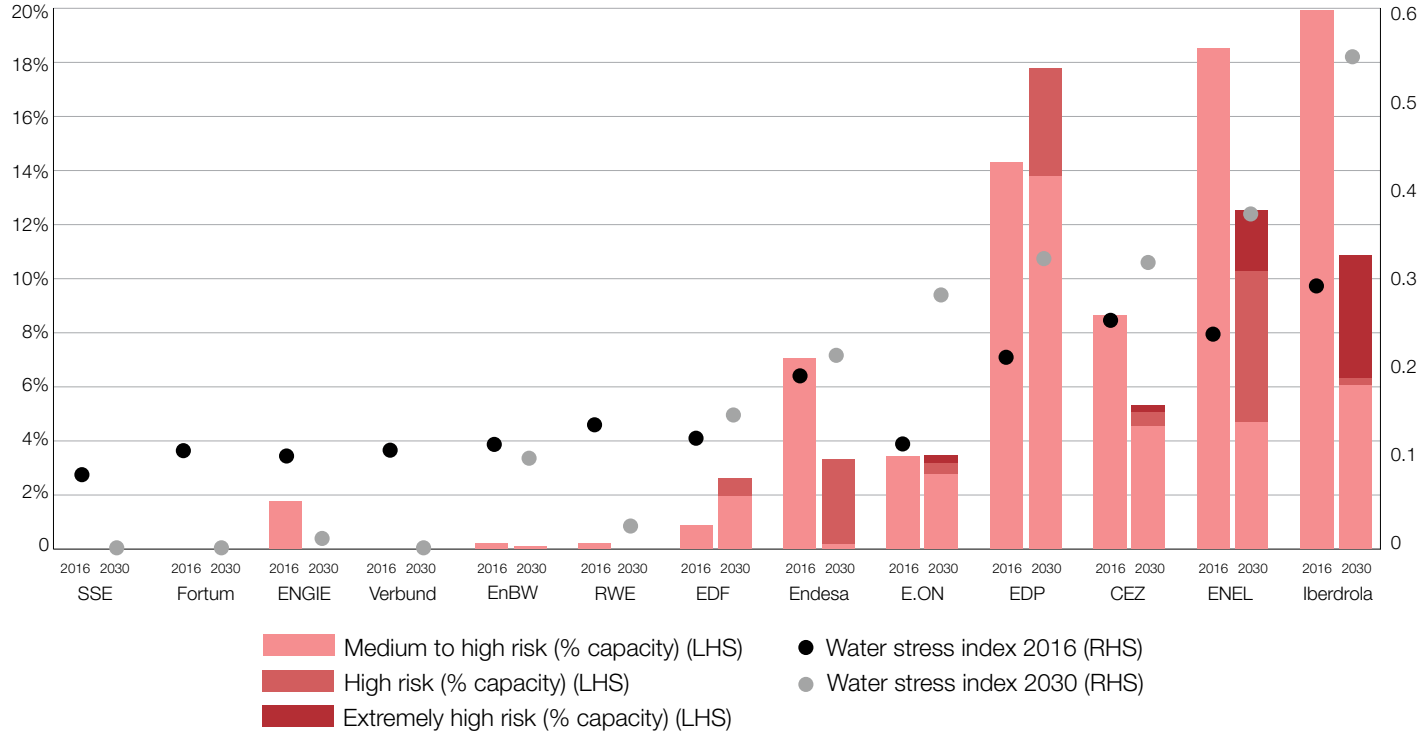
Source: CDP, WRI, company reports, GlobalData

Figure 23: Thermal asset water stress exposure



Source: CDP, WRI, company reports, GlobalData

Figure 24: Hydro asset water stress exposure



Source: CDP, WRI, company reports, GlobalData

Figure 25: Water risk management

Company	Disclosure Score	Risk asessment rank	Supply chain management rank	Targets rank	Governance rank	Internal managment & regulatory adherence rank	Overall management rank
Endesa	1	1	7	2	8	6	1
Iberdrola	1	8	1	1	4	1	2
EDF	1	2	1	7	4	6	3
Verbund	1	3	11	6	1	6	4
ENGIE	1	9	7	2	9	1	5
Centrica	1	6	1	7	3	6	6
Enel	1	6	10	2	12	1	7
Fortum	2	3	1	11	1	6	8
EDP	1	10	12	5	4	1	9
SSE	1	5	7	10	10	6	10
E.ON	1	11	6	12	4	1	11
RWE	2	12	1	9	10	13	12
EnBW (i)	3					13	13
CEZ	4	13	13	13	13	6	14
Weighting	**10%**	**40%**	**10%**	**20%**	**10%**	**10%**	

(i) EnBW is ranked on 'disclosure score' and 'internal mgt. & regulatory adherence rank' only, due to lack of other data.
Source: CDP, company reports

Water stress in context

Water stress as a result of climate change may have a detrimental impact on electricity production. During recent warm, dry summers several power plants in Europe, the US and Australia, were forced to reduce production owing to cooling-water scarcity and high river temperatures.

- In 2003, cooling water returned to rivers already at record high temperatures was beyond the temperature limits set by the French nuclear safety authority, causing EDF to shut down 4,000 MW of production capacity in France.
- In 2011 hydropower capacity in France gradually deteriorated to the third-lowest point in 60 years. The French government also established a committee to monitor electricity supply amid fears a severe drought could force the 44 nuclear reactors situated by rivers to cut production levels.
- Throughout the US, climate change is predicted to reduce summer-time generating capacity of vulnerable power stations of up to 7.2-8.8% under drought conditions[15]. Since 2000, drought and competition for water within the Colorado river basin has already had negative impacts on the 4,200 MW of generating capacity in hydropower production.
- In 2007 AGL, an Australian electric utility company saw sharp reduction in hydro output, including reducing to zero output from the country's largest hydro facility Dartmouth, as a result of low water levels.

Water cooling technologies and the low carbon transition

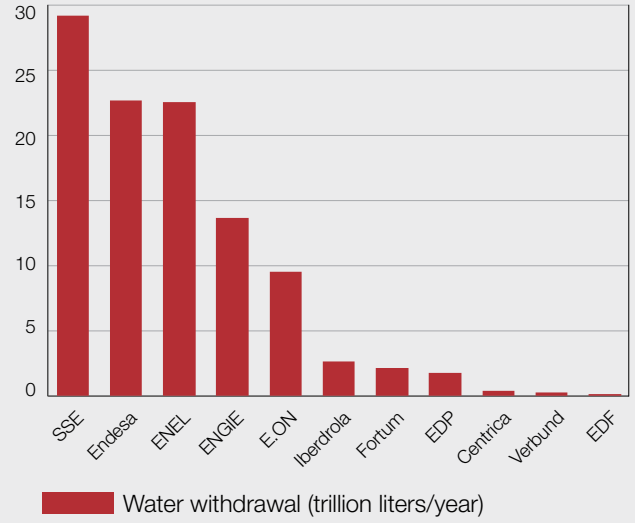
Water demands from the global power sector are set to increase by 140% by 2050[16]. The quantity and quality of water required for electricity generation varies significantly by energy process and cooling system, and the selection of such technologies has important implications for regional water use.

The cooling system employed is a greater determinant of water usage than the particular technology generating electricity, both in terms of water consumption and water withdrawal[17]. As water-related risks intensify, the choice of cooling technology in water scarce regions could either constrain generation, or ensure continued generation.

15. Bartos M. Chester M. (2015) Impacts of climate change on electric power supply in the Western United States
16. UN Statistics: http://www.unwater.org/statistics/statistics-detail/en/c/211820/
17. J Macknick, R Newmark, G Heath and K C Hallett (2012) A Review of Operational Water Consumption and Withdrawal Factors for Electricity Generating Technologies

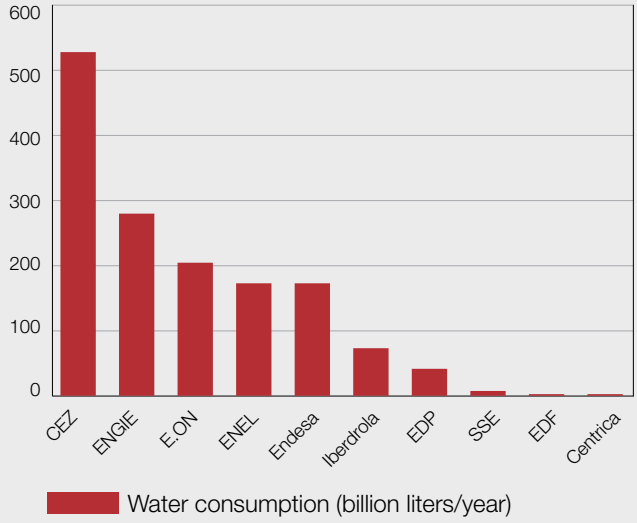
There are trade-offs to favoring cooling technologies that both withdraw and discharge large volumes of water, over systems that withdraw less and consume more. While withdrawal of water at a given point in time can stress the water system (depending on the needs of other users, the seasonality of water availability and the state in which the water is returned), water consumed is by definition not returned, and necessarily decreases the amount of water available to other users[18]. The volume of water consumed by a company is therefore dependent on the cooling technology employed and greater water consumption or withdrawal does not necessarily infer better or worse water management.

Figure 26: Water withdrawal



Source: CDP, company reports

Figure 27: Water consumption



Source: CDP, company reports

Figures 26 and 27 show disclosed water consumption and withdrawal rates in 2015. The difference in withdrawal and consumption levels demonstrate the difficulties in comparing leaders and laggards in terms of water use. SSE has extremely high water withdrawal yet its water consumption is negligible and it has among the lowest water risks. Endesa has the second highest water withdrawal and also consumes a considerable amount of water yet demonstrates sophisticated water risk management.

According to the IPCC, thermal plants currenty provide about 80% of global electricity and are able to utilize a number of different cooling systems[19]. Thermoelectric power plants boil water to create steam, which spins turbines to generate electricity. This heat comes predominantly from burning fuel or the splitting of atoms in a nuclear reactor. Cooling water is used as a heat removal device absorbing the waste heat. The water is then either discharged, recirculated or evaporated depending on the cooling system in operation.

There are three cooling systems used in thermal plants:

1. **Once-through cooling systems:** Large volumes of water are withdrawn from a water body and pumped to a cooling water circuit where it cools the turbine. The water is subsequently discharged back to source at a higher temperature. This is the least complex, cheapest, and mostly thermally efficient option but can be damaging to the surrounding hydrological cycle as a result of warmer discharge water, resulting in thermal pollution. The system uses the greatest volumes of water, yet less than 1% of water is lost or consumed in the process.

2. **Wet tower cooling systems:** Cooling towers facilitate evaporation of water to remove waste heat by pumping water to cooling towers. As the water falls through the tower and comes into contact with air, some is evaporated but the remaining water condenses and collects in a basin at the base of the tower where it is fed back into the system and reused in the circuit. Tower cooling uses less water than once-through cooling, but has the highest consumptive demand of all cooling technologies.

3. **Closed loop dry cooling systems:** Small amounts of water are used in dry cooling. The system utilizes fully closed re-circulating water circuits from which there is no intentional loss. The heat generated is transferred to the atmosphere as hot air. These systems, while proven technologies, often are not cost competitive when water is free and widely available. Despite low water withdrawals and consumption, it is by far the most expensive and has the lowest efficiency. Low efficiencies require more fuel per unit electricity output, which can in turn lead to higher air pollution.

Changing precipitation patterns, and the increasing number and severity of extreme weather events is likely to exacerbate water scarcity issues, and could significantly affect energy production and delivery. Utilities face an unusual situation whereby a transition to a less carbon-intensive electricity sector could result in either an increase or a decrease in water use, depending on the choice of technologies and cooling systems employed[20]. With cooling technologies proving to be a greater determinant of water use than fuel, a decarbonization of fuel type will not guarantee a reduction in water use and could still put assets in water scarce regions at risk. With this in mind, companies need to manage water risk to ensure that power plants have reliable access to sufficient quantities of water throughout their lives, before committing to investment in new plants, retro-fits or upgrades.

18. Global Energy Outlook 2016
19. IPCC, Climate Change 2014: Mitigation of Climate Change
20. Macknick et al. (2012)

Transition opportunities

- Renewable share of capacity for the 14 companies increased from 25% in 2010 to 32% in 2016, and for our sample 20% of electricity generated in 2016 was from renewables.
- Enel is ranked first. It has a clear strategic direction with its "Open Power" concept. Its 2017-2019 strategy outlines strong investment in renewables and smart solutions with 30% and 23% of planned CAPEX focused on renewables and digitalization respectively.
- EDP and Verbund rank second and third respectively. EDP has the highest share of other renewables[21] in its generation portfolio reflecting its position as a global leader in wind power. Verbund is a clear leader in hydro production and has the goal of 100% renewable electricity generation by 2020.
- RWE is ranked last and EDF second last. Both companies have very low proportions of renewable generation and capital flexibility is somewhat limited by nuclear decommissioning obligations.

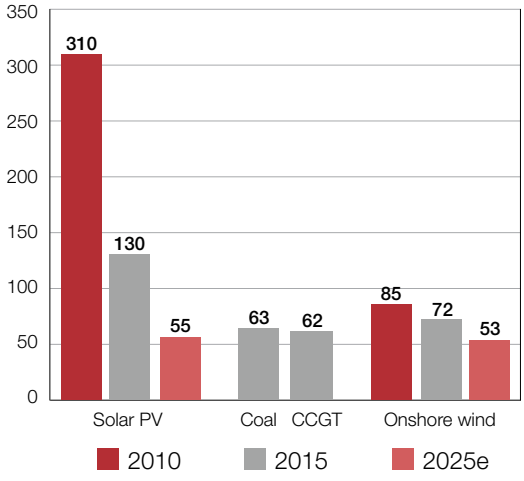
Overview

The European utilities sector is in significant transition. With the share of variable renewable energy increasing, distribution grids are shifting from unidirectional centralized power systems to a smarter and more distributed structure. New demands from customers in energy services are transforming market dynamics and utilities are adapting their traditional business models in order to capitalize on these transition opportunities.[22]

The decisions taken by both E.ON and RWE to split into separate renewable and fossil fuel-focused companies illustrates the momentous impact the transition to a low carbon economy can have, and with various European and national-level policies supporting the generation of electricity from renewable energy sources, disruption of traditional energy systems will continue. The EU's 2030 framework for climate and energy sets targets to provide at least 27% of energy consumption and 45% of electricity from renewables by 2030.[23]

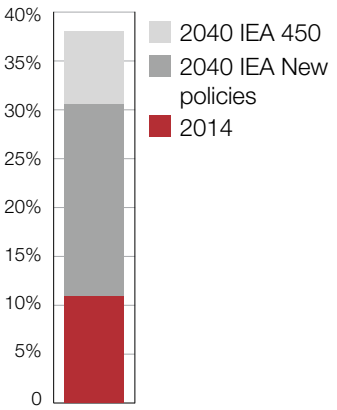
Wind and solar are becoming progressively competitive at utility scale. The levelized cost of electricity (LCOE) for both solar PV and onshore wind has significantly decreased since 2010, and by 2025 it is forecast to fall a further 59% for solar PV and 26% for onshore wind (Figure 28).[24] Both Bloomberg New Energy Finance (BNEF) and IEA forecasts predict significant growth in the two technologies, with BNEF predicting that for Europe more than 80% of investment in new generating capacity between 2016-2040 will go to solar and wind[25].

Figure 28: Global weighted average LCOEs, US$/MWh



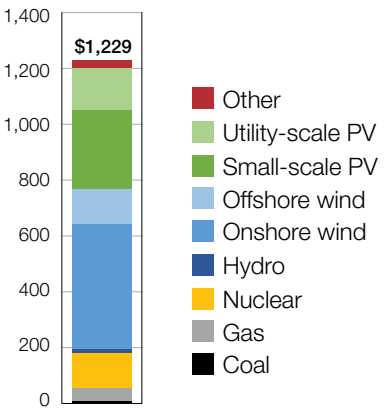
Source: IRENA "The Power to Change: Solar and Wind Cost Reduction Potential to 2025" June 2016, IEA WEO 2016

Figure 29: Europe - Share of wind and solar PV in total electricity generation



Source: IEA WEO 2016

Figure 30: Europe - capital investment by technology, 2016-2040 (US$ billion, 2015 real)



Source: BNEF NEO 2016

21. Other renewables' includes solar, wind, biomass and geothermal, and omits hydro.
22. See boxes "Decentralized energy…" and "Customers have the power…" in this chapter for further discussion.
23. http://europa.eu
24. IRENA "The Power to Change: Solar and Wind Cost Reduction Potential to 2025", June 2016
25. BNEF, New Energy Outlook 2016

In this chapter we assess the extent to which companies are capturing these transition opportunities in renewables, smart services and technologies using five key metrics:

- **Metric 1) Generation from renewables (GWh):** expressed as a percentage of a company's total electricity generation. A higher ranked company will produce a higher percentage of its electricity from renewables. We calculate this metric separately for hydro and other renewables.

- **Metric 2) Change in installed renewable capacity:** This is a measure of the rate of increase of the utilities' renewables portfolios. We use installed capacity (MW) in this metric rather than production (GWh) in acknowledgement of the year-on-year fluctuations in renewable energy resources. We also calculate the relative increase in renewables capacity for the companies compared to their domestic market growth rate. We calculate this metric only for other renewables.

- **Metric 3) Renewable targets:** We assess companies' forward looking renewable targets in terms of both quantity and ambition. This provides an indication of those companies seeking to reduce carbon exposure and capitalize on the growing renewables market.

- **Metric 4) Smart services & innovation:** This metric identifies companies taking the lead in smart energy products and innovation. Smart meters installed as a percent of customer base is used as a proxy to reflect companies taking the lead in smart solutions. We also rank companies on their average R&D expense to sales ratio over the period 2014-2016, providing an indicator of companies' focus on innovation.

- **Metric 5): Capital flexibility and CAPEX strategy:** We look at how companies are intending to allocate future capital expenditure across areas such as renewables, smart energy solutions and digitalization. In addition we rank the percentage of growth CAPEX relative to maintenance CAPEX and the ratio of economic net debt[26] to EBITDA is used as an indicator of financial flexibility.

Figure 31: Transition opportunities summary

Company	Generation from renewables	Change in renewable capacity	Renewable targets	Smart services & innovation	Capital flexibility & CAPEX strategy	Overall weighted rank	Transition opportunities rank	Transition opportunities grade
Enel	4	5	3	5	1	4.7	1	A
EDP	1	8	4	7	5	5.2	2	A
Verbund	9	1	1	6	6	5.4	3	A
Iberdrola	2	12	7	2	3	5.5	4	A
E.ON	5	4	2	11	9	6.4	5	B
Fortum	13	6	6	1	2	6.5	6	B
EnBW	10	3	5	14	4	7.1	7	C
SSE	3	11	8	13	7	7.5	8	C
Endesa	7	14	9	3	9	8.1	9	C
CEZ	8	2	11	12	13	8.8	10	D
ENGIE	6	13	12	10	11	8.9	11	D
Centrica	11	9	14	8	8	9.6	12	D
EDF	14	7	10	4	14	10.1	13	E
RWE	12	10	13	9	12	10.3	14	E
Weighting	**25%**	**15%**	**15%**	**15%**	**30%**			

Note: In calculating the weighted rank in this table, we use the weighted ranks for each area.
We display non-weighted ranks in this summary for simplicity only
Source: CDP

26. Economic net debt = net financial debt + provisions for pensions + provisions for asset retirement obligations

Highlights

- Generation portfolios vary significantly. Across 2015 and 2016 the share of total renewable generation ranged from 95% for Verbund to just 3.5% for Centrica (Figure 32).
- Despite growth in renewable portfolios (excluding hydro), only four companies have outperformed domestic market growth over 2010-2015 (see Figure 33). Wind and solar continue to offer strong growth potential and utilities should seek to capitalize on this opportunity.
- Renewable targets vary significantly in both level and ambition. Verbund has the goal of 100% renewable electricity generation by 2020, whereas Centrica has no target, having recently divested its wind capacity.
- Enel and its subsidiary Endesa have been leaders in the roll out of smart meters (Figure 35). Fortum and EDF have the highest R&D to sales ratios, illustrating a commitment to innovation.
- Figure 37 illustrates the different approaches companies have in their allocation of future capital. EDP has the highest share of CAPEX allocated to renewables and digitalization (58% of total) and EnBW has the highest level of growth CAPEX (76%). CEZ's ambition to become a major European player in renewables is not reflected in its future CAPEX strategy.
- Fortum has the lowest economic net debt/EBITDA of the companies and is looking to utilize this capital flexibility to facilitate growth. Companies that have a significant share of nuclear assets such as EDF, E.ON and RWE have lower capital flexibility due to asset retirement obligations (Figure 38).
- Many companies are shifting strategy; investing more in smart solutions (Enel's 2017-2019 strategy has €4.7 billion or 23% of planned CAPEX focused on digitalization) and becoming more customer focused (Centrica is moving strategy away from generation and focusing on end-consumer services).
- With new business models emerging and increasing focus from companies on smart energy solutions and customer services, utilities need to highlight the actions taken in these growth areas and present clear indicators of performance to investors. Companies should use scenario analysis to assess the potential opportunities presented by the energy transition as recommended by the TCFD.

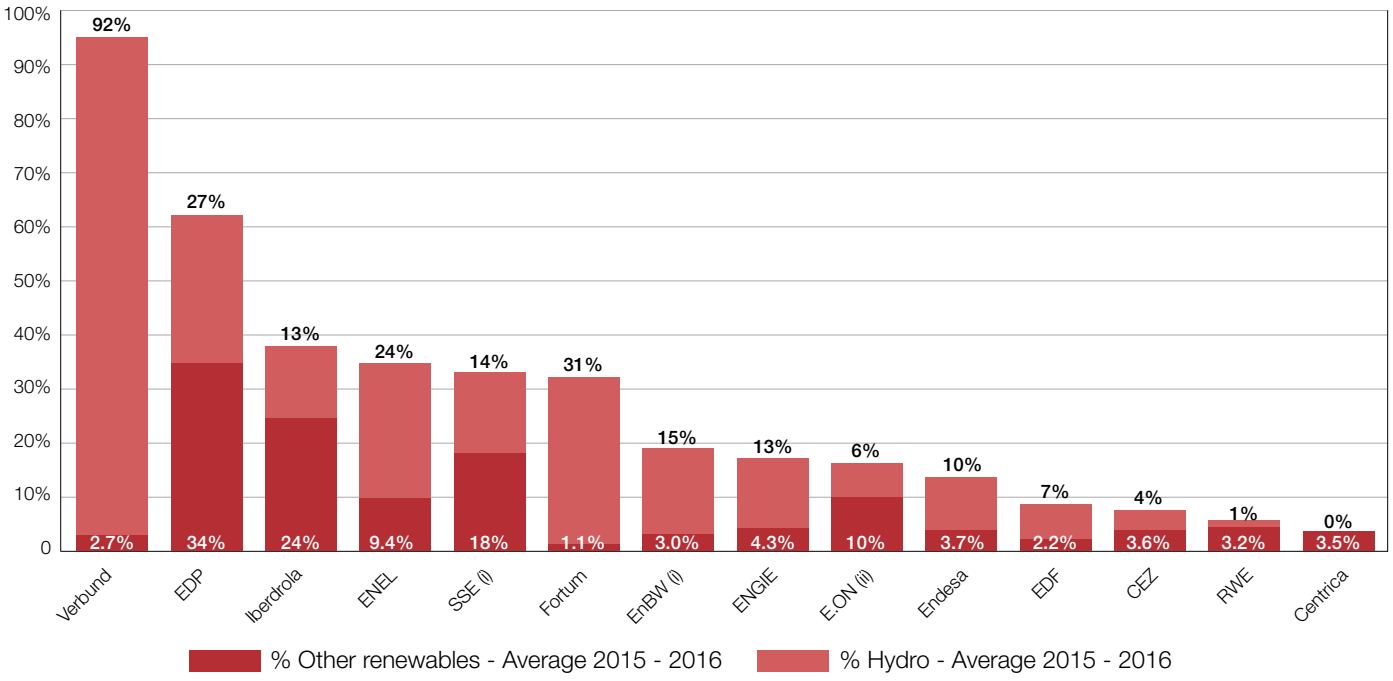
Decentralized energy – a smarter distribution network

Energy distribution grids are shifting from unidirectional centralized power systems towards more distributed, dynamic and digitized networks. With the share of variable renewable energy increasing, flexibility of grid infrastructure will be essential, which is underpinned by storage, demand response and interconnection.

Companies are targeting a new market of services and technologies such as: the Internet of Things (IoT), transactive energy, distributed energy resources (DER), smart buildings, data management and electric transportation. However, utilities are now in direct competition with various other sectors – telecoms, manufacturers, internet service providers, technology companies – all looking to establish a footprint in the value chain and improve their market position (e.g. Google's acquisition of Nest, Tesla's acquisition of SolarCity).

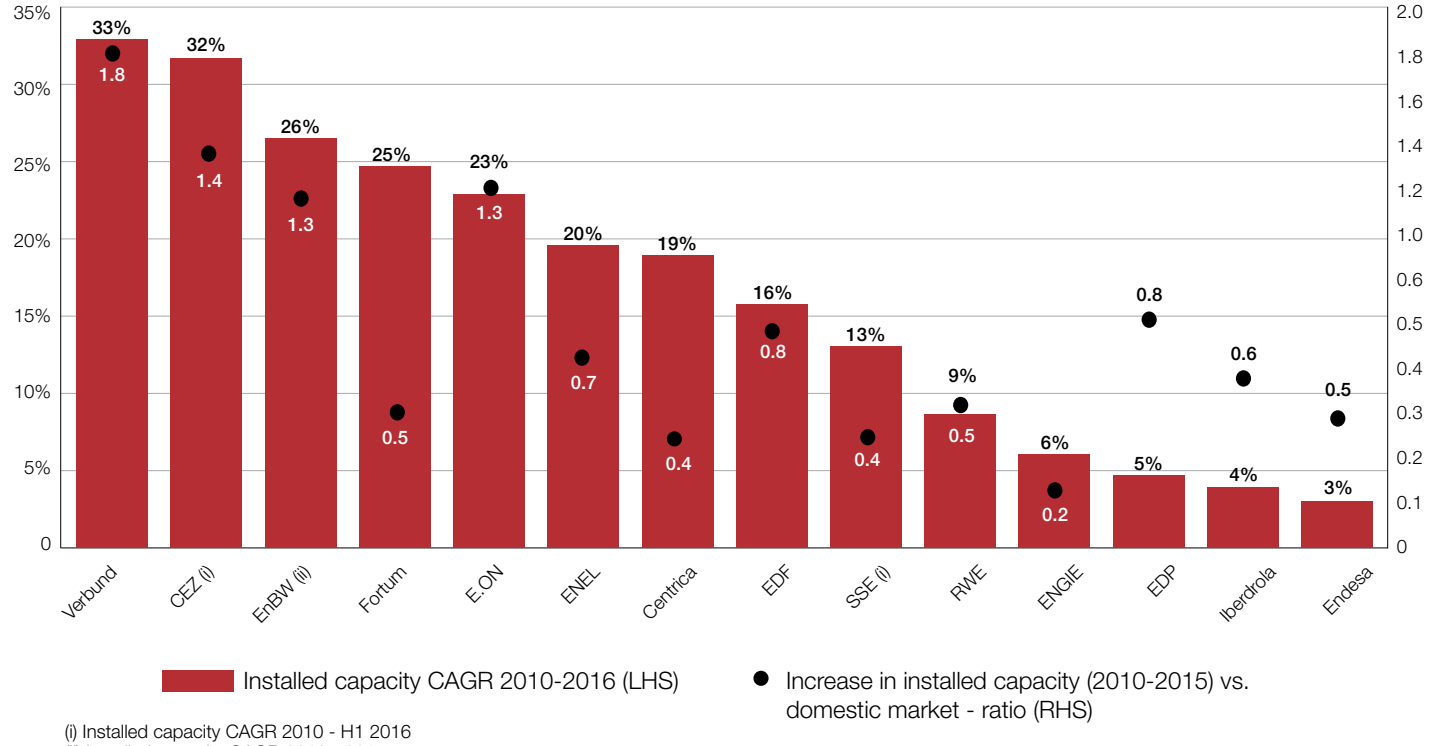
Residential, commercial and industrial energy consumers in Europe are becoming more actively involved in energy generation and management, choosing to install DER for example. Utilities need to innovate and adapt, and be prepared for a more connected and personalized customer relationship with more complex end-user demands.

Figure 32: Generation from renewables



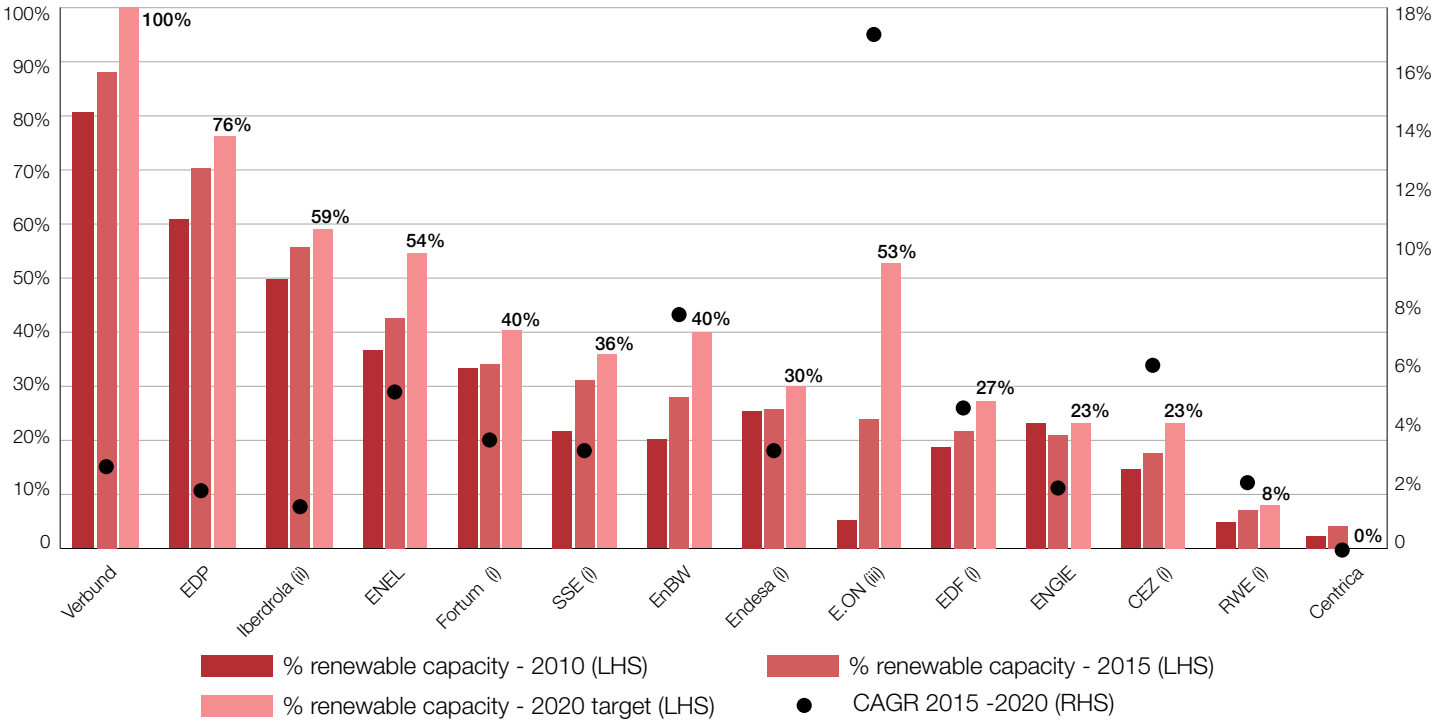
(i) Average of 2015 and H1 2016
(ii) For E.ON Hydro is 2015 only
Source: CDP, company reports

Figure 33: Change in installed capacity for other renewables



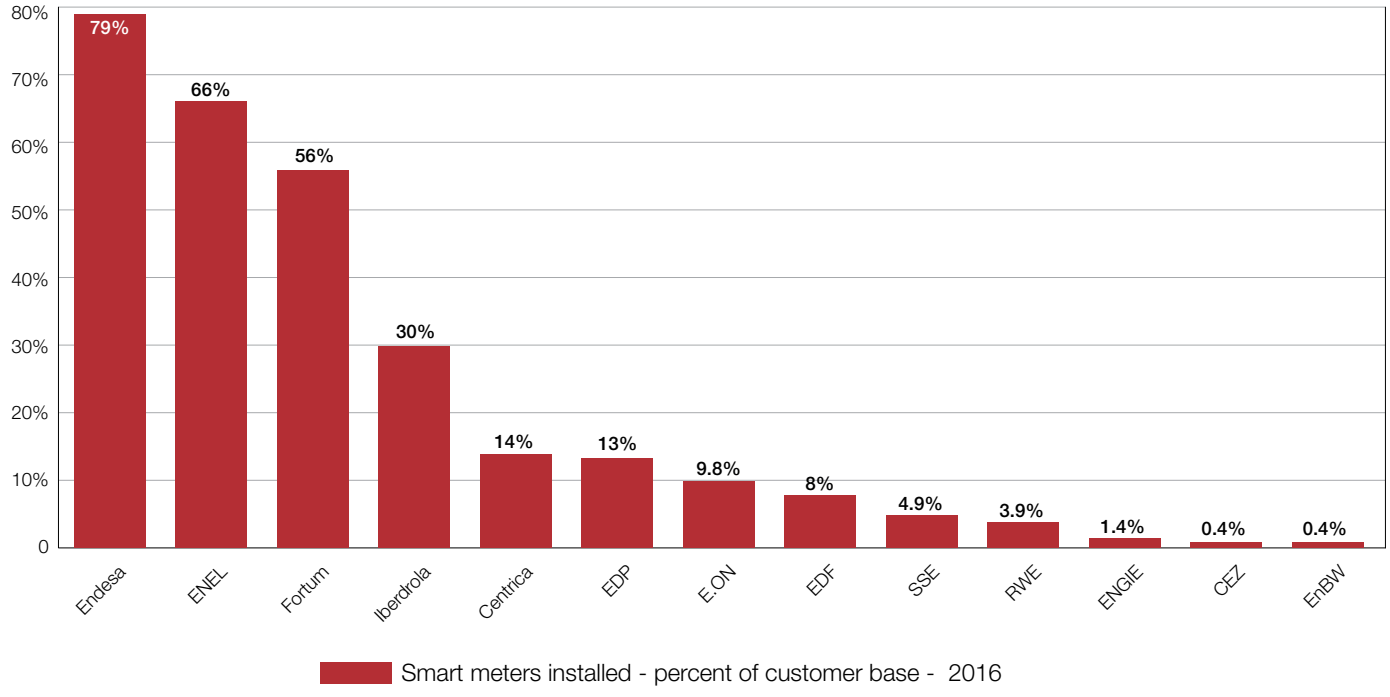
(i) Installed capacity CAGR 2010 - H1 2016
(ii) Installed capacity CAGR 2010 - 2015
Source: CDP, company reports, Eurostat, BP Statistical Review 2016

Figure 34: Renewable targets



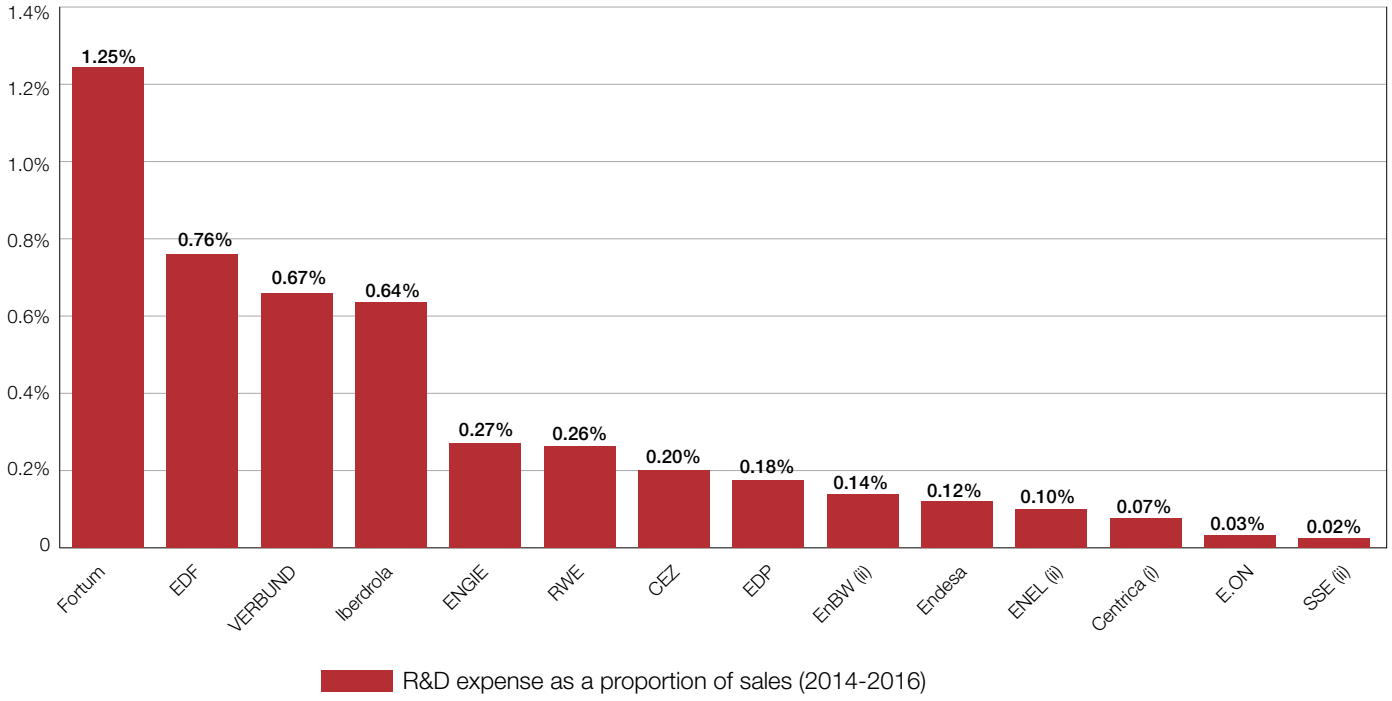
(i) Calculated from planned renewable capacity additions.
(ii) Generation target converted to capacity target using equivalent % increase.
(iii) Target based on plan to divest share of Uniper by 2020.
Source: CDP, company reports

Figure 35: Smart meters installed – percent of customer base



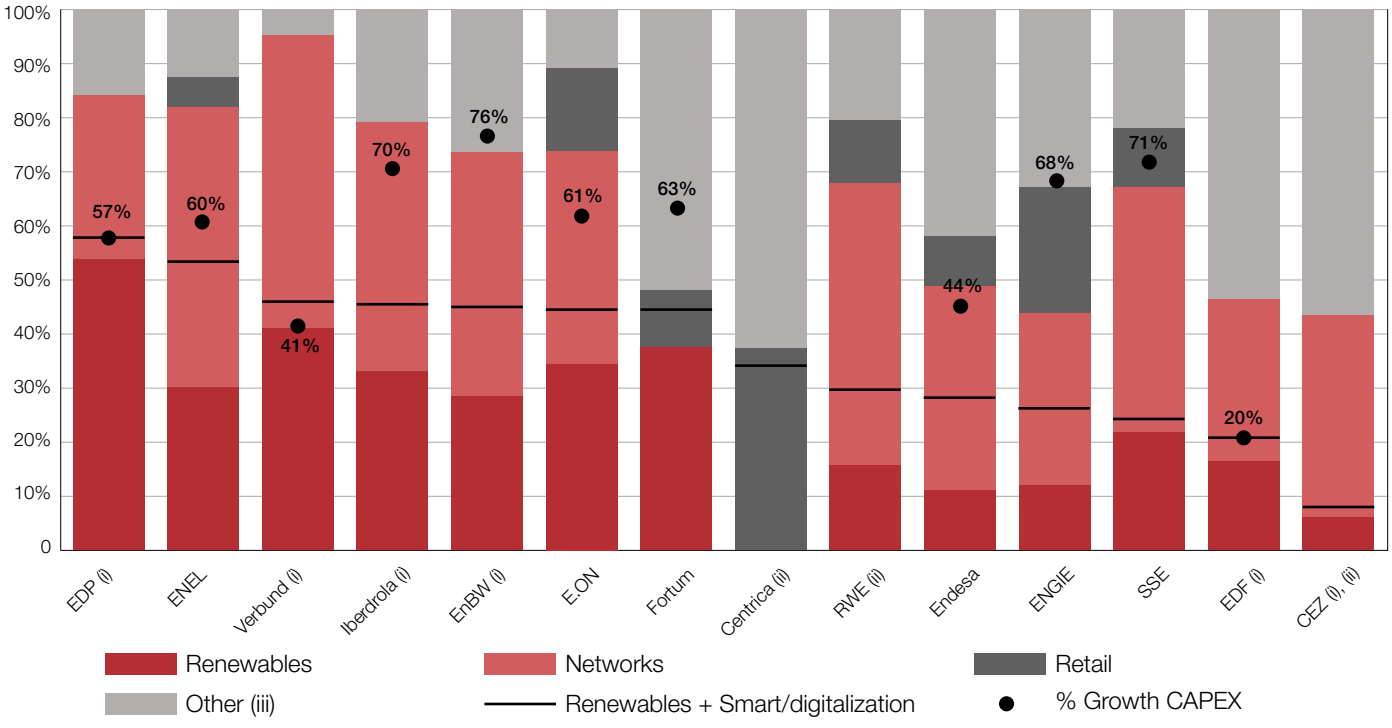
Verbund not included - no data available
Source: CDP, company reports

Figure 36: Research and development expense as a proportion of sales



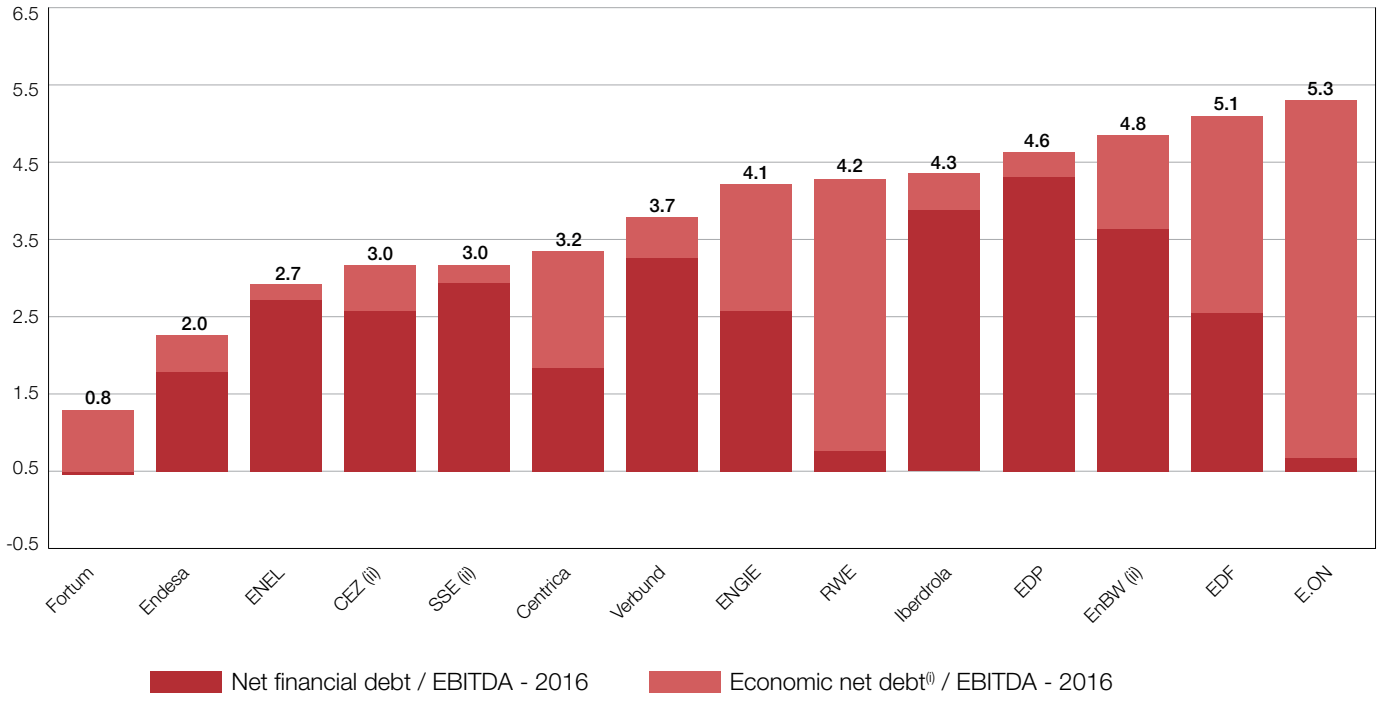
(i) R&D figure based on Centrica Innovations budget. Normalized by sales in 2016.
(ii) For 2014-2015
Source: CDP, Company reports

Figure 37: Future CAPEX split



(i) Split not available; "Other" contains retail
(ii) % Growth CAPEX value not available
(iii) Other may contain thermal generation, E&P, other non-specified
Source: CDP, company reports

Figure 38: Economic net debt/EBITDA



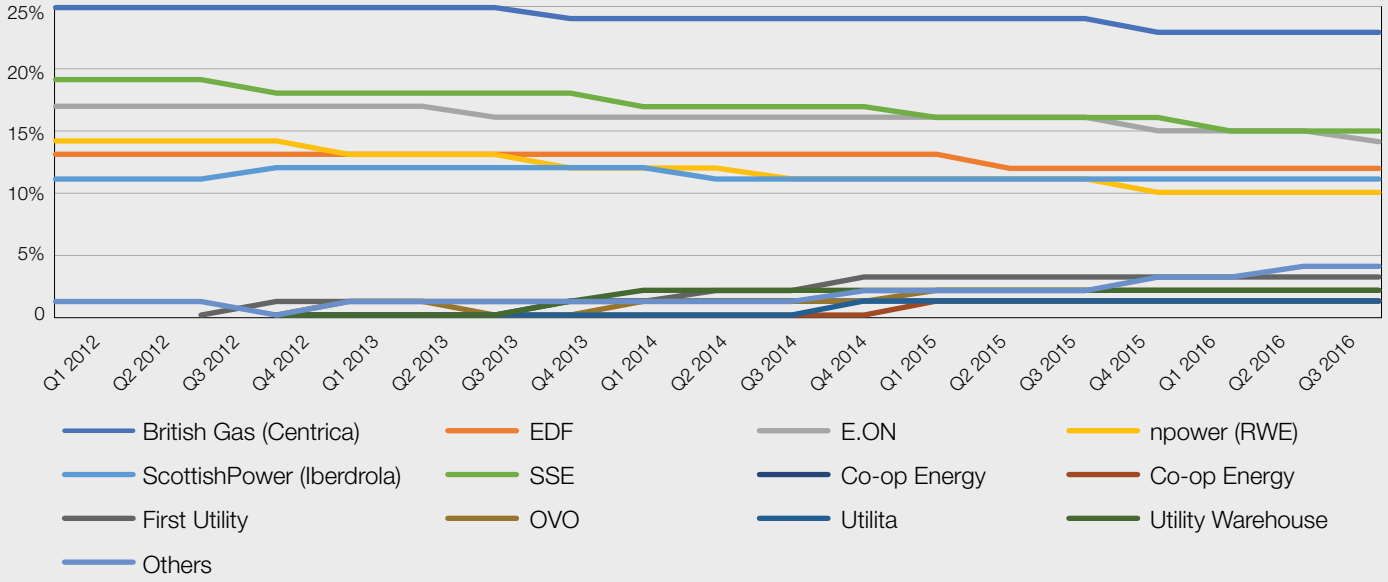
(i) Economic net debt = net financial debt + provisions for pensions + provisions for asset retirement obligations
(ii) Values at Q3 2016 for CEZ and EnBW and H1 2016 for SSE
Source: CDP, company reports

Customers have the power – customer satisfaction and retention

New customer demands are already transforming the European utility market. A more digital, connected and personal customer relationship is developing, and distributed energy resources (DER) and localized battery storage are allowing customers to become more self-sufficient.

With competition from new disruptive service providers on the rise, customer satisfaction becomes increasingly important to maximize client retention. Figure 39 reveals the competitive pressure felt by the 'Big Six'[27] in the UK electricity market – in 2012 other suppliers held a market share of below 2% but this reached a combined 15% in Q3 2016.

Figure 39: UK electricity supply market shares

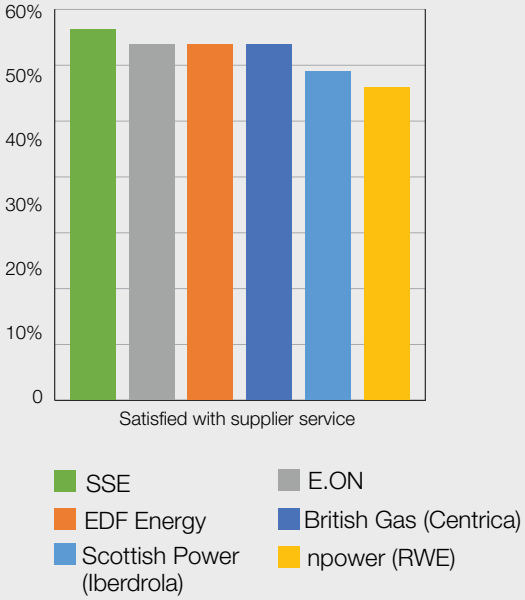


Source: Ofgem

Traditional utility business models need to adapt to this new environment and companies need to offer innovative products and bespoke services. More customers, both residential and industrial, are seeking to manage their energy usage and costs, as well as control the type of energy they purchase. Many corporations have significant sustainable energy consumption targets, as demonstrated by the RE100 initiative[28].

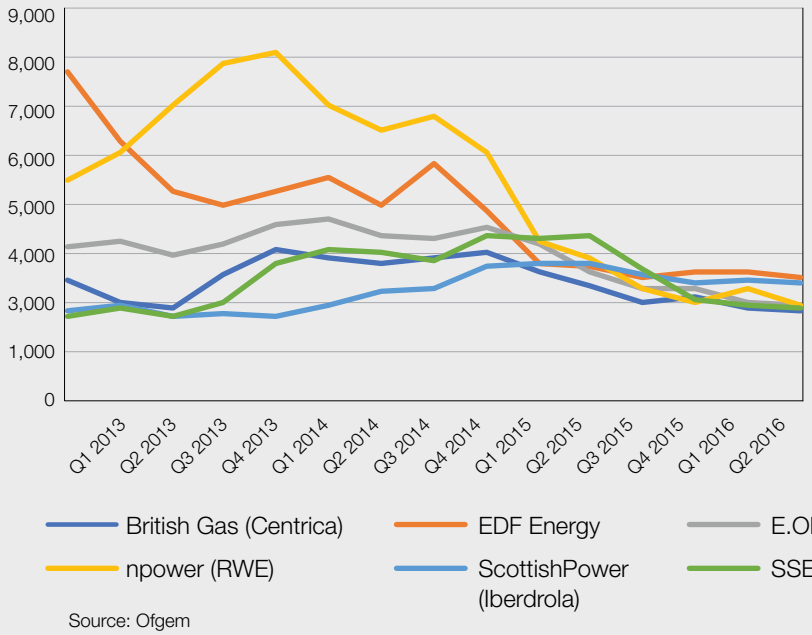
Improved customer focus will be essential to successfully manage both business to consumer (B2C) and business to business (B2B) relationships. Companies will need to place increasing importance on customer satisfaction metrics such as those measured by Ofgem in the UK, as illustrated in Figures 40 & 41.

Figure 40: Customer satisfaction in 2016 for UK electricity suppliers



Source: Ofgem

Figure 41: Complaints received per 100,000 customer accounts



Source: Ofgem

27. The 'Big Six' includes British Gas (Centrica), EDF Energy, npower (RWE), E.ON, Scottish Power (Iberdrola) and SSE.
28. RE100 is a collaborative, global initiative of influential businesses committed to 100% renewable electricity: http://there100.org/

Climate governance & strategy

- Iberdrola ranks first overall. It has a target for zero emissions from power generation by 2050, the largest proportion of short-term CEO bonus incentivized by climate metrics and the largest identified proportion of board-level climate experts.
- CEZ ranks last, due to lack of disclosure of many key metrics and a weak emissions reduction target. RWE is second from bottom, performing poorly across most indicators.
- Only EDP out of the 14 companies has climate-linked performance metrics in its CEO's long term remuneration, indicating a lack of alignment between long term low carbon strategy and financial incentives. Also, just four of the 14 companies have individuals with identified climate change expertise on their boards despite the major financial risks that climate change could pose.

Overview

On a national and Europe-wide scale, energy transition policies are setting a clear course towards decarbonization of electricity supplies. The EU ETS, Germany's Energiewende, and the UK's decision to close all coal fired power plants by 2025 are all examples of energy transition polices which are requiring major strategic changes at EU electric utilities. There is also a growing awareness of the need for all sectors to put in place climate risk management strategies and disclose to investors and stakeholders to a much higher standard on climate risk and strategy than has been the case in the past. In particular, the G20 Financial Stability Board's Task Force on Climate-related Financial Disclosures has recently published draft recommendations, which could become the basis for nationally recommended or even mandated disclosures on climate going forward.

In this chapter, we assess how companies are planning for a low carbon future through aligning their strategy with the risks and opportunities presented by the low carbon transition. We rank companies on their climate governance and strategy using the following key metrics:

- **Metric 1) Emissions reduction targets:** We assess each company's carbon reduction targets against the utility industry's 2°C transition pathway, guided by the Sectoral Decarbonization Approach, and measure progress in achieving stated targets.
- **Metric 2) Board climate responsibility:** This metric measures the percentage of board members with identified climate expertise. It also assesses the level of engagement of board members with climate issues and the disclosure of how climate change risks are managed throughout the organization, from board to operational level.
- **Metric 3) Climate-related remuneration:** This assesses the extent to which executive remuneration at companies is linked to climate-related metrics. It is divided into the short term operational performance focus (annual bonus) and the longer term strategic focus (long term incentive plan).
- **Metric 4) Low carbon strategy:** This metric evaluates the steps taken by companies to address possible climate risks and incorporate climate risks into their annual reporting.
- **Metric 5) Use of an internal carbon price:** This metric is used to identify the extent to which the potential for higher carbon prices are incorporated into future capital expenditure plans and other key business decisions.
- **Metric 6) CDP Score:** For a company's response to the CDP climate change information request, assesses the level of detail and comprehensiveness of the content, as well as awareness of climate change issues, management methods and progress towards action taken on climate change.
- **Metric 7) Carbon regulation supportiveness:** We use InfluenceMap analysis to assess companies on their stance on climate change and how they seek to influence climate policy and legislation, either directly or through trade bodies [29].

29. InfluenceMap is a UK-based not-for-profit whose remit is to map, analyze and score the extent to which corporations are influencing climate policy and legislation. scores companies in two ways: i) Organizational score: represents the stance a company takes in influencing climate policy and legislation as well as its transparency of positions on key climate issues, and ii) Relationship score: represents the strength of a company's relationships with trade bodies or other entities and its ability to influence climate policy and legislation. The two scores for each company are combined to produce a total score which ranges from 0 (complete opposition to carbon regulation) to 100 (fully supportive of carbon regulation) with 50 representing a relatively neutral stance. See http://www.influencemap.org for additional details.

Figure 42: Climate governance and strategy summary

Company	Emissions reduction targets	Board climate responsibility	Climate-related remuneration	Low carbon strategy	Use of internal carbon price	CDP Score	Carbon regulation supportiveness	Overall weighted rank	Climate governance & strategy rank	Climate governance & strategy grade
Iberdrola	4	1	2	1	1	A	4	3.5	1	A
EDP	5	5	1	7	1	A	3	4.5	2	B
Verbund	1	14	6	1	10	A	5	5.1	3	B
EDF	3	3	6	4	6	A	8	5.3	4	B
Enel	8	7	6	1	4	A	6	5.4	5	B
Centrica	2	10	6	7	8	A	9	6.0	6	C
SSE	9	4	4	7	11	A-	1	6.3	7	C
ENGIE	11	2	3	12	6	A	9	7.1	8	C
EnBW	6	11	6	4	14	B	2	7.2	9	C
E.ON	10	9	6	7	3	A-	7	7.5	10	C
Fortum	6	6	6	12	8	A-	11	8.1	11	D
Endesa	12	8	6	4	4	B	13	8.8	12	D
RWE	14	13	5	7	11	B	14	10.1	13	E
CEZ	12	12	6	14	13	D-	12	11.1	14	E
Weighting	**35%**	**10%**	**10%**	**10%**	**10%**	**10%**	**15%**			

Note: In calculating the weighted rank in this table, we use the weighted ranks for each area (where relevant).
We display non-weighted ranks in this summary for simplicity only.
Source: CDP

Highlights

Emissions reduction targets

- To achieve its part of a 2°C transition, the GHG emissions intensity of EU power generation would have to fall sharply, by 67% by 2030 and 97% by 2050.
- All 14 utilities reviewed have emissions reduction targets in place, but with strikingly different levels of ambition and compatibility with needs implied by the science.
- Verbund, Enel and EDP have proactive targets, validated by the Science Based Targets Initiative as compatible with a 2°C transition. Endesa and Iberdrola also have targets for near complete decarbonization of power generated by 2050, though it is less clear their targets are compatible with nearer term needs for emissions reduction or needs to reduce emissions from other parts of their operations including Scope 3 emissions.
- RWE and CEZ have the weakest targets, implying significantly higher emissions over coming years than required from EU power generators for a 2°C transition. Their targets also extend only as far as 2020. There is significant need to increase the ambition of these targets.
- EDP has a strong target, approved as compatible with the 2°C sector decarbonization pathway. However, it ranks poorly on target achievement. In 2016 it introduced a target for 55% reduction between 2015-2030, weaker than an earlier target of 70% reduction between 2008-2020 after making slower than expected progress. Enel and SSE are also off target relative to a linear decarbonization path toward their target level and will need to make up ground in later years to achieve targets.
- Centrica and SSE's targets imply the fastest yearly progress in reducing emissions per unit of electricity generated, but are from higher starting points than many other companies.
- EDF and Fortum targets imply no further decarbonization, set at emissions intensity levels they had already achieved. Though they provide a commitment not to increase emissions, these targets lack ambition.
- Endesa discloses multiple targets which imply differing levels of ambition. Its 2050 target is to reduce emissions from electricity generation to zero, but its 2019 target implies a slower rate of decarbonization than many others assessed.
- Many companies' targets expire by 2020 or earlier. Given the industry will need to achieve considerable further emissions reduction beyond 2020 to remain consistent with a 2°C transition, investors may wish to engage with companies to encourage the setting of new long term science-based targets.

Figure 43: Emissions reduction targets summary

Company	SBTI approved/committed rank	Quality of target vs 2DS pathway rank	Implied yearly emissions intensity reduction rank	Performance against target rank	Overall weighted rank	Overall rank
Verbund	1	1	12	2	3.4	1
Centrica	6	5	2	1	3.8	2
EDF	6	2	13	3	5.2	3
Iberdrola	4	4	10	6	5.6	4
EDP	1	6	3	14	6.0	5
Fortum	6	3	13	7	6.4	6
EnBW	6	8	6	4	6.4	6
Enel	1	7	7	12	6.8	8
SSE	4	9	1	13	7.2	9
E.ON	6	10	8	8	8.4	10
ENGIE	6	11	4	11	8.6	11
Endesa	6	12	9	9	9.6	12
CEZ	6	13	11	5	9.6	12
RWE	6	14	5	10	9.8	14
Weighting	**20%**	**40%**	**20%**	**20%**		

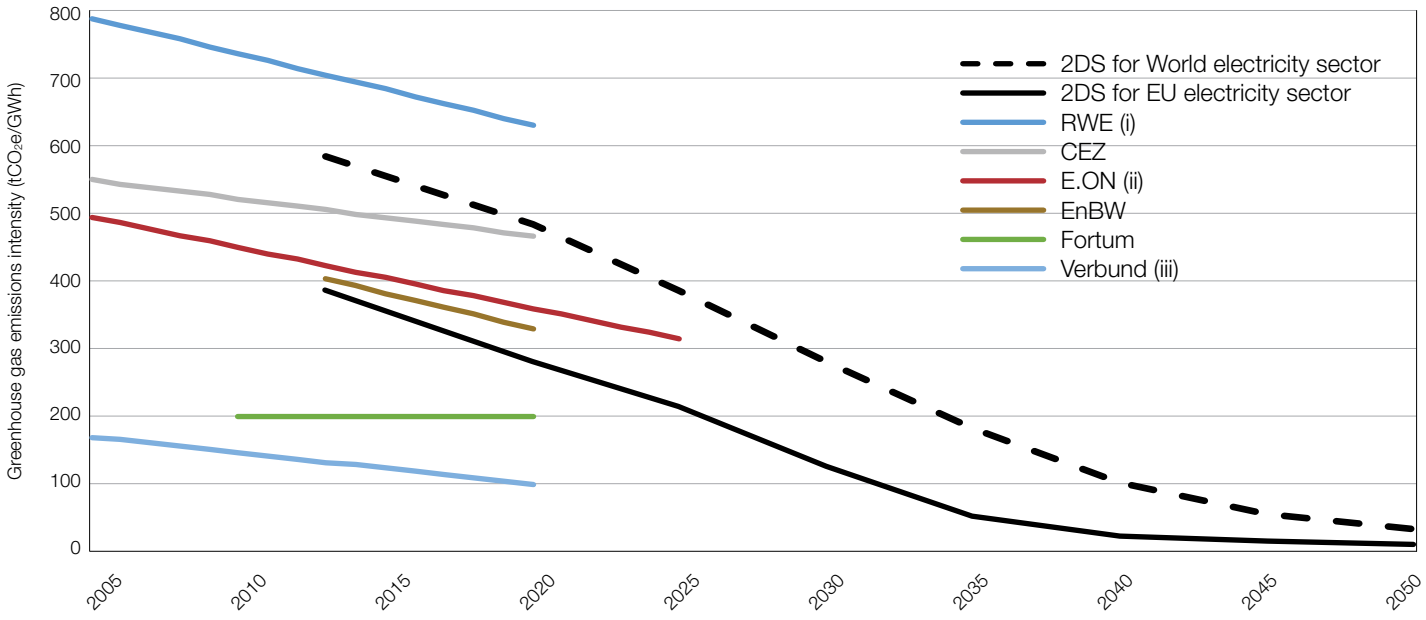
Source: CDP

Figure 44: Targets approved by the Science Based Targets Initiative

Company	Has an approved science based target?	Approved science based target details
EDP	Approved science based target	EDP commits to reduce Scope 1 and 2 emissions from electricity production 55% per TWh by 2030, from 2015 levels. The company also commits to reduce absolute Scope 3 emissions 25% over the same time period.
Enel	Approved science based target	Enel commits to reduce CO_2 emissions 25% per kWh by 2020, from a 2007 base-year. The target includes the decommissioning of 13 GW of fossil power plants in Italy, and is a milestone in the long term goal to operate in carbon neutrality by 2050.
Verbund	Approved science based target	Verbund commits to reduce GHG emissions 90% by 2021 from a 2011 base-year (Scope 1, Scope 2, and Scope 3 emissions from fuel-and-energy related activities and business air travel). This is a milestone in the long term goal to achieve carbon neutrality by 2050.
Iberdrola	Committed companies	
SSE	Committed companies	

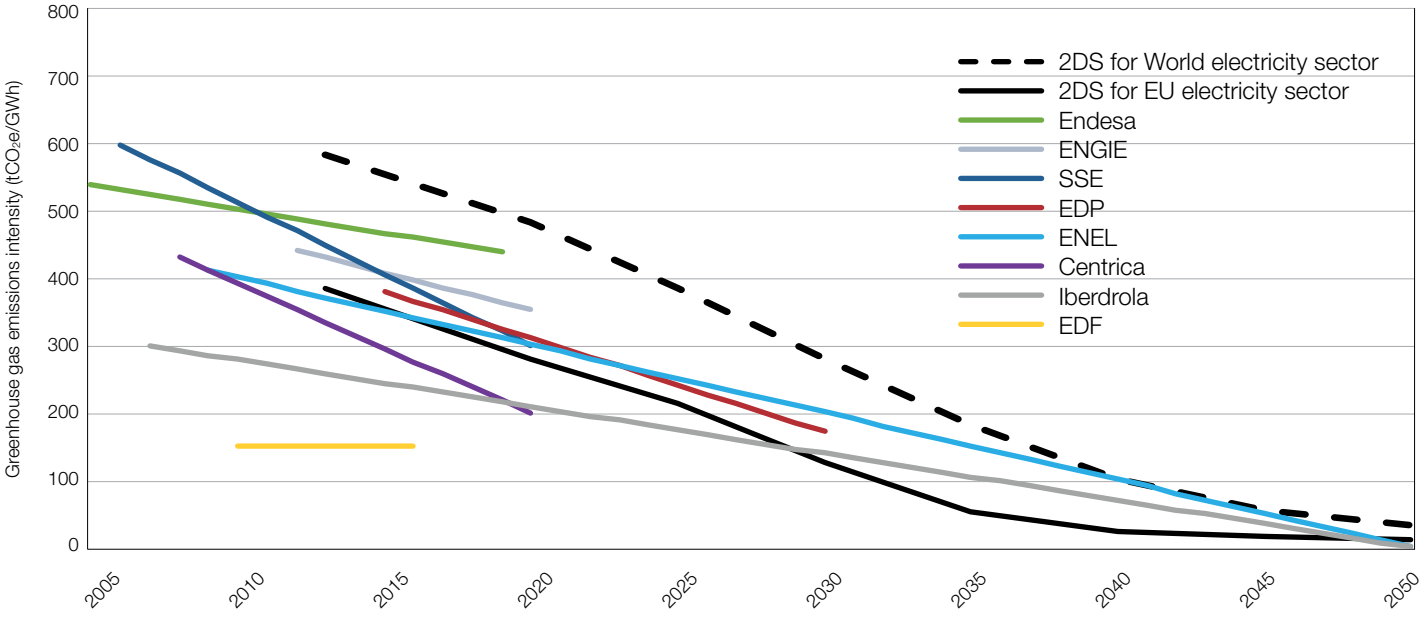
Source: Science Based Targets Initiative

Figure 45: Intensity-based targets - Germany, Northern, & Eastern Europe focused utilities



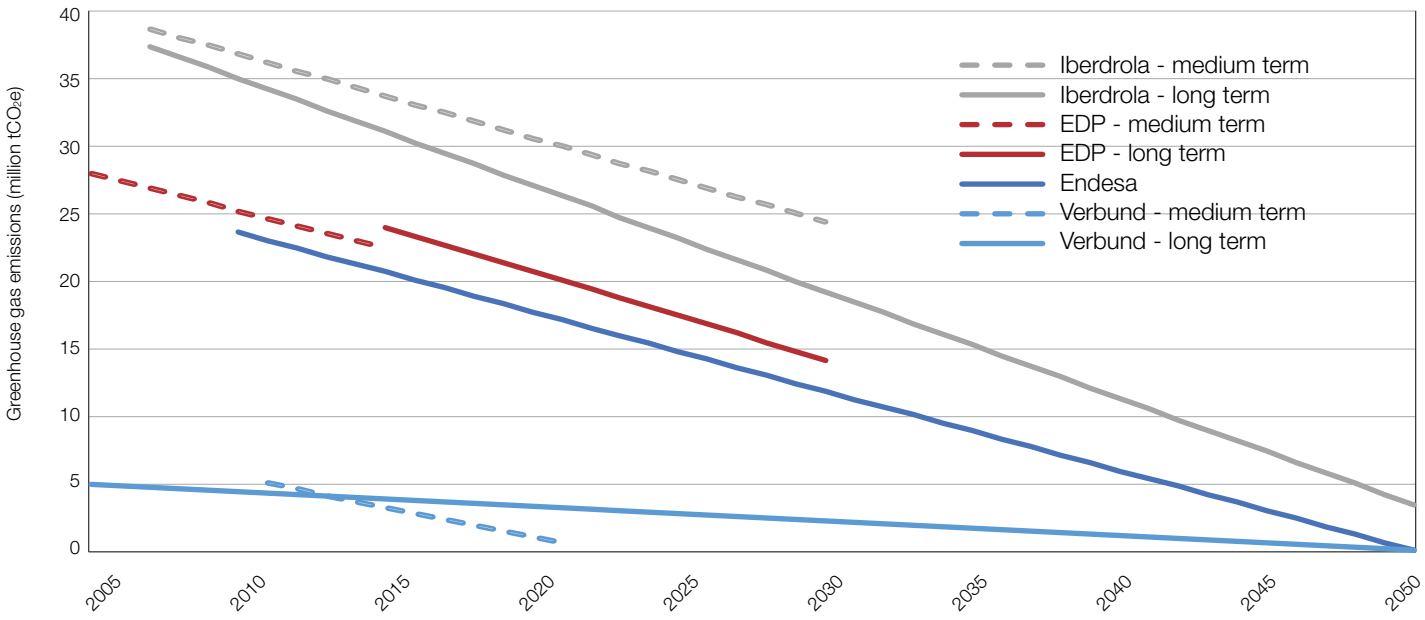
(i) Pre-Innogy split
(ii) Europe operations only, pre-Uniper split
(iii) Absolute target converted to intensity
Source: CDP, company reports

Figure 46: Intensity-based targets - Southern & Western Europe focused utilities



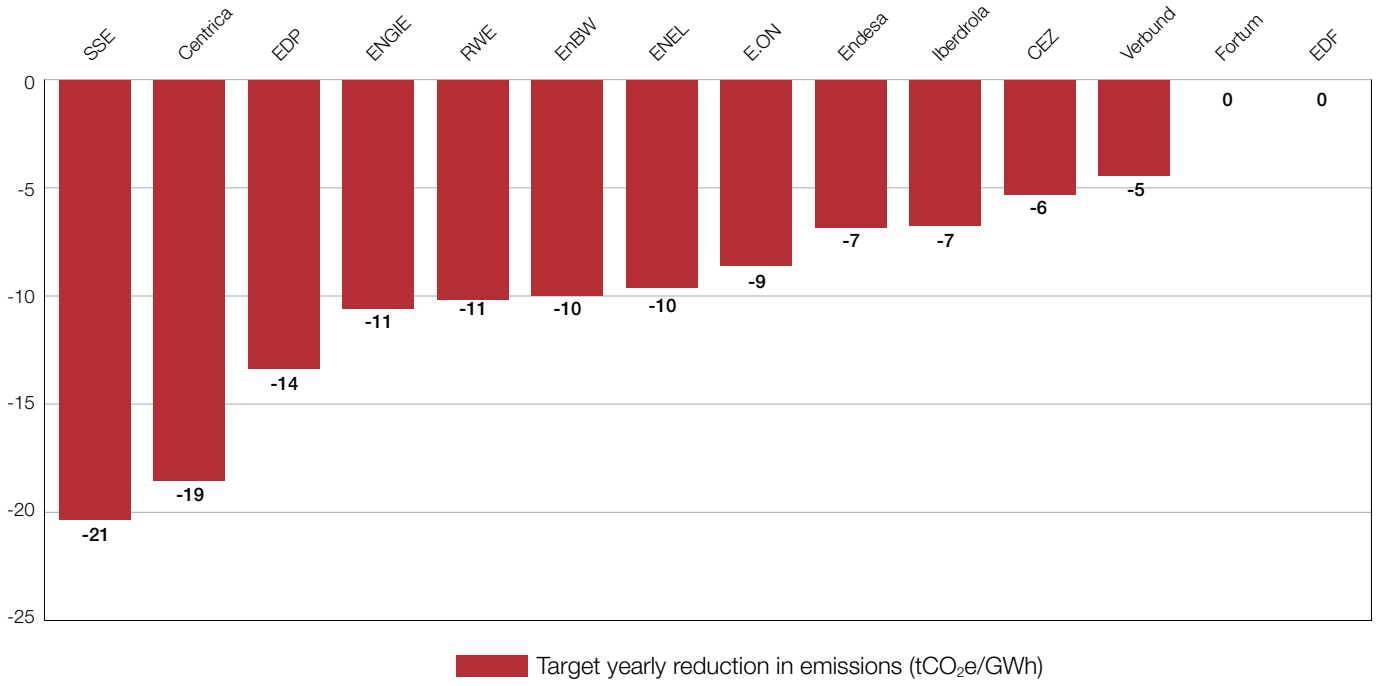
Source: CDP, company reports

Figure 47: Absolute emissions reduction targets



Source: CDP, company reports

Figure 48: Targeted yearly reduction in emissions (tCO_2e/GWh)

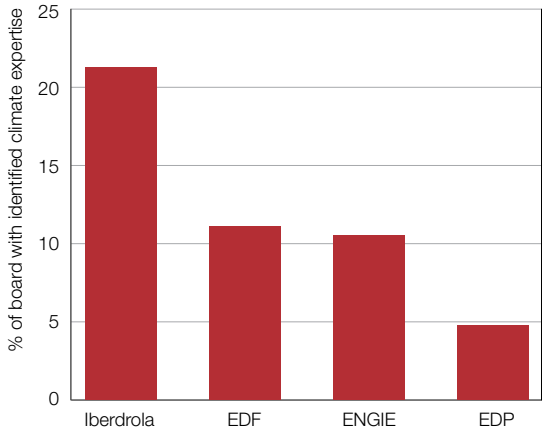


Source: CDP, company reports

Board climate responsibility

- Iberdrola, EDF, ENGIE and EDP are the only four companies that have identified climate expertise on their boards.
- EDF board member Bruno Lechevin is the President of ADEME, France's environment and energy management agency. The company has the Director of Energy of France's Ministry of Environment, Energy and Sea attending board meetings with advisory capacity. ENGIE also has a commissioner of the French Department of Climate and Energy assisting the meetings of the board.
- Until 2016 Fortum had a board member whose main occupation was Secretary-General of the World Meteorological Organization. Currently however, Fortum has no identified board level climate expert.
- SSE gives the clearest picture of how climate change management and responsibility is integrated into its organizational structure. The Executive Committee implements the sustainability policy as agreed by the Board and monitors progress against specific sustainability targets and initiatives. There are seven sub-committees which assist in the effective management of these initiatives e.g. key environmental and energy efficiency targets are monitored by the Safety, Health, Environment Audit Committee.
- There is good disclosure of climate risk management at Iberdrola. The CSR Committee reviews climate change policy and at operational level the Sustainability Management Team maintains numerous emission targets. The Sustainability Management Team is led by the Chief Sustainability Officer who reports the teams' actions to the Board at least quarterly.
- At E.ON, the CEO is also the Chief Sustainability Officer. He chairs both the Sustainability Council and the Health, Safety & Environment (HSE) Governance Council.

Figure 50: Proportion of board members with identified climate expertise



Source: CDP, company reports

Figure 49: Board responsibility and management

Company	Is it clear where the highest level of responsibility resides?	Is this with the board, a board committee or the EMT?	Is there a board level committee with CC responsibilities?	Who is this chaired by?	Climate change management rank	Climate change responsibility disclosure rank	Overall weighted rank	Board responsibility rank
SSE	Yes	Board	Yes	Board member	4	1	1.8	1
Iberdrola	Yes	Board committee	Yes	Board member	4	2	2.5	2
Engie	Yes	Board committee	Yes	Chairman	1	5	4.0	3
Fortum	Yes	Board	No	N/A	9	3	4.5	4
EDF	Yes	Board committee	Yes	Board member	4	6	5.5	5
Enel	Yes	Board committee	Yes	Chairwoman	1	7	5.5	5
Endesa	Yes	EMT	No	N/A	11	4	5.8	7
EDP	Yes	Board committee	Yes	Chairman	1	8	6.3	8
E.ON	Yes	EMT	Yes	CSO	4	9	7.8	9
Centrica	Yes	Board	Yes	Board member	4	11	9.3	10
EnBW	Yes	EMT	No	N/A	11	10	10.3	11
CEZ	No	Board	No	N/A	11	12	11.8	12
RWE	No	EMT	No	N/A	14	13	12.0	13
Verbund	No	EMT	No	N/A	14	13	13.3	14
Weighting					**25%**	**75%**		

Source: CDP, company reports

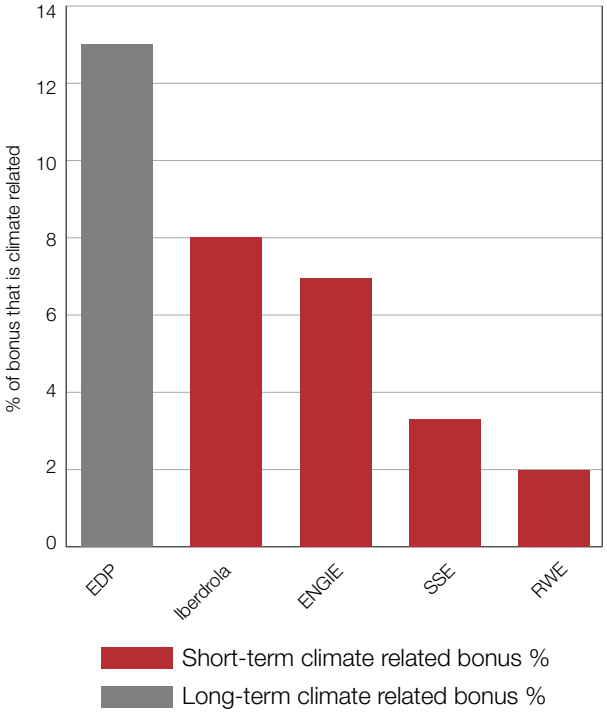
Climate-related remuneration

- We have identified five companies where the CEO has climate-linked performance metrics in their short-term bonus schemes. The highest proportion of the short term or annual bonus linked to climate related factors is 8% at Iberdrola. Climate-linked performance metrics include emission intensity reduction targets and renewable energy production targets.
- EDP is the only company identified as having climate linked metrics in their CEO's long term bonus scheme. 13% of the long-term bonus is linked to the 'sustainability index applied to the EDP group' which focuses on metrics such as the effectiveness of climate change strategies.
- Changes to annual bonus schemes between 2015 and 2016 led to a lower emphasis on climate change in a number of cases. The weightings of climate related metrics as a proportion of annual bonuses fell at Iberdrola from 22% to 8%, RWE from 9% to 2% and EDP from 7.5% to 0%.

Low carbon strategy

- Endesa, Enel, Iberdrola and Verbund are all committed to carbon neutrality by 2050.
- All companies identify climate related risks in the risk management sections of their annual reports.
- Seven of the 14 companies present climate related KPIs in the key figures/highlights sections of their annual reports, indicative of them being areas of key strategic focus. This includes carbon emission figures and installed renewables capacity.
- All companies except CEZ report discussing climate risks with their board, consider climate-related risks in all geographical areas and assess climate-related risks further than six years into the future.

Figure 52: Climate-related CEO remuneration



Source: CDP, company reports

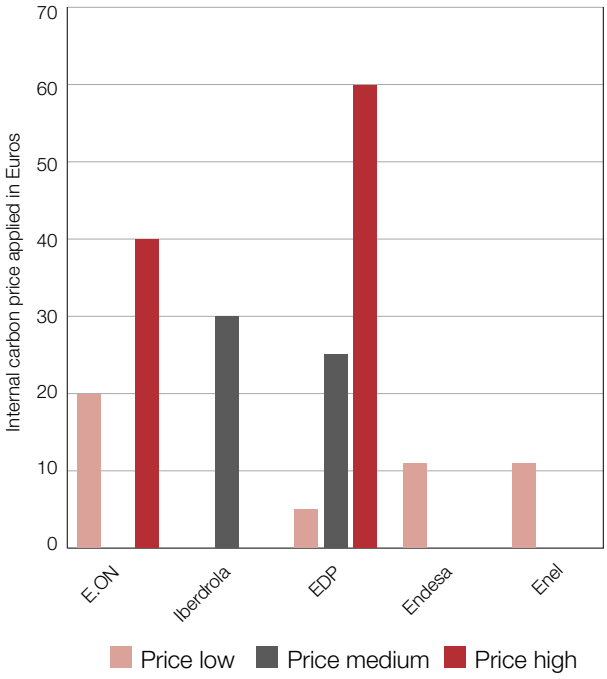
Figure 51: Low carbon strategy and risk scorecard

Companies	Climate risks identified within main risks in annual reporting	Climate risks discussed at board level	Climate risks considered in all geographical areas	Climate risks considered 6 or more years into the future	Climate risks evaluated six-monthly or more frequently	Climate related KPIs in "Key figures" of annual reporting	Carbon Neutral by 2050	Total	Rank
Enel	✓	✓	✓	✓	✓	✓	✓	7	1
Iberdrola	✓	✓	✓	✓	✓	✓	✓	7	1
Verbund	✓	✓	✓	✓	✓	✓	✓	7	1
EDF	✓	✓	✓	✓	✓	✓	✗	6	4
EnBW	✓	✓	✓	✓	✓	✓	✗	6	4
Endesa	✓	✓	✓	✓	✗	✓	✓	6	4
Centrica	✓	✓	✓	✓	✓	✗	✗	5	7
E.ON	✓	✓	✓	✓	✓	✗	✗	5	7
EDP	✓	✓	✓	✓	✗	✓	✗	5	7
RWE	✓	✓	✓	✓	✓	✗	✗	5	7
SSE	✓	✓	✓	✓	✓	✗	✗	5	7
Engie	✓	✓	✓	✓	✗	✗	✗	4	12
Fortum	✓	✓	✓	✓	✗	✗	✗	4	12
CEZ	✓	✗	✗	✗	✗	✗	✗	1	14

Internal carbon price

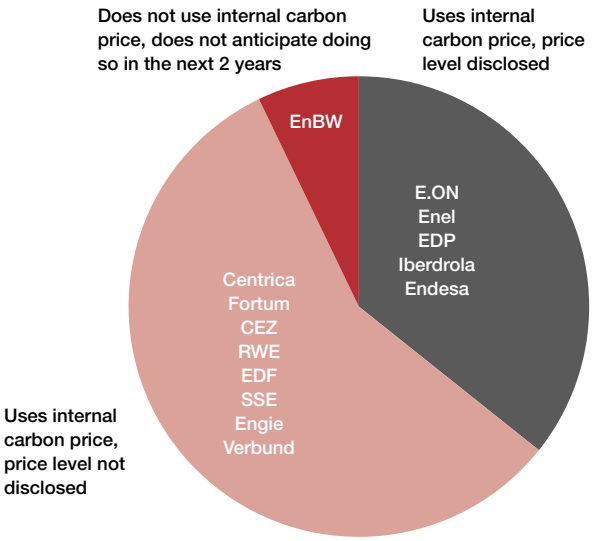
- All companies assessed except EnBW report that they apply an internal carbon price in capital investment decisions.
- Iberdrola, EDP, E.ON, Endesa and Enel are transparent on price levels applied (Figure 53), and apply multiple future carbon price scenarios to decision making, including ones with prices well above recent traded carbon prices in the EU ETS.

Figure 53: Internal carbon price applied



Source: CDP, company reports

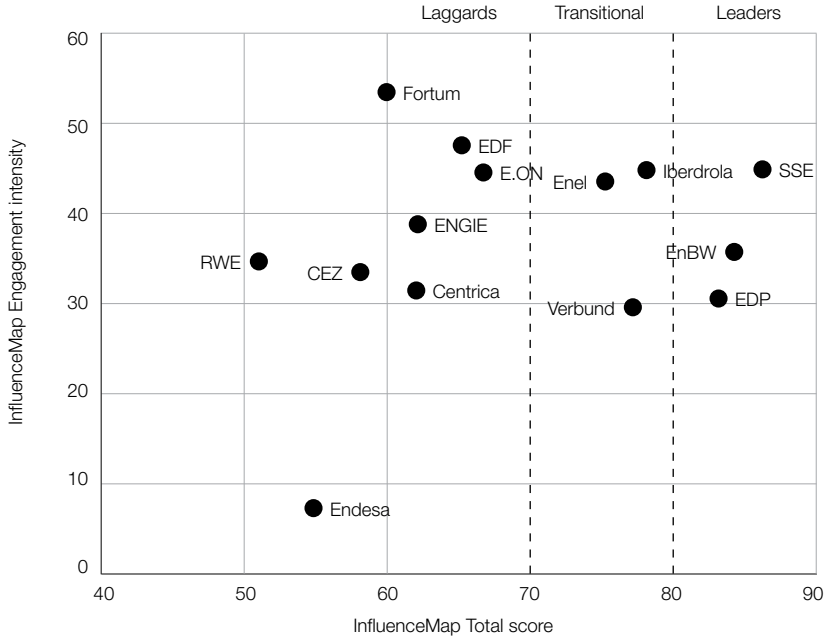
Figure 54: Use of an internal carbon price



Carbon regulation supportiveness

- The European electric utilities sector is the most active sector on climate policy engagement, according to InfluenceMap analysis. There has been a significant increase in support and engagement with low carbon polices following the Paris agreement at COP21 in late 2015.
- The European utility sector has supported strong GHG emission reduction targets in line with the ambitions of the UN Climate Treaty. Every company in the study was found to have supported carbon pricing and reforms to the EU ETS to reduce surplus allowances and increase the price of emissions permits. However, a number of utilities continue to resist specific low carbon policies and regulations.
- SSE, EDP and EnBW have demonstrated the clearest consistent support for low carbon policy at both national and EU level. SSE has actively supported the UK Carbon Price Floor and ambitious renewable energy targets in Scotland. EDP, having supported a mandatory '3 target' approach (emission reductions, renewables and energy efficiency) for the EU 2030 Climate and Energy package, has continued to lobby in support of EU renewable targets and support mechanisms. EnBW has called for more ambitious EU 2030 renewable energy and energy efficiency targets, as well as national level renewable targets.
- RWE and Endesa have been the least supportive of climate change policy, particularly domestic policies. Despite evidence of a softening of its opposition to renewable energy legislation, RWE actively supported the repeal of a levy on coal in Germany in 2015 and supports a continued role for coal in the energy mix. Endesa has not clearly communicated support for emissions reductions in line with IPCC recommendation, or the Paris Agreement.
- Enel demonstrate the clearest switch from lobbying against particular legislative items in the past to progressively becoming more supportive of some policy items, whilst becoming less vocally opposed on others e.g. senior executive Francesco Venturini called in April 2016 for a binding EU wide renewables target of 30% (up from 27%).
- Fortum, CEZ and Centrica have opposed EU renewable energy targets with Fortum, CEZ and ENGIE lobbying against renewable subsidies. E.ON oppose the UK Carbon Price Floor, while Verbund advocates against certain renewable energy support schemes. Both E.ON and Verbund disapprove of feed-in tariffs.

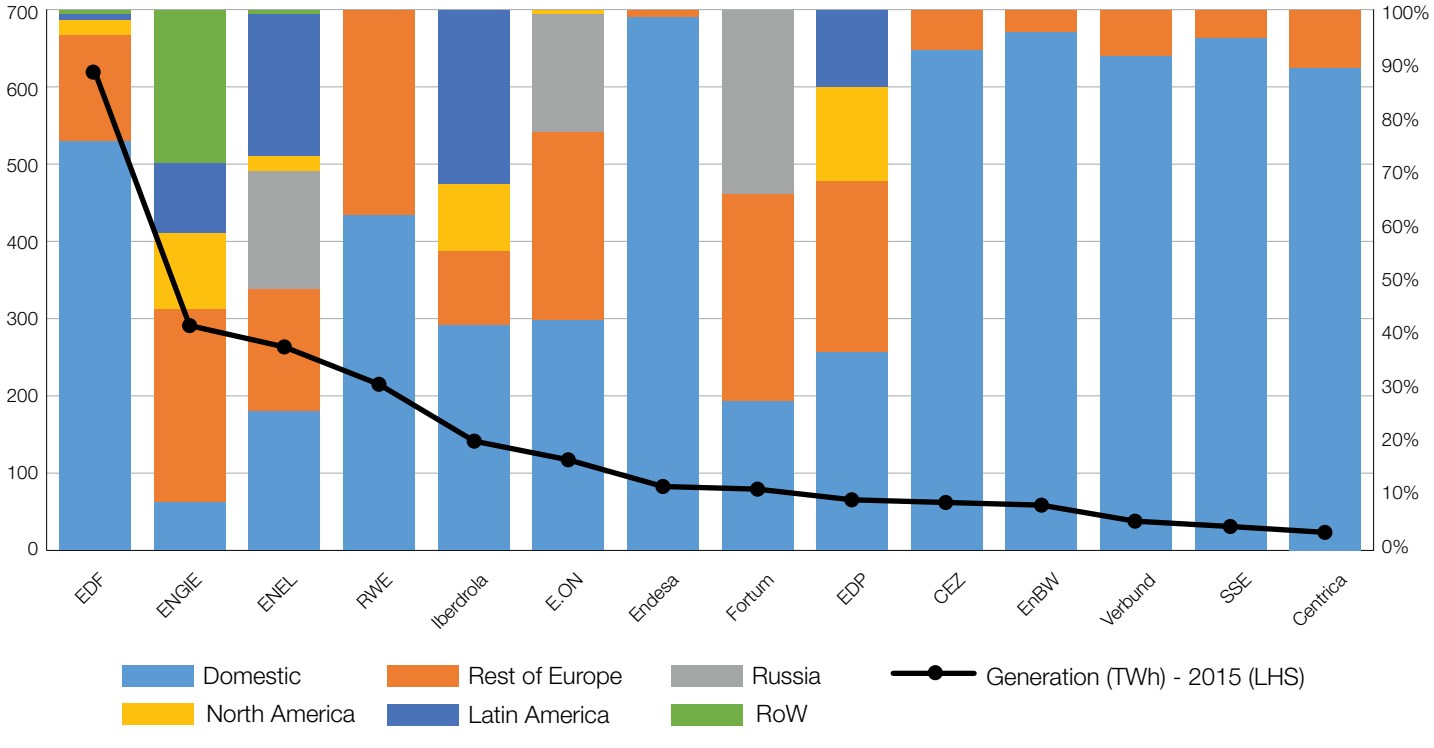
Figure 55: Carbon regulation supportiveness



Source: InfluenceMap[30]

Supplementary figures

Figure 56: Electricity generation split by region



Source: CDP, company reports

30. The 'engagement intensity' is a metric of the extent to which the company is engaging on climate change policy matters, whether positively or negatively. A low score indicates low levels of engagement with a higher score showing greater engagement with climate policies.

Company performance overview

			Transition risk					Physical risk				Transition opportunities						Climate governance and strategy								Total		
League Table Rank	Companies	Country	Transition risk rank	Emissions performance	Share of fossil fuels	Locked-in emissions	Carbon cover	Physical risk rank	Thermal asset water stress exposure	Hydro asset water stress exposure	Water risk management	Transition opportunities rank	Generation from renewables	Change in renewable capacity	Renewable targets	Smart services & Innovation	Capital flexibility & CAPEX strategy	Climate governance and strategy rank	Emissions reduction targets	Board climate responsibility	Climate related remuneration	Low carbon strategy	Use of internal carbon price	CDP score	Carbon regulation supportiveness	Green	Amber	Red
1	Verbund	Austria	1	1	2	1	4	1	1	4	4	3	9	1	1	6	6	3	1	14	6	1	10	1	5	13	4	2
2	Iberdrola	Spain	4	4	4	9	2	13	12	13	2	4	2	12	7	2	3	1	4	1	2	1	1	1	4	12	4	3
3	Fortum	Finland	5	5	5	10	3	3	5	2	8	6	13	6	6	1	2	11	6	6	6	12	8	8	11	4	12	3
4	Enel	Italy	8	8	11	4	9	14	13	12	7	1	4	5	3	5	1	5	8	7	6	1	4	1	6	8	7	4
5	SSE	UK	6	13	8	2	6	2	3	1	10	8	3	11	8	13	7	7	9	4	4	7	11	8	1	4	12	3
6	Centrica	UK	2	2	1	11	1	8	8	N/A	6	12	11	9	14	8	8	6	2	10	6	7	8	1	9	5	9	4
7	EDF	France	3	3	3	8	5	6	8	7	3	13	14	7	10	4	14	4	3	3	6	4	6	1	8	6	10	3
8	EDP	Portugal	11	7	7	13	8	11	11	10	9	2	1	8	4	7	5	2	5	5	1	7	1	1	3	7	9	3
9	E.ON	Germany	7	6	6	7	10	9	7	9	11	5	5	4	2	11	9	10	10	9	6	7	3	8	7	3	14	2
10	ENGIE	France	9	12	9	6	7	7	10	3	5	11	6	13	12	10	11	8	11	2	3	12	6	1	9	3	10	6
11	EnBW	Germany	13	9	10	12	12	4	2	5	13	7	10	3	5	14	4	9	6	11	6	4	14	11	2	4	7	8
12	Endesa	Spain	10	10	13	3	13	12	14	8	1	9	7	14	9	3	9	12	12	8	6	4	4	11	13	4	7	8
13	CEZ	Czech Republic	12	10	12	5	11	10	4	11	14	10	8	2	11	12	13	14	12	12	6	14	13	14	12	1	7	11
14	RWE	Germany	14	14	14	14	14	5	6	6	12	14	12	10	13	9	12	13	14	13	5	7	11	11	14	0	9	10
Weighting:		**Metric**		25%	25%	30%	20%		45%	25%	30%		25%	15%	15%	15%	30%		35%	10%	10%	10%	10%	10%	15%			
		Area	35%					10%				30%						25%										

Source: CDP

This heat map is designed to help investors pinpoint priority areas for engagement.

Green = good performance

Amber = monitor performance, possible concern

Red = area of concern, engage with company

We have not assigned a uniform number of green, amber and red across the metrics according to rank. Instead, we have reviewed the results of each metric in detail and assigned the above colours according to the underlying values for each metric.

Appendix II: Company summaries

RWE[(i)]

Country: Germany

Market cap (2016 av): EUR 7.2bn
2015 share of EU electricity generation: 6.5%
2016 emissions intensity: 686 tCO_2/GWh

League Table rank	Managing transition risks	Managing physical risks	Transition opportunities	Climate governance & strategy
14	E	C	E	E

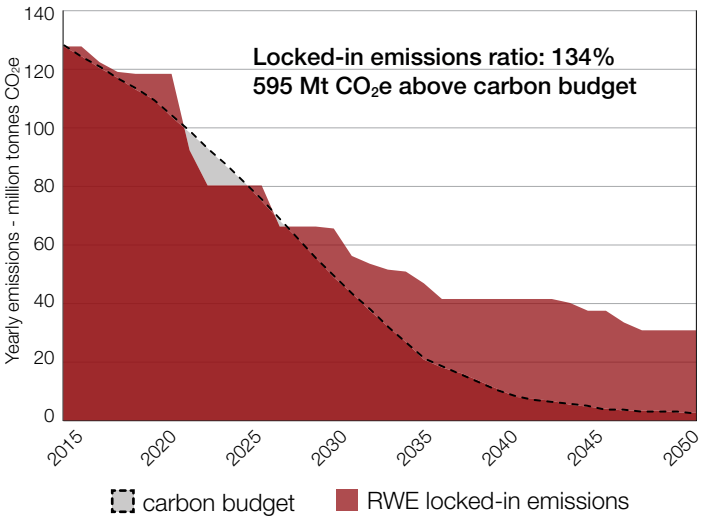
Company strengths

- Multiple climate linked KPIs for CEO and executive board including targeting a lower emissions intensity, though with lower weighting applied in the CEO's 2016 short term incentives than in 2015.
- Offers smart energy solutions such as Innogy SmartHome.
- Exposed to low water stress risk in 2016.

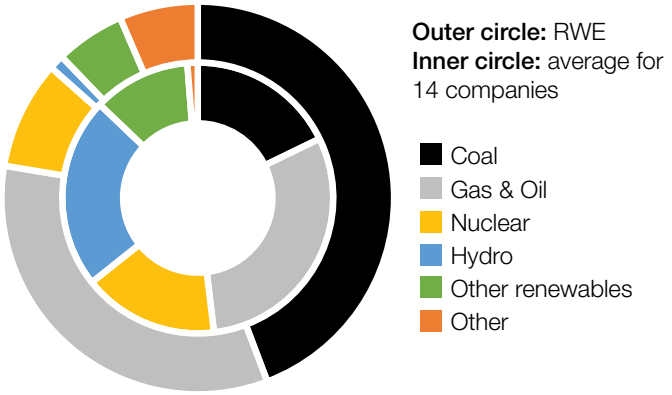
Company weaknesses

- Over three-quarters of generation capacity from fossil fuels, including 44% coal. Has highest emissions intensity in the sample, over ten times the GHG per unit of power generated as the top ranked company.
- Has the highest estimated locked-in emissions ratio (134% of implied 2°C carbon budget for 2015-2050), and this amount in absolute terms is by far larger than any other company assessed (595 million tonnes CO_2e over implied emissions budget vs next highest of 234mt).
- Had highest estimated earnings impact from EU carbon pricing in 2015 at 13.7% of EBITDA and is least supportive of low carbon policies.
- Emissions reduction target significantly weaker than the 2°C transition pathway.
- Declined to respond to CDP's 2016 water questionnaire.

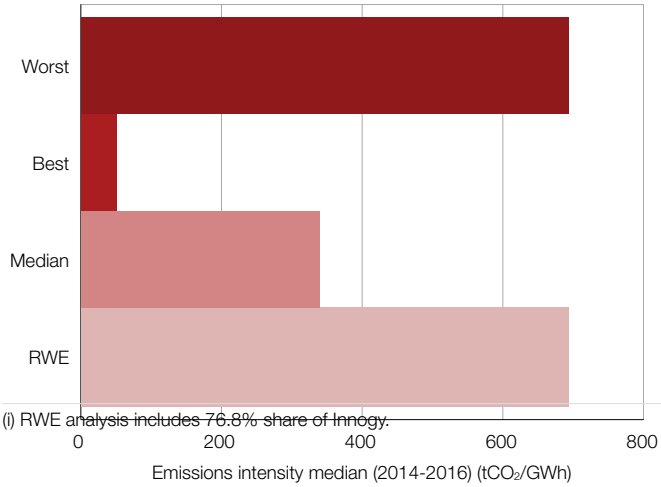
Locked-in emission trajectory vs. carbon budget



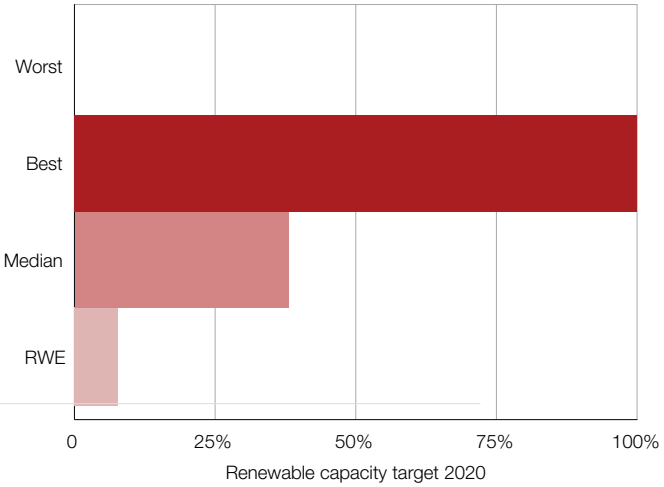
Installed capacity split by resource type - 2016



Emissions intensity



Renewable capacity target



(i) RWE analysis includes 76.8% share of Innogy.

CEZ

Country: Czech Republic

Market cap (2016 av): EUR 8.8bn
2015 share of EU electricity generation: 1.9%
2016 emissions intensity: 500 tCO_2/GWh

League Table rank	Managing transition risks	Managing physical risks	Transition opportunities	Climate governance & strategy
13	D	D	D	E

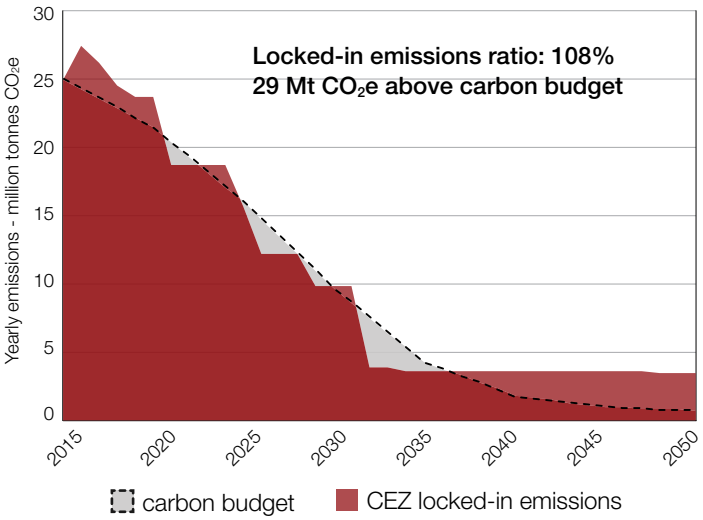
Company strengths

- Ambition to become a major European player in renewables and relative to its current portfolio has the fourth most ambitious renewable energy target
- Over the 2010-2016 period significantly increased its share of other renewables and outperformed the trend in its domestic market.
- None of its thermal capacity is exposed to high water stress in 2016 and only 6% exposed to extremely high water stress by 2030.
- Invests in innovative cleantech companies through its venture capital fund "Inven Capital" (€4-18m per year).

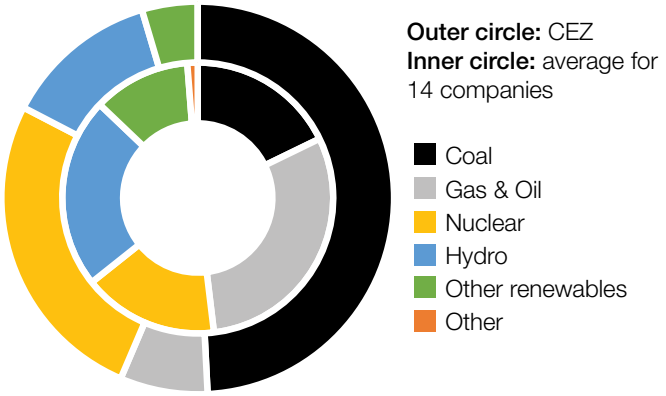
Company weaknesses

- Has the highest share of coal by capacity split and has had recent coal expansion.
- Has the second highest emissions intensity.
- Ranks last on climate strategy and governance due to a lack of disclosure on many metrics.
- Emissions reduction target significantly weaker than the 2°C transition pathway.
- Did not respond to CDP's 2016 water questionnaire request.
- Estimated locked-in emissions ratio of 108%, above implied carbon budget.

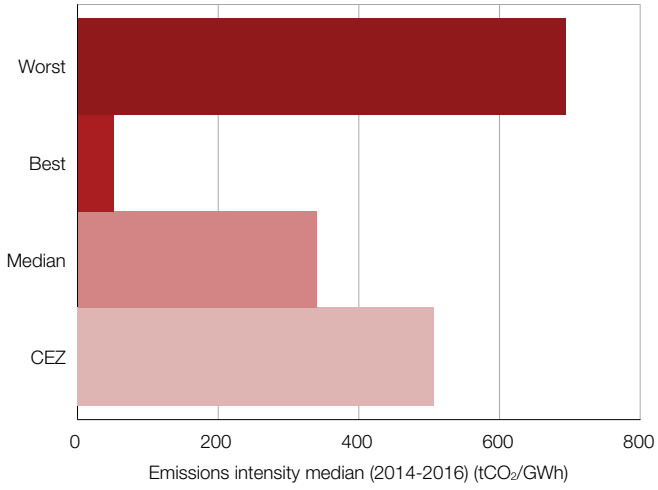
Locked-in emission trajectory vs. carbon budget



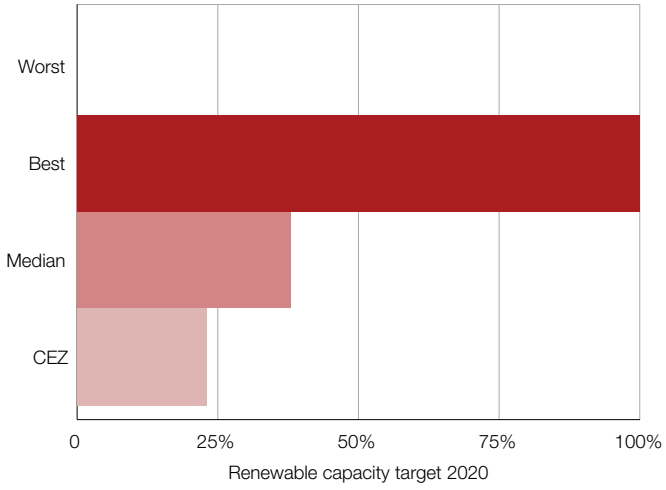
Installed capacity split by resource type - H1 2016



Emissions intensity



Renewable capacity target



Endesa

Country: Spain

Market cap (2016 av): EUR 20bn
2015 share of EU electricity generation: 2.4%
2016 emissions intensity: 415 tCO_2/GWh

League Table rank	Managing transition risks	Managing physical risks	Transition opportunities	Climate governance & strategy
12	D	D	C	D

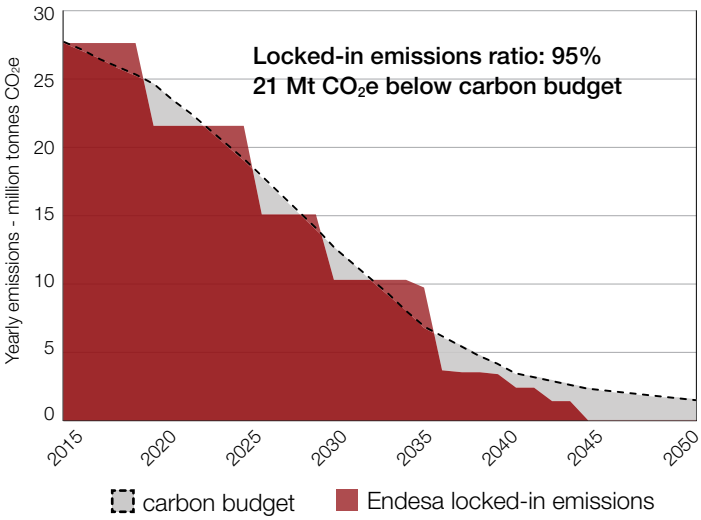
Company strengths

- Plans to expand presence in the renewables sector after acquisition of remaining 60% of Enel Green Power España from its parent company Enel in Q3 2016.
- A leader in smart meter deployment and has good capital flexibility relative to peers.
- Committed to become carbon neutral by 2050.
- Remains within its implied carbon budget by 2050 (locked-in emissions ratio estimated at 95%).
- Best water risk management plan.

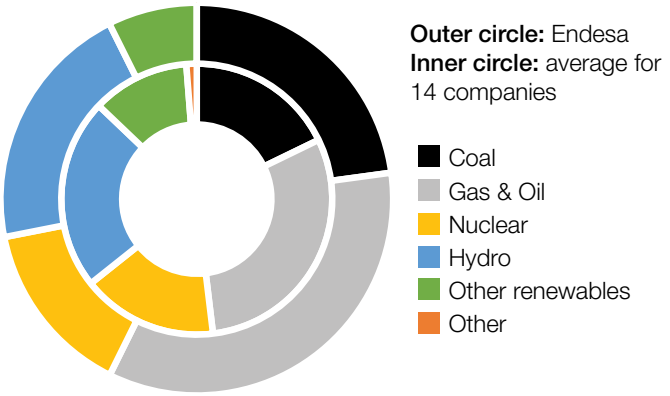
Company weaknesses

- High share of coal and fossil fuel assets.
- Emissions intensity is above the sample average and trended higher over 2009-2016.
- Thermal and hydro assets located in high water stress risk areas.
- Had second highest estimated earnings impact from EU carbon pricing in 2015 at 7.8% of EBITDA.

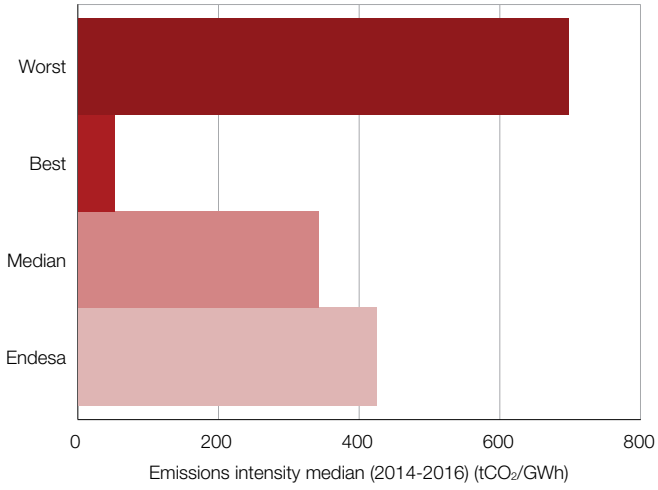
Locked-in emission trajectory vs. carbon budget



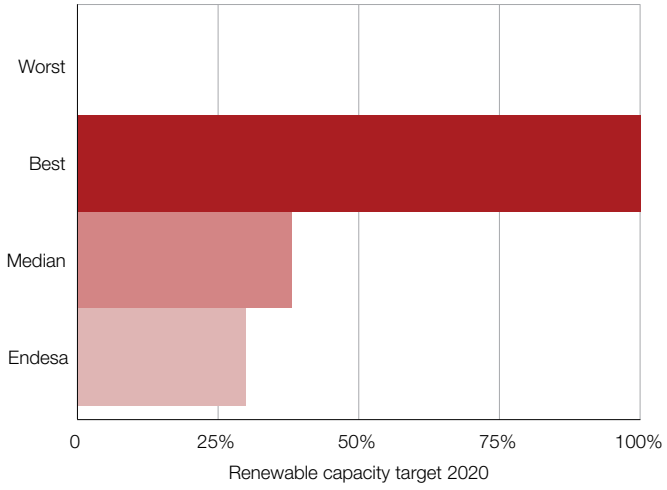
Installed capacity split by resource type - 2016



Emissions intensity



Renewable capacity target



EnBW

Country: Germany

Market cap (2016 av): EUR 5.6bn
2015 share of EU electricity generation: 1.7%
2015 emissions intensity: 330 tCO_2/GWh

League Table rank	Managing transition risks	Managing physical risks	Transition opportunities	Climate governance & strategy
11	E	C	C	C

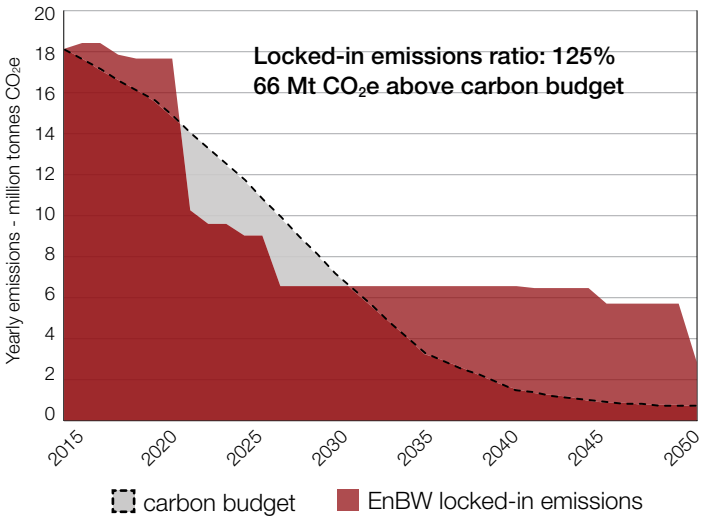
Company strengths

- Has been growing its renewable portfolio focusing on both onshore and offshore wind and beat domestic market growth over the 2010-2015 period.
- Reasonably ambitious target to increase total renewable capacity share to 40% by 2020 (2015 was 28%).
- 2016-2018 CAPEX strategy has strong focus on renewables and smart energy solutions. This future CAPEX plan also has the highest share allocated to growth CAPEX (76%).

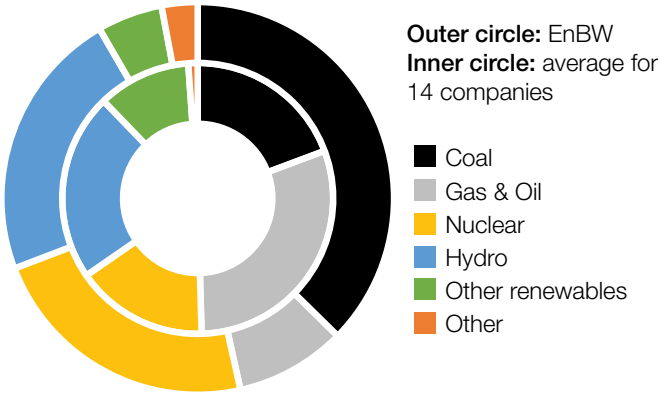
Company weaknesses

- Only company in sample that states it does not apply an internal carbon price.
- High proportion of coal assets and limited expected decommissioning of plants between 2025 to 2050. Is set to exceed its implied carbon budget with an estimated locked-in emission ratio of 125%.
- Had third highest estimated earnings impact from EU carbon pricing in 2015 at 6.1% of EBITDA.

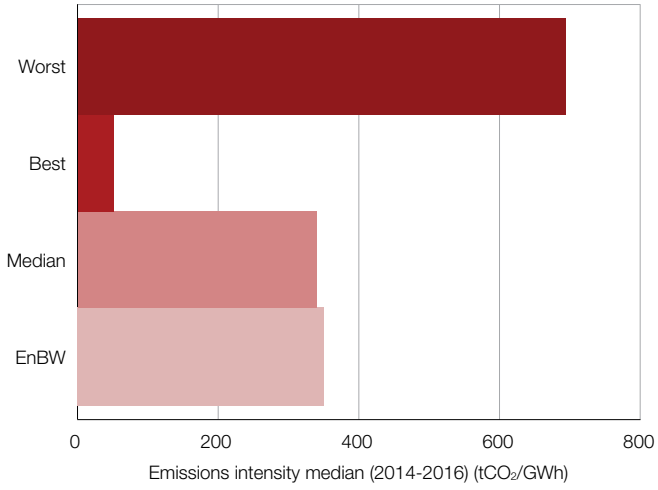
Locked-in emission trajectory vs. carbon budget



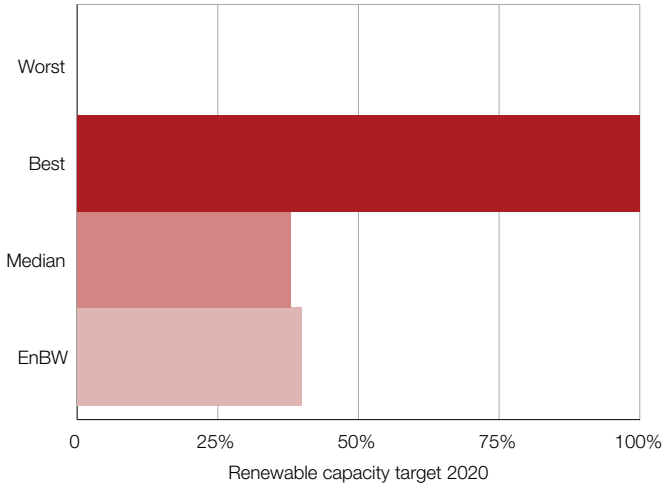
Installed capacity split by resource type - 2015



Emissions intensity



Renewable capacity target



ENGIE

Country: France

Market cap (2016 av): EUR 34bn
2015 share of EU electricity generation: 4.0%
2016 emissions intensity: 298 tCO_2/GWh

League Table rank	Managing transition risks	Managing physical risks	Transition opportunities	Climate governance & strategy
10	C	C	D	C

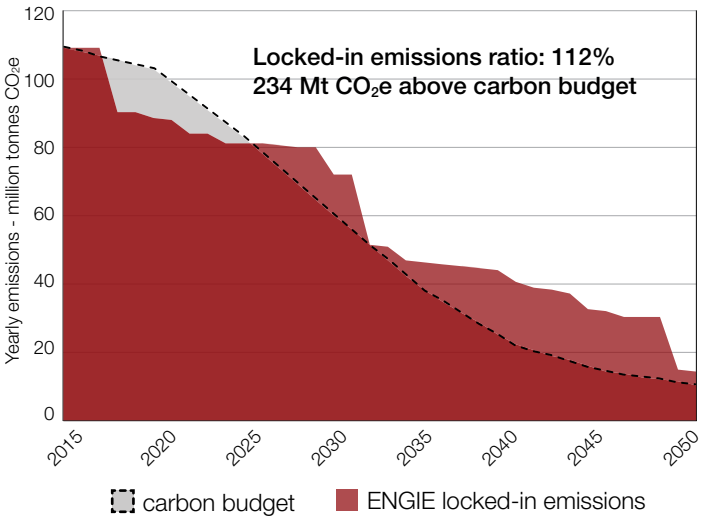
Company strengths

- Recently announced disposal or closure of a number of its most carbon intensive assets.
- After the rebrand of GDF Suez to ENGIE in April 2015 it set out a clear strategy to 2018 which includes a €15bn portfolio rotation program and shows increasing focus on renewables and customer solutions as well as digitalization and technology.
- Has identified board-level climate expertise.

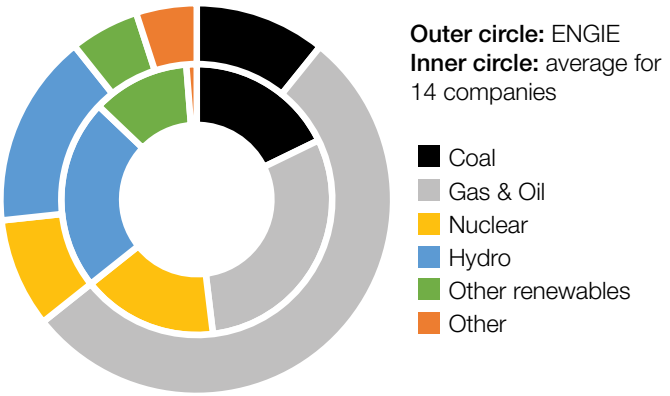
Company weaknesses

- Percentage change in installed capacity of other renewables lagged behind peers over 2010-2016 and target of a 25% renewable share of capacity by 2025 lacks ambition versus peers.
- Emissions intensity is above the sample average and showed an increasing trend over 2009-2015 before a significant fall in 2016.
- Locked-in emissions ratio is estimated at 112%, above its implied carbon budget. In absolute terms its estimated emissions over budget is second highest after RWE at 234 million tonnes CO_2e between 2015-2050.

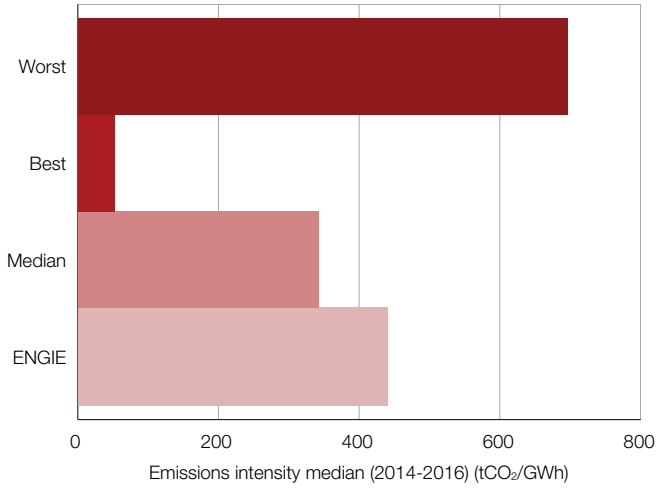
Locked-in emission trajectory vs. carbon budget



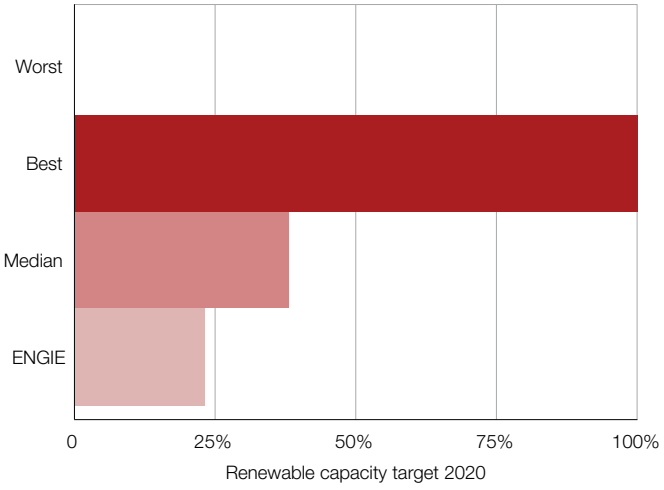
Installed capacity split by resource type - 2016



Emissions intensity



Renewable capacity target



E.ON[(i)]

Country: Germany

Market cap (2016 av): EUR 17bn
2015 share of EU electricity generation: 2.7%
2016 emissions intensity: 325 tCO_2/GWh

League Table rank	Managing transition risks	Managing physical risks	Transition opportunities	Climate governance & strategy
9	C	C	B	C

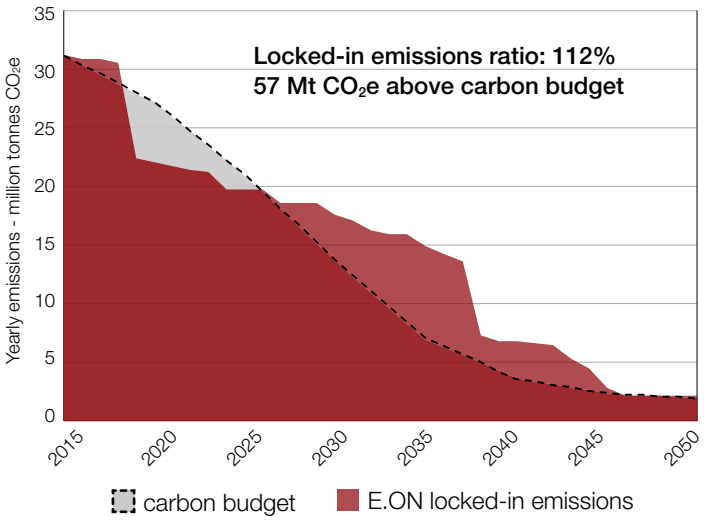
Company strengths

- Decision to split the company illustrates a shifting strategy to concentrate on renewables, distribution and customer solutions.
- Future CAPEX strategy is centered around the new E.ON business model.

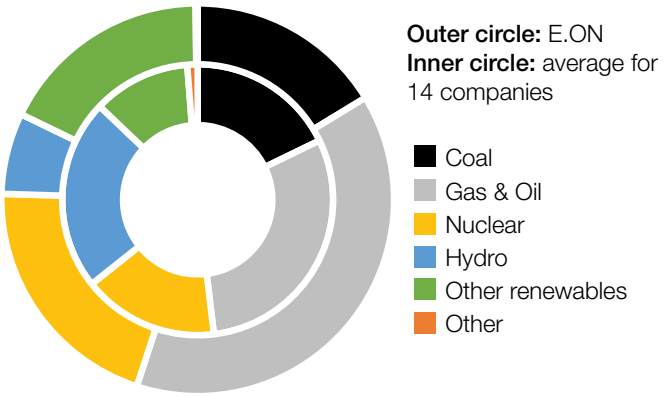
Company weaknesses

- E.ON's remaining exposure to Uniper assets on an equity share basis means fossil fuel power generation is still a significant portion of the company's asset portfolio resulting in a relatively high emissions intensity. However, E.ON has indicated that it intends to sell its remaining stake in Uniper over the medium-term.
- Capital flexibility is somewhat limited by nuclear decommissioning obligations highlighted by a high value for economic net debt / EBITDA.
- Locked-in emissions ratio estimated at 112%, above implied carbon budget.

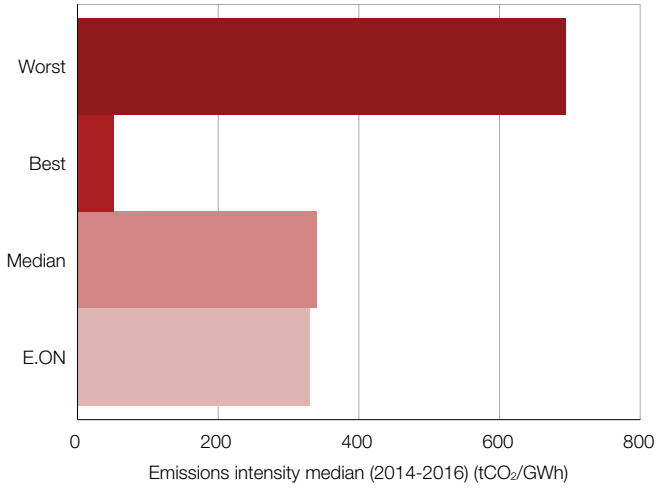
Locked-in emission trajectory vs. carbon budget



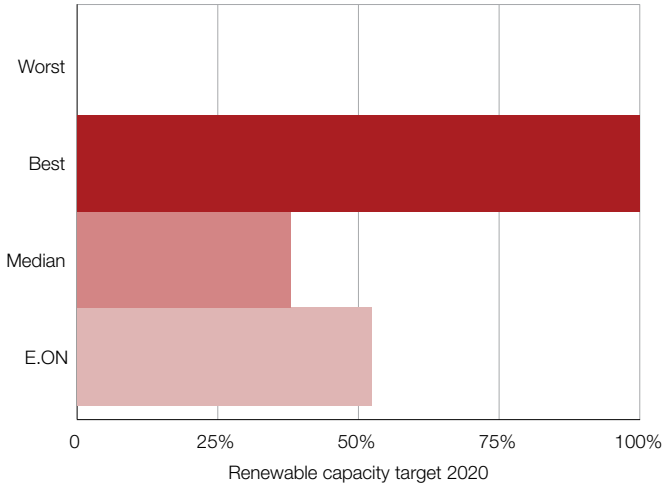
Installed capacity split by resource type - 2016



Emissions intensity



Renewable capacity target



(i) E.ON analysis includes 46.65% share of Uniper.

EDP

Country: Portugal

Market cap (2016 av): EUR 11bn
2015 share of EU electricity generation: 1.4%
2016 emissions intensity: 270 tCO_2/GWh

League Table rank	Managing transition risks	Managing physical risks	Transition opportunities	Climate governance & strategy
8	D	D	A	B

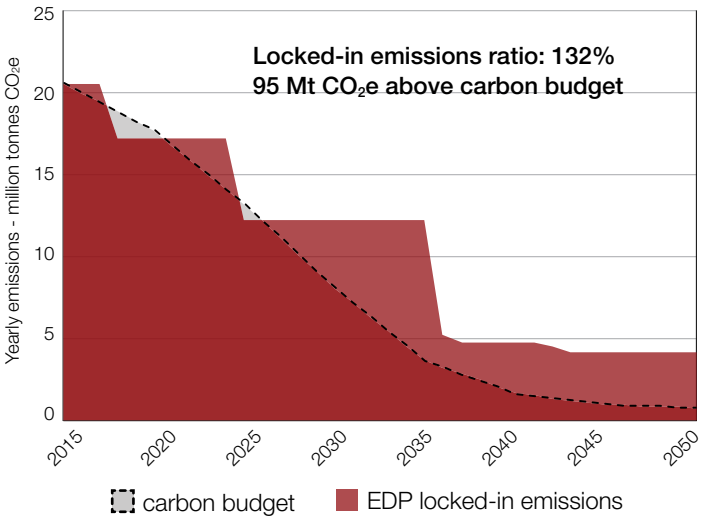
Company strengths

- Strong emissions reduction target, approved by Science-Based Targets Initiative as 2°C compatible.
- Highest share of generation and capacity of other renewables (34% of generation) - global leader in wind power.
- Highest share of future CAPEX planned for renewables and digitalization (58%).
- Has provided lobbying support for EU renewable targets and CEO supports immediate decarbonization of the economy.
- CEO's remuneration package includes climate-related long term incentives.

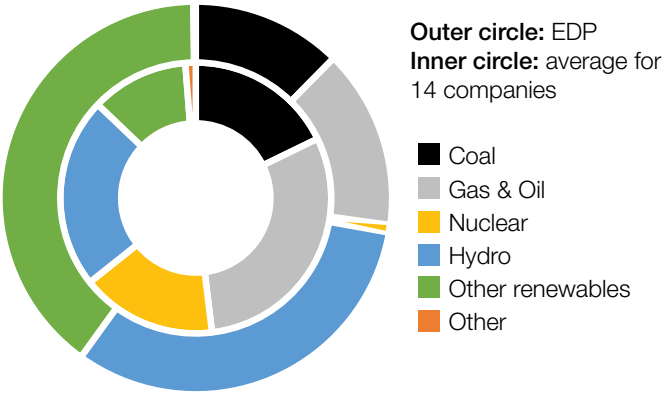
Company weaknesses

- High share of coal generation (30%, fifth worst in sample).
- Second highest estimated locked-in emissions ratio (132% of implied 2°C carbon budget for 2015-2050), driven by significant new fossil fuel assets commissioned since 2000.
- High water stress risks for thermal and hydro assets.

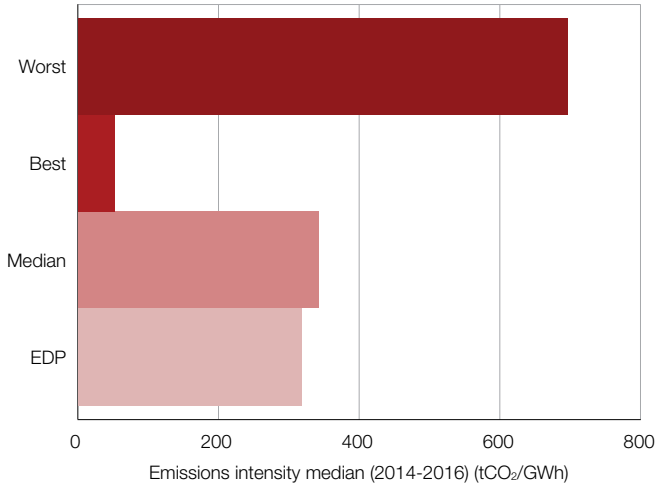
Locked-in emission trajectory vs. carbon budget



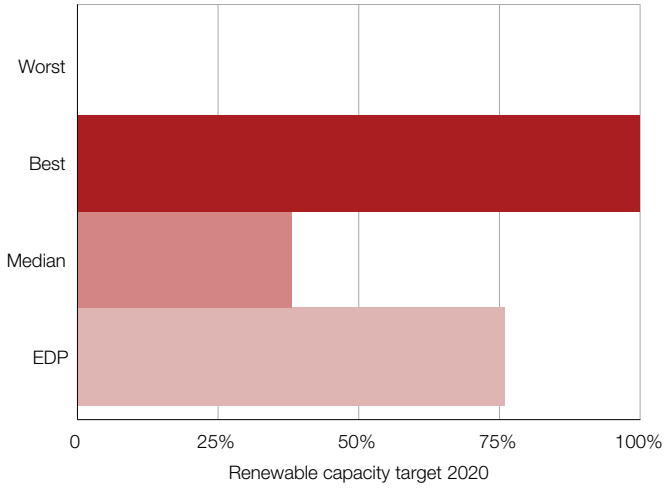
Installed capacity split by resource type - 2016



Emissions intensity



Renewable capacity target



EDF

Country: France

Market cap (2016 av): EUR 23bn
2015 share of EU electricity generation: 18.4%
2016 emissions intensity: 77 tCO_2/GWh

League Table rank	Managing transition risks	Managing physical risks	Transition opportunities	Climate governance & strategy
7	B	C	E	B

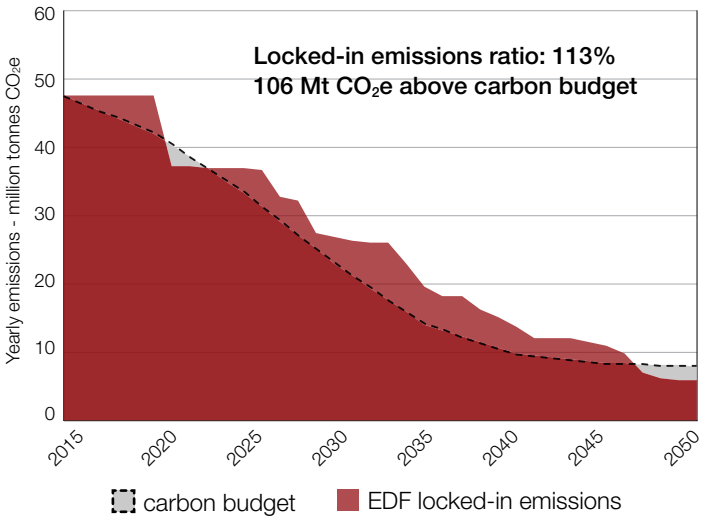
Company strengths

- Second lowest emissions intensity.
- Second highest R&D expense as a proportion of sales.
- One of a small number of companies assessed with identified board-level climate expertise.

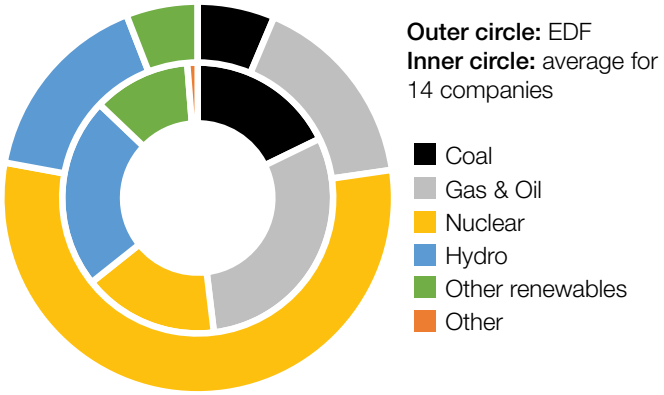
Company weaknesses

- Estimated locked-in emissions ratio of 113% of implied 2°C carbon budget for 2015-2050. Given EDF's large size this is the third largest amount over-budget in absolute terms.
- Low share of CAPEX allocated to renewables and growth activities relative to other companies in sample.
- Due to its large nuclear asset base, it has less capital flexibility than competitors, highlighted by a high economic net debt/ EBITDA.
- Company-wide emissions target does not imply any further decarbonization. Has a number of other segment-specific targets but cannot be readily converted to a company wide target.

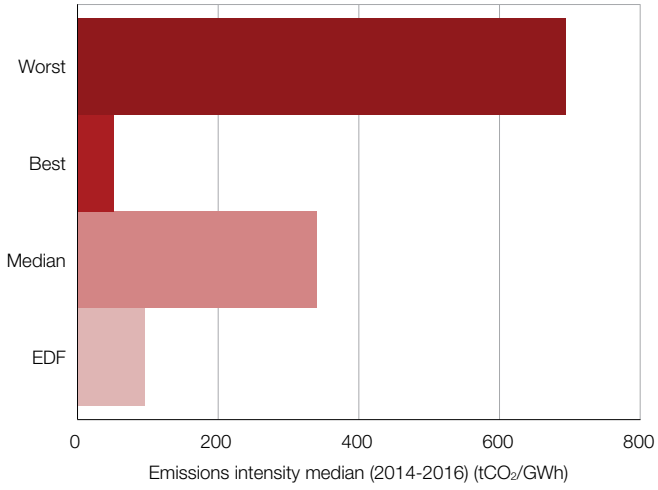
Locked-in emission trajectory vs. carbon budget



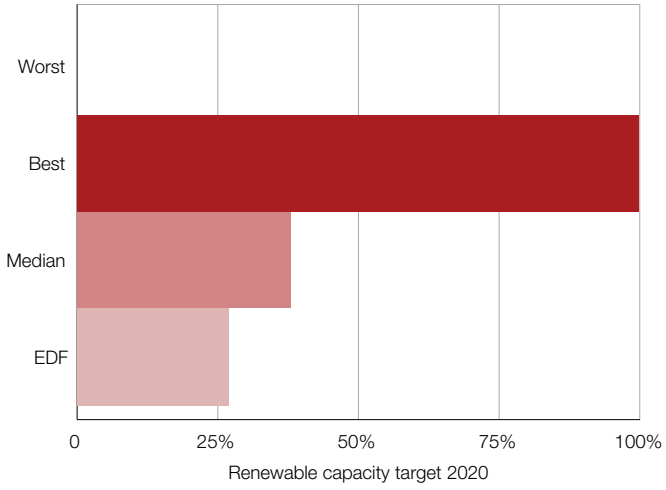
Installed capacity split by resource type - 2016



Emissions intensity



Renewable capacity target



Centrica

Country: UK

Market cap (2016 av): EUR 15bn
2015 share of EU electricity generation: 0.6%
2016 emissions intensity: 137 tCO_2/GWh

League Table rank	Managing transition risks	Managing physical risks	Transition opportunities	Climate governance & strategy
6	B	C	D	C

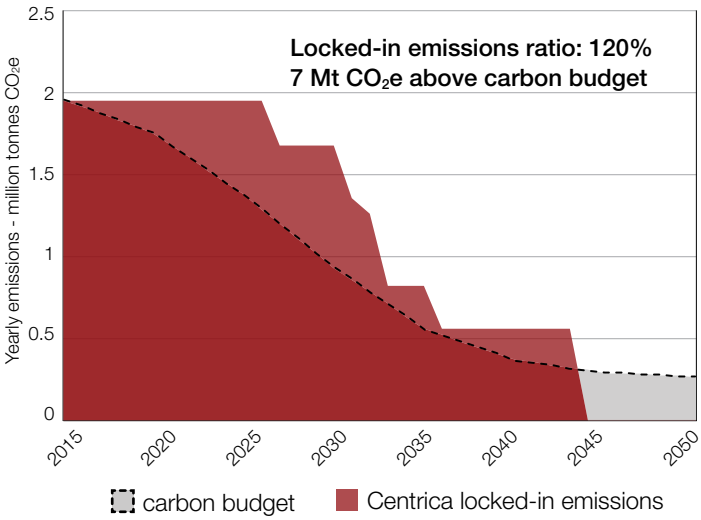
Company strengths

- Only company with no coal assets in its generation portfolio.
- Largest reduction in emissions intensity from 2009-2016 of all 14 companies.
- Making significant investments (£1.2 billion over 2016-2020) in smart solutions such as the connected home and distributed energy. Strong customer focus.

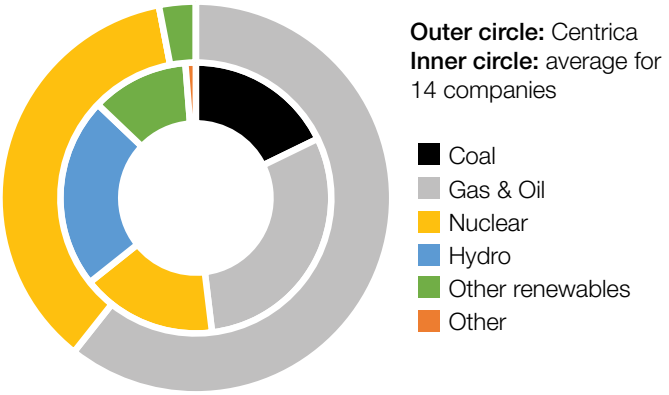
Company weaknesses

- Generation portfolio tilted heavily towards gas. With some of these assets having long expected lifetimes remaining, Centrica has an estimated emissions lock-in ratio of 120% of its implied carbon budget.
- Very low generation from renewables, and has decided to sell off all wind capacity but states it will continue to buy renewable electricity through power purchase agreements. As yet there is no renewable target associated with this new strategy.

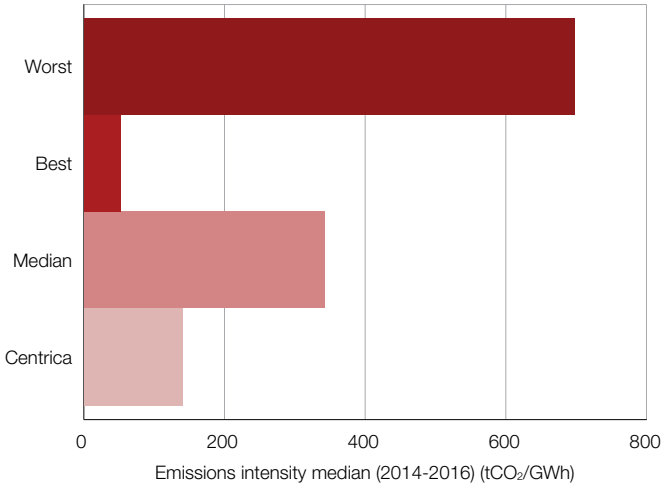
Locked-in emission trajectory vs. carbon budget



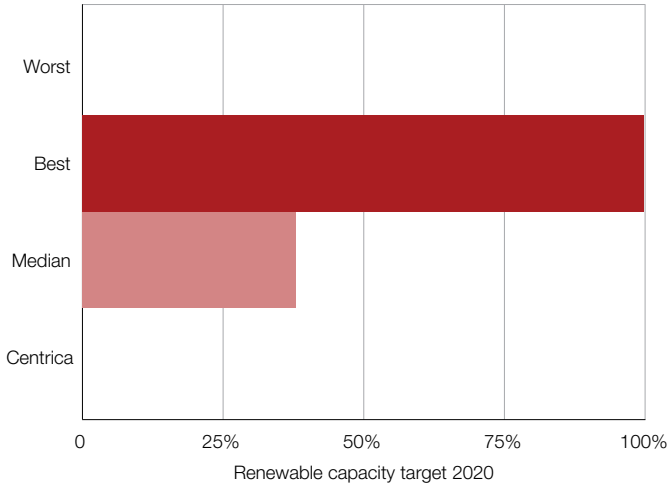
Installed capacity split by resource type - 2016



Emissions intensity



Renewable capacity target



SSE

Country: UK

Market cap (2016 av): EUR 20bn
2015 share of EU electricity generation: 0.9%
2016 emissions intensity: 397 tCO_2/GWh

League Table rank	Managing transition risks	Managing physical risks	Transition opportunities	Climate governance & strategy
5	C	B	C	C

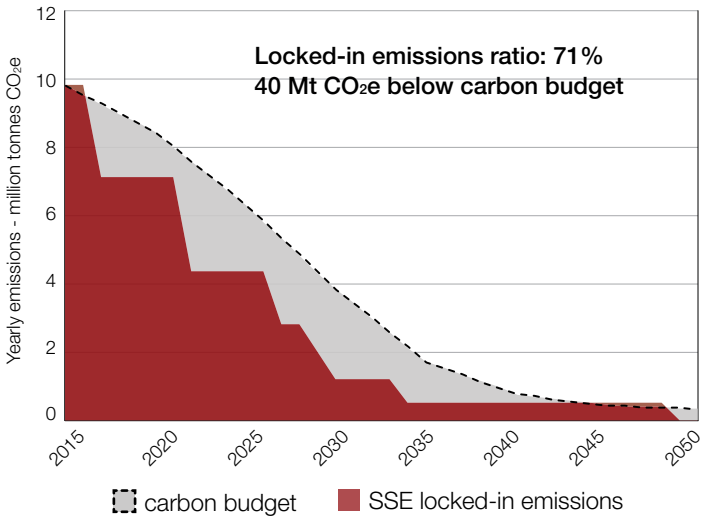
Company strengths:

- Remains within its implied carbon budget by 2050 (locked-in emissions ratio estimated at 71%). Decommissioned a large coal-fired generator in 2016.
- Third largest share of other renewables.
- Emissions reduction target has sharpest downward trajectory.
- Low exposure to water stress risks.
- Strongest supporter of low-carbon policies according to InfluenceMap analysis.

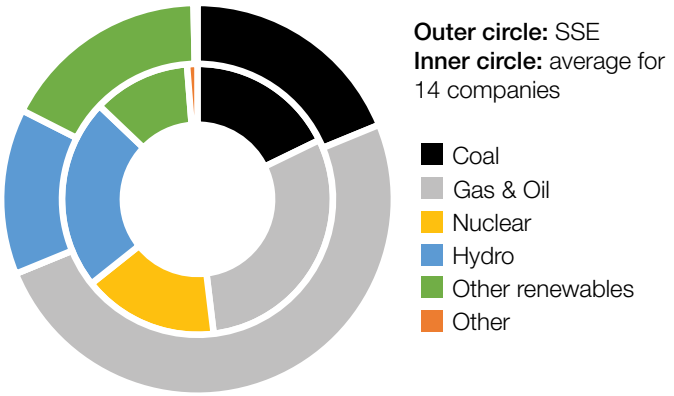
Company weaknesses:

- Current emissions intensity is above sample average.
- Increase in installed renewable capacity lagged behind domestic market growth over 2010-2015 and future renewable investment could be more ambitious.
- R&D expense as a proportion of sales is the lowest for our sample of companies.

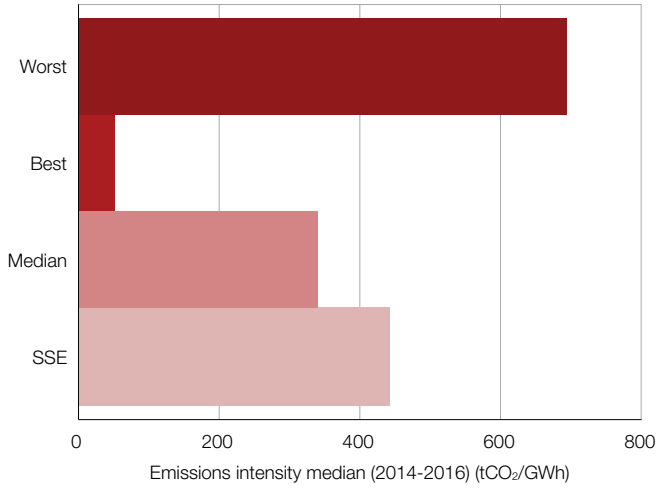
Locked-in emission trajectory vs. carbon budget



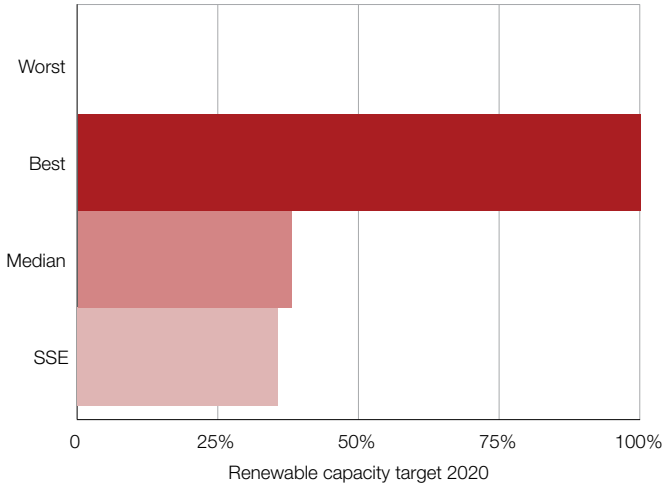
Installed capacity split by resource type - Sep 2016



Emissions intensity



Renewable capacity target



Enel[(i)]

Country: Italy

Market cap (2016 av): EUR 37bn
2015 share of EU electricity generation: 3.9%
2016 emissions intensity: 395 tCO_2/GWh

League Table rank	Managing transition risks	Managing physical risks	Transition opportunities	Climate governance & strategy
4	C	E	A	B

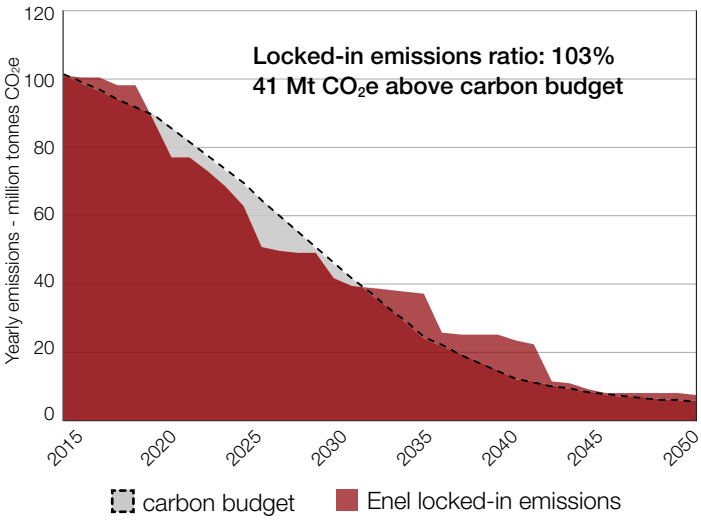
Company strengths

- Ranks first for transition opportunities. Clear strategic direction with its "Open Power" concept. Significant 2020 renewables target equivalent to 54% of capacity.
- Target to be carbon neutral by 2050 and emissions reduction target approved by Science-Based Targets Initiative as 2°C compatible.
- 2017-2019 strategy outlines strong investment in renewables and smart solutions with 30% and 23% of planned CAPEX focused on renewables and digitalization respectively.

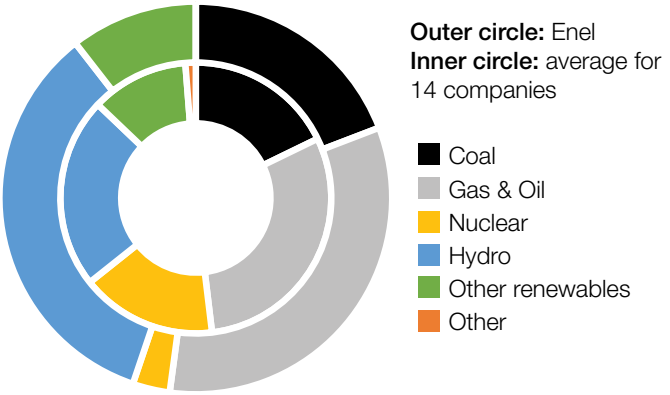
Company weaknesses

- Ranks last on water resilience, with high exposure to water scarcity. 71% of its thermal capacity is likely to be exposed to high or extremely high water stress risk by 2030.
- Current emissions intensity is above the sample average.
- Locked-in emissions ratio estimated at 103% of implied carbon budget.

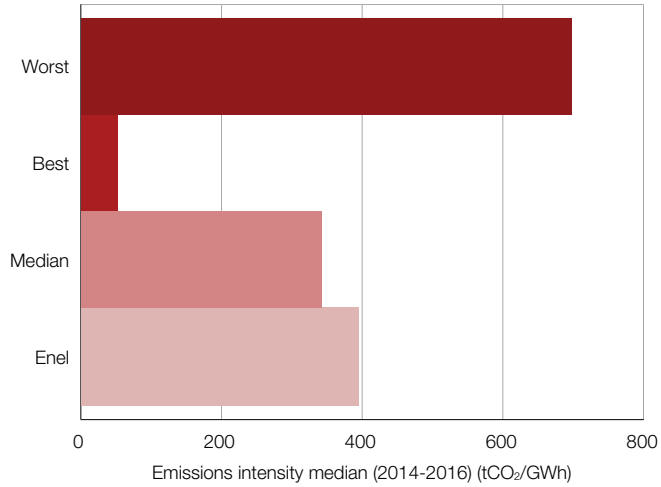
Locked-in emission trajectory vs. carbon budget



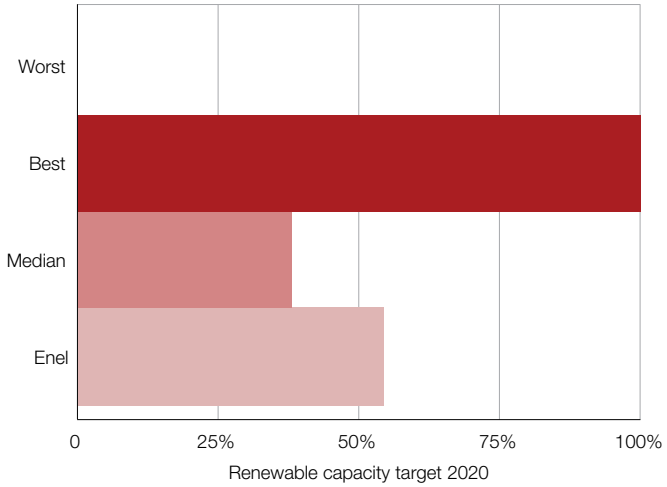
Installed capacity split by resource type - 2016



Emissions intensity



Renewable capacity target



(i) Enel analysis includes 70.14% share of Endesa.

Fortum

Country: Finland

Market cap (2016 av): EUR 13bn
2015 share of EU electricity generation: 1.5%
2016 emissions intensity: 184 tCO_2/GWh

League Table rank	Managing transition risks	Managing physical risks	Transition opportunities	Climate governance & strategy
3	B	B	B	D

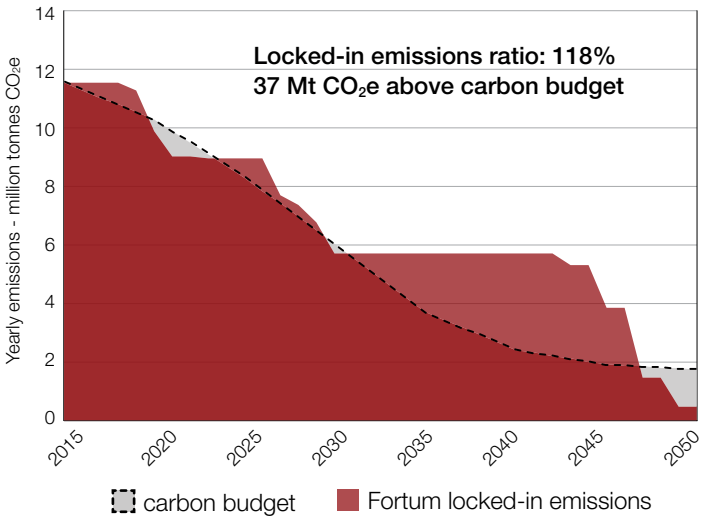
Company strengths

- Third lowest share of generation from coal and a significant portion from hydro.
- Is expanding portfolio in wind and solar and has a focus on sustainable city solutions such as waste to energy, heating and cooling.
- R&D expense as proportion of sales is highest of all the companies.
- Lowest economic net debt/EBITDA for all the companies indicating good capital flexibility.
- Marginal thermal water stress risk and no hydro capacity located in high water stress regions in 2016 or by 2030.

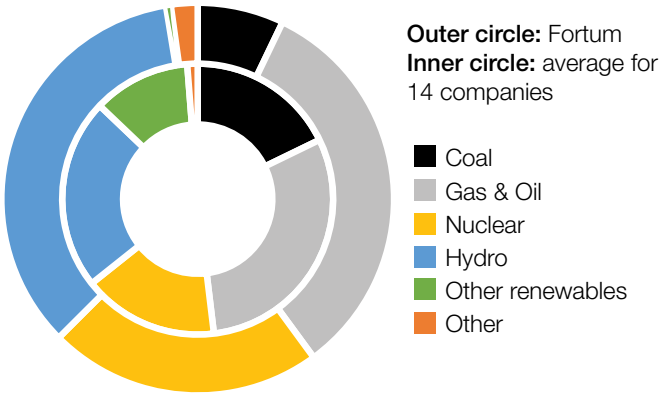
Company weaknesses

- Emissions target implies no further decarbonization and lacks ambition.
- Is set to exceed its implied carbon budget with an estimated locked-in emission ratio of 115%.
- Fortum directly opposed EU renewable energy targets and subsidies in consultations with policy makers in 2016.

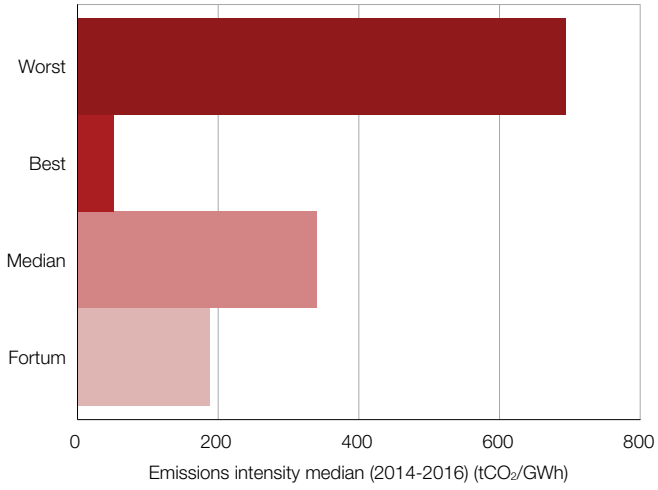
Locked-in emission trajectory vs. carbon budget



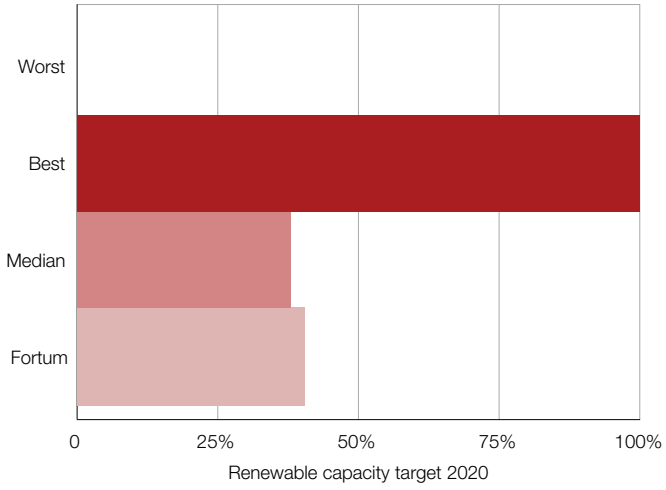
Installed capacity split by resource type - 2016



Emissions intensity



Renewable capacity target



Iberdrola

Country: Spain

Market cap (2016 av): EUR 40bn
2015 share of EU electricity generation: 2.4%
2016 emissions intensity: 176 tCO_2/GWh

League Table rank	Managing transition risks	Managing physical risks	Transition opportunities	Climate governance & strategy
2	B	E	A	A

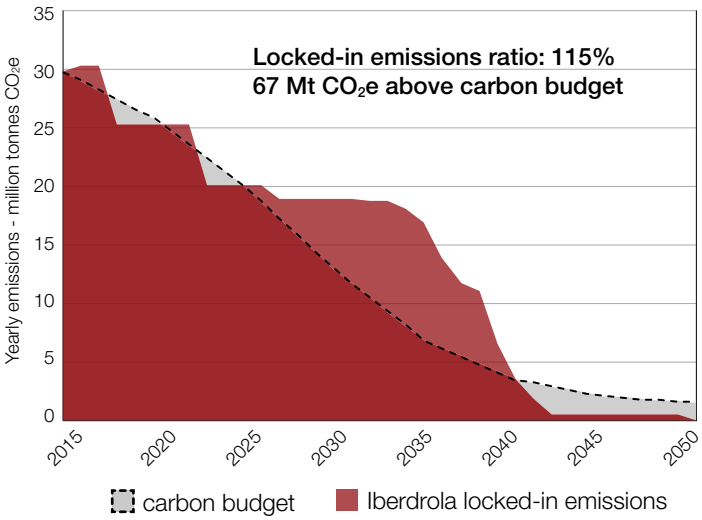
Company strengths

- Targets carbon neutrality by 2050.
- Low share of coal assets, and closed large coal facility in 2016.
- Second highest share of other renewables – global leader in wind power.
- Investment in clean energy sees 33% of CAPEX (2016-2020) planned for renewables, and 70% of CAPEX is growth oriented.
- Has climate-linked KPIs in executive remuneration and board has directors with identified climate expertise.

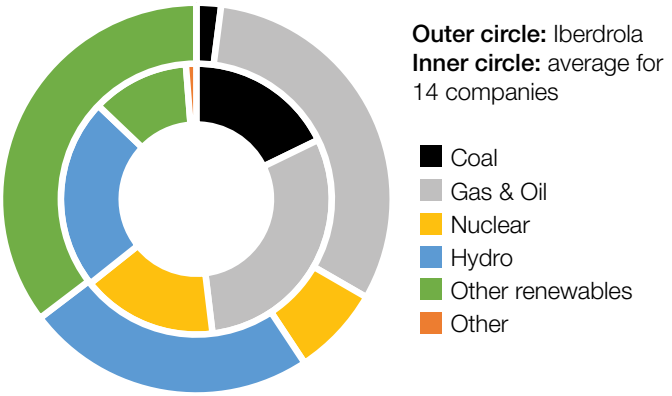
Company weaknesses

- Is set to exceed its implied carbon budget with an estimated locked-in emission ratio of 118%.
- Thermal and hydro assets have significant exposure to high water stress regions.

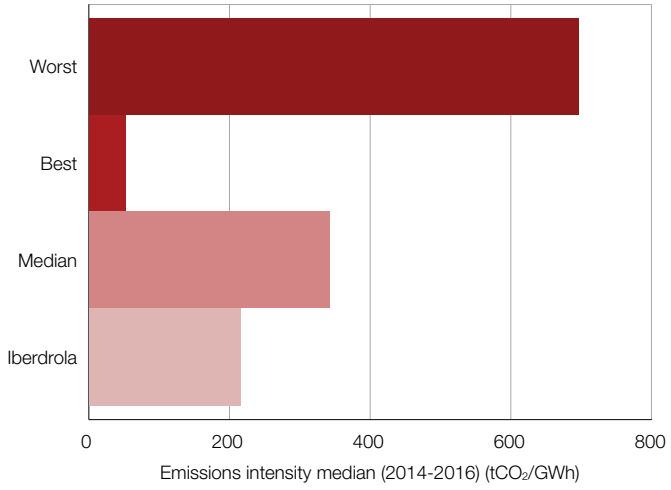
Locked-in emission trajectory vs. carbon budget



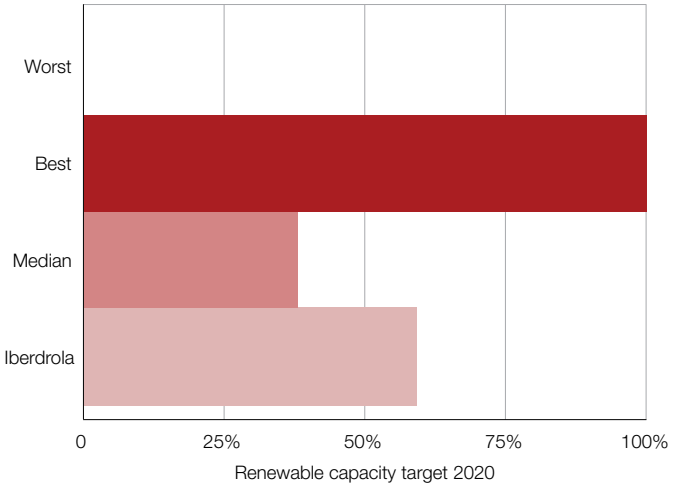
Installed capacity split by resource type - 2016



Emissions intensity



Renewable capacity target



Verbund

Country: Austria

Market cap (2016 av): EUR 4.7bn
2015 share of EU electricity generation: 1.0%
2016 emissions intensity: 31 tCO_2/GWh

League Table rank	Managing transition risks	Managing physical risks	Transition opportunities	Climate governance & strategy
1	A	A	A	B

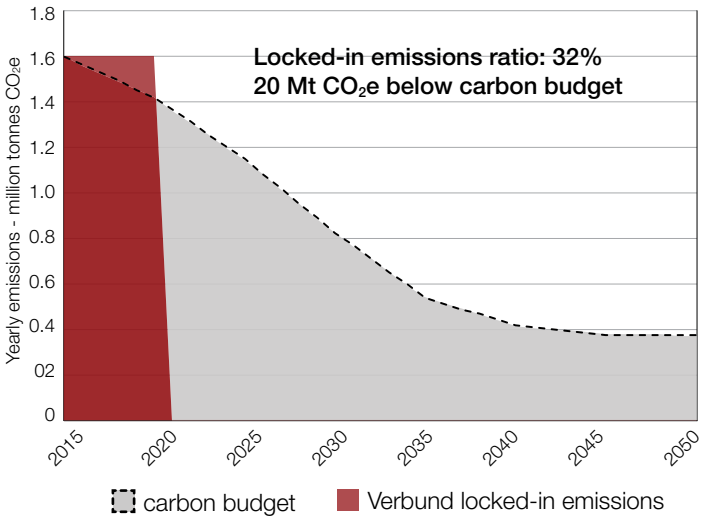
Company strengths

- Lowest share of fossil fuels and highest share of renewables.
- Targeting a 100% renewable energy portfolio by 2020. Clear leader in hydro but has also increased wind power operations in recent years.
- Remains within its implied carbon budget by 2050. Locked-in emissions ratio estimated at 32%, by far the lowest of the companies assessed.
- Ranks first on water resilience; it is the only company to have lower overall water stress risk in 2030 compared with 2016.

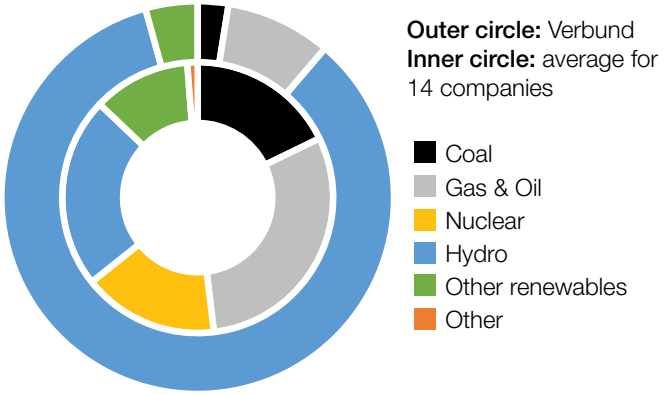
Company weaknesses

- Future CAPEX plan (2016-2019) has 41% allocated to growth CAPEX, which is below sample average.
- Weak level of disclosure on board level climate risk management.

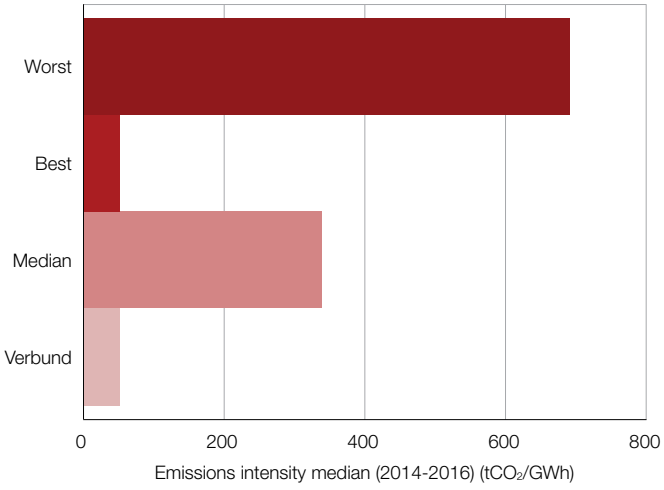
Locked-in emission trajectory vs. carbon budget



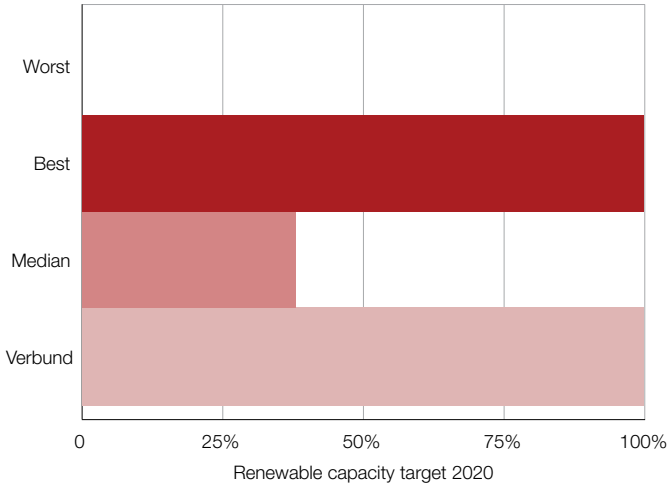
Installed capacity split by resource type - 2016



Emissions intensity



Renewable capacity target



Appendix III: Methodology and limitations

Transition risks

The overall transition risk ranking is determined as follows:

We combine the weighted ranks of the four-metrics using the following weightings: metric 1) 25%, metric 2) 25%, metric 3) 30%, metric 4) 20%.

Metric 1) Emissions performance:
The weighted rank for the metric is calculated by applying a 75% weight to current emissions intensity and 25% weight to the change in emissions intensity.

Current emissions intensity

- We collate emissions intensity per GWh of electricity produced for the period 2014-2016 using data from the CDP questionnaire and company sources and use the median emissions intensity for analysis. For SSE and EnBW, emission intensities are calculated from 2014-2015, due to a lack of 2016 data, while only 2016 data is used for RWE and E.ON due to recent company restructuring.

Change in emissions intensity

- We use our proprietary function to assess the companies' emissions reduction performance for each of the following periods: 2009-2016, 2010-2016, 2011-2016. Our function considers the full emissions profile of each of the three periods.
- The function measure the total emissions intensity over a period and calculates the implied constant reduction rate per annum required to create the same aggregate emission profile (over the same period) starting from the base year for the period.
- The function is therefore independent of end date for the period (i.e. 2016) but dependent on start date. This is why we apply the function to three periods with differing start dates.
- We calculate the implied constant reduction rate for each of the three periods and take the median value in order to exclude anomalies (e.g. temporary altered production, or a material acquisition with a significantly different emissions intensity).
- We rank the companies based on the median implied constant reduction rate with the companies who have reduced their emissions more aggressively favored.
- For SSE and EnBW, emission intensities are calculated from 2009-2015 and for CEZ the trend in emissions was calculated over 2010-2016 due to lack of data.

Metric 2) Share of fossil fuel generation:
The weighted rank for the metric is calculated by applying the following weightings: production share of fossil fuels (av. 2015-2016) – 20%, production share of coal (av. 2015-2016) – 50%, the CAGR for the proportion of installed capacity of fossil fuels (2010-2016) – 10%, and the CAGR for the proportion of installed capacity of coal (2010-2016) – 20%.

- We collate generation levels (GWh) for 2015 and 2016 from annual reports and data reported to CDP.
- The proportion of fossil fuels (coal, gas and oil) is calculated as percentages of total generation for 2015 and 2016 to determine the production share of fossil fuels.
- The proportion of fossil fuels is calculated as a percentage of total installed capacity. This is used to calculate the CAGR for proportion of installed capacity of fossil fuels over 2010 – 2016.
- The method outlined above is repeat for coal production and the CAGR for proportion of installed capacity of coal.

Metric 3) Locked in emissions

- The model measures cumulative generation emissions over 35 years from 2015-2050, determining the extent to which companies remain within their allocated carbon budget, relative to company specific targets for decarbonization based on a convergence pathway to the 2°C outcome for 2050 set out by Science Based Targets Initiative (SBTI) and in accordance with the IEA 2DS scenario.
- Asset level data, including active and pipeline capacities, commissioning and decommissioning dates and power plant type are derived from company filings and GlobalData. Generic emissions factors for each plant type are taken from the IPPC fifth assessment report.
- The SBTI sets out company specific targets that are in line with the level of decarbonization required to keep global temperature increase below 2°C, compared to pre-industrial temperatures. The Science-Based-Targets (SBTs) used in the model are derived from the Sectoral Decarbonization Approach (SDA), which defines the methodology for setting corporate emission reduction targets for different industry classifications. The SDA for the power generation sector is used in this model. A geographical weighting approach is also incorporated. The IEA 2DS scenario places different decarbonization demands on different regions. Therefore, a greater precedence is given to developed nations to decarbonize while developing nations are able to decarbonize at a slower rate.

- The model compares the emissions budget entailed by the company's generation intensity decarbonization pathway and projected generation trends in the sector at the country/regional level. The SBTs determine the convergence line in which all companies must reach by 2050 to remain consistent with the 2DS scenario (around 20gCO_2/kwh in 2050). The assessment is based on the difference between a company's installed and planned emissions to 2050 and the emissions budget entailed by the company's carbon budget.

- The technical lifetime of each plant is determined based on the age of the plant and the decommissioning/shutdown date. Where the decommissioning years are not given, the model determines when a plant is likely to go offline based on the commissioning date and the average lifespan of the plant type, in accordance with its geographical location. After decommissioning, it is assumed that all assets are replaced with zero-carbon generation capacity, which does not add to further yearly emissions.

Metric 4) Carbon cover

We use 2015 financial year data on verified emissions that are subject to the EU ETS, EU allowances purchased, and free allowance allocations from responses to the 2016 CDP climate change information request, question CC13.1a. From this, we calculate the utilities' carbon cost exposure at a €7.70/tCO2e carbon price, the average traded price for the December 2015 EUA contract on the Intercontinental Exchange. We sourced 2015 EBITDA from Bloomberg and added back the estimated carbon cost at the €7.70 average carbon price. We then calculate carbon cover by dividing the adjusted EBITDA by the utilities' carbon obligations, their verified EU emissions subject to the EU ETS minus free allowances allocated, multiplied by €7.70.

Limitations

- There is inherent uncertainty associated with the locked in emissions model. The model looks to project future emissions based on likely changes in generation from 2015-2050 but cannot account for a variety of external factors that are likely to affect the emissions profile of companies in the future. For example, capacity utilization may be higher or lower than assumed, individual generation units may be more or less emissions intensive than assumed, and existing generators may be shut down early or operated longer than assumed. With this in mind, the results should be treated as estimates of the future rather than as certain outcomes.

- The company specific carbon budget is drawn from a designated base year (2015) and is therefore sensitive to the assets, generation split and estimated emissions level of that year. By starting the model from a set base year does not account for emissions reduction actions that may have occurred previously and therefore influences the carbon budget calculated.

- Some companies did not verify the GlobalData datasets. As a result, where possible asset data was taken from company disclosures with corrections sometime made based on correspondence with the company. However, in these cases commissioning and decommissioning dates were often not present in the company sourced asset lists.

- The incompleteness of datasets in terms of capacity, commissioning and decommissioning data means that for a large proportion of assets, default factors were applied based on assumed technical lifetimes of particular assets in each location.

- After any decommissioning it is assumed that assets are replaced with zero-carbon generation capacity, which does not add to further yearly emissions.

Physical risks: Water resilience

The overall water resilience rank and grades are determined as follows:

- We combine the weighted ranks of the two-metrics using the following weightings: metric1) 45% metric 2) 25% and metric 3) 30%. This determines the overall weighted rank for water resilience.

- EnBW is only scored on the 'disclosure' and 'internal management and regulatory adherence' metrics of the water risk management section, as it was not included in the 2016 CDP water questionnaire sample. Centrica does not have any hydro generation and therefore is weighted 70% for its thermal assets and 30% for risk management.

- The water resilience grade is awarded according to the overall weighted rank.

We apply the following methodologies to determine the weighted rank for each metric:

Metric 1) Thermal asset water stress exposure

- We collate geographical coordinates, capacity data and decommissioning years for over 5,600 assets from the GlobalData database. Where decommissioning dates were not present from GlobalData, estimated decommissioning dates were obtained from the locked-in emissions model. Due to minimal water usage, renewable sites are excluded from the analysis. Assets are further filtered to exclude plants that have already been decommissioned, shut down or cancelled, leaving an asset list of over 1,000 thermal, nuclear and biomass burning plants.

- E.ON's, RWE's, and Enel's stakes in Uniper, Innogy and Endesa are accounted for by multiplying the capacities of the assets owned at the parent level by the relative ownership stakes. The sites are then incorporated into the asset portfolio of the parent company. (Endesa is also assessed independently.)

- We use WRI's Aqueduct tool to assign a current and future water stress risk classification to the facilities according to their geographic location. This are categorized into: low, low to medium, medium to high, high, and extremely high water stress risk. The classifications are based on three risk areas weighted for the electric power industry: (i) Physical risks quantity (81.2%) based on baseline water stress, inter-annual and seasonal variability, flood occurrence, drought severity, upstream storage, and groundwater stress. (ii) Physical risks quality (1.4%) based on return flow ratio and upstream protected land. (iii) Regulatory and reputational risk (17.4%) based on media coverage, access to water and threat to amphibians.

Current water stress (2016)

- To account for the ownership stake each company has in an individual asset, total capacities are multiplied by the ownership stake percentage given by GlobalData.

- Each site is weighted based on capacity relative to a company's total capacity. This gives a greater precedence to sites with higher capacities.

- At a facility level, we identify the level of water stress risk exposure using the WRI water risk indicator score calculated by the tool based on the above metrics. The score, ranging from 0 (low risk) to 5 (high risk) corresponds to one of the 5 risk categories and assigns a classification for each site.

- We calculate the number of each company's facilities in each WRI risk category. Then we scale the number according to the following weights: low=0%, low to medium=5%, medium to high=15%, high=35%, extremely high=45% and divide by the total number of facilities. This approach assigns greater weight to facilities facing higher water stress risks.

- Finally we normalize this number to produce a water stress exposure index ranging from 0 (all facilities exposed to low water stress risk) to 1 (all facilities exposed to extremely high water stress risk). The higher the index value the more exposed a company is to water stress and therefore we use the index to rank the companies relative water stress asset exposure levels.

Future water stress (2030)

- We account for sites that are confirmed or estimated (using the locked in emisisons model) to go offline by 2030 and exclude them from the future water stress analysis.

- At the facility level, we identify the level of water stress risk exposure weighting the three scenarios: 25:50:25 (optimistic: business as usual: pessimistic) as defined by WRI.

- We calculate the number of each company's facilities in each WRI risk category. Then we scale this number according to the following weights: low=0%, low to medium=5%, medium to high=15%, high=35%, extremely high=45% and divide by the total number of facilities. This approach assigns greater weight to facilities facing higher water stress risks.

- Finally, we normalize this number to produce a water stress exposure index ranging from 0 (all facilities exposed to low water stress risk) to 1 (all facilities exposed to extremely high water stress risk). Therefore, the higher the index value the more exposed a company is to water stress risk.

- We present the percentage of each company's facilities in each WRI risk category and present the medium to high, high, and extremely high risk facilities in year end 2016 and 2030.

Metric 2) Hydro asset water stress exposure

- Hydro plant data is collated from GlobalData. We assess 90% of each company's total capacity by ranking the assets according to capacity and calculating a cumulative total. Where coordinates are missing from the GlobalData set, and not received via company correspondence, they are collected manually for 80% of total capacity.

- The ownership stake is accounted for and each site is weighted based on capacity relative to a company's total capacity. Additionally, capacities are weighted according to the % that hydropower makes up in a company's generation portfolio; thereby giving greater precedence to the assets of companies that are more reliant on hydropower to generate electricity.

- Water stress is calculated using the method set out in Metric 1 for 2016 and 2030.

Metric 3) Water risk management

Water risk assessment and management is assessed based on metrics taken from the 2016 CDP water questionnaire and from other company reporting. Companies that did not respond to the original questionnaire request were sent a précised version containing the key metrics required for this report. EnBW and Verbund were not within the sample set of the 2016 water questionnaire and were also sent a summary questionnaire.

We use the following categories/sub-categories to assess companies' water risk management:

- Disclosure: Companies are ranked based on their response to the CDP's 2016 water questionnaire and an additional request to those companies that did not receive the questionnaire or did not respond.
- Risk assessment: Does the organization undertake a water risk assessment, does this cover all facilities and suppliers, what geographical scale does the water assessment apply to, how frequently is an assessment made and have companies evaluated how water risks could affect the success of the organization's growth strategy.
- Supply chain management: Does the water risk assessment apply to direct operations and/or supply chain and do companies request suppliers to report on their water use, risks and/or management.
- Targets: Whether companies have company-wide targets (quantitative) or goals (qualitative) related to water are these targets forward looking; do the targets relate to risk mitigation, improved water stewardship and sector best practice measures.
- Governance: Who has the highest level of direct responsibility for water within the organization and how frequent are the briefings on water issues.
- External and internal regulatory adherence and management: Is water risk addressed in company filings/websites, does this relate to external/internal water management schemes, alternative regulatory or voluntary water schemes or water stress testing.

The metrics are collated based on the weighting of each section to determine the overall water risk management rank.

Limitations

- Asset level data was not verified by every company within the sample, and therefore there could be inaccuracies within the dataset.
- Where decommissioning dates were not provided, we used the locked-in emissions model to predict likely shutdown dates. These are estimates and actual shut down dates will vary from the estimates.
- In relation to water use, the water cooling technology used with power plants is often more important than the fuel type employed. It was therefore difficult to compare water withdrawal or consumption intensities between companies, as a higher water withdrawal does not necessarily correspond with poor water management and vice versa. For example, a gas power plant in a water abundant area may employ a once-through-cooling system where large volumes of water are withdrawn for cooling before a similar volume of water is discharged. Conversely, a similar gas plant in a less water abundant area may try to conserve its water resource by employing a closed loop water system where smaller volumes of water are withdrawn but the majority of the water is consumed. With this in mind, it becomes difficult to accurately compare companies water use without facility by facility level information relating to the cooling technology employed.

Transition opportunities

The overall transition opportunities rank and grade is determined as follows:

- We combine the weighted ranks of the five metrics using the following weightings: metric 1) 25%, metric 2) 15%, metric 3) 15%, metric 4) 15%, metric 5) 30%. This determines the overall weighted rank for transition opportunities.
  The transition opportunities grade is awarded according to the overall weighted rank.

We apply the following methodologies to calculate the weighted rank for each metric:

Metric 1) Generation from renewables

- We collate generation levels (GWh) for 2015 and 2016 from annual reports and data reported to CDP.
- The proportion of other renewables (includes solar, wind, biomass and geothermal) and proportion of hydro are calculated as percentages of total generation in 2015 and 2016 and the average is then taken.
- The weighted rank for the metric is calculated by applying a 75% weight to the proportion of other renewables generation and 25% weight to the proportion of hydro generation.

Metric 2) Change in installed renewable capacity

- We collate installed capacity data (MW) for the period 2010 – 2016 from annual reports and data reported to CDP.
- The proportion of other renewables (includes solar, wind, biomass and geothermal) is calculated as a percentage of total installed capacity.
- We calculate the CAGR for proportion of installed capacity of other renewables over 2010–2016.
- For the domestic market CAGR, we use wind + solar consumption CAGR as a proxy (as wind and solar make up on average 85% of other renewables for the companies). This is calculated using Eurostat and BP statistical review data on electricity consumption by country and % share of wind + solar generation.

- We express the company CAGR 2010-2015 as a ratio of the domestic market CAGR 2010-2015.

- The weighted rank for the metric is calculated by applying a 60% weight to the company CAGR and 40% weight to the ratio of company CAGR to domestic market CAGR.

Metric 3) Renewable targets

- We collate data for renewable targets (includes other renewables and hydro) from company reports, investor presentations and responses to the CDP climate change questionnaire, section CC3.1d.

- Percentage renewable capacity targets from companies are linearly extrapolated to an equivalent target for 2020 to allow for comparison. Where a clear renewable target is not disclosed, planned renewable capacity additions are used, with total capacity assumed constant from the 2016 total.

- We calculate the CAGR for proportion of installed capacity of renewables over 2015–2020.

- The weighted rank for the metric is calculated by applying a 70% weight to the 2020 renewable capacity target and 30% weight to the CAGR over 2015-2020.

Metric 4) Smart services & innovation

- We collate financial data, R&D expenses, the cumulative number of smart meters installed and the number of customers for each company. Data is sourced from company reports, investor presentations and data reported to CDP.

- We express the cumulative number of smart meters installed as a percentage of the total number of customers for each company.

- We rank companies on their average R&D expense to sales ratio over the period 2014-2016. This provides an indication of companies' innovation capability and level of focus on innovation.

- The weighted rank for the metric is calculated by applying a 60% weight to smart meters per customer and 40% weight to R&D expenses to sales ratio.

Metric 5) Capital flexibility and CAPEX strategy

- We collate financial data and details for planned capital expenditure from company reports, investor presentations and responses to the CDP climate change questionnaire, section EU4.3.

- Future capital expenditure is split by business area for each company. Companies are ranked based on the percentage of capital expenditure allocated to renewables as well as other smart energy solutions such as connected home and digitalization.

- In addition we rank the percentage of growth CAPEX relative to maintenance CAPEX. (Where maintenance CAPEX is viewed as the necessary expenditure to keep existing operations running).

- As a measure of capital flexibility Economic net debt / EBITDA is calculated for 2016 where Economic net debt = net financial debt + provisions for pensions + provisions for asset retirement obligations

- The weighted rank for the metric is calculated by applying a 45% weight to the future CAPEX rank, 30% weight to % growth CAPEX and 25% weight to Economic net debt / EBITDA.

Limitations

- Future company commitments on spending plans are not binding and can develop with company strategic decisions.

- Smart meter deployment is also dependent on government support and regulation.

- To allow for comparison planned renewable targets were linearly extrapolated to an equivalent target for 2020. Therefore specific complexities for each company target were not accounted for by the analysis.

- There is a lack of cross-company quantitative data when assessing performance in areas such as smart services, digitalization and technology. Many companies report on innovative product offerings but do not disclose data such as number of units sold or number of customers using an innovative new service. Some companies have started to highlight specific investment in areas such as digitalization but in general communication could be better.

Climate governance and strategy

The overall climate governance and strategy rank and grades are determined as follows:

- We combine the weighted ranks of the seven metrics using the following weightings: metric 1) 35%, metric 2) 10%, metric 3) 10%, metric 4) 10%, metric 5) 10%, metric 6) 10% and metric 7) 15%. This determines the overall weighted rank for climate governance and strategy.

- The climate governance and strategy grade is awarded according to the overall weighted rank.

We apply the following methodologies to calculate the weighted rank for each metric:

Metric 1) Emissions reduction targets
We combine four underlying factors using the following weights: metric 1a) 20%, metric 1b) 40%, metric 1c) 20%, metric 1d) 20%.

Metric 1a) Science Based Target approved/committed

- We identify which companies have an approved science based target published by the Science Based Targets Initiative, and rank approved companies equal first. Ranking behind these are companies that have publicly committed to setting a science based target in future with the SBTI. Companies with neither approved targets or commitments rank equal last.

Metric 1b) Quality of target

- We start by modelling companies' target emissions intensity trajectory by calculating an assumed linear pathway between their base year and target year, using the base year emissions intensity and disclosed percentage reduction over the target lifetime.

- We compare this with the emissions intensity for EU power generation calculated from forecasted emissions and power generation output for 2013-2050 from the IEA's 2-degree scenario included in IEA Energy Technology Perspectives 2016.

- We compare company target pathways against the 2DS pathway by calculating the average annual difference between the two pathways, and rank the company beating the 2DS the most first.

Metric 1c) Implied yearly emissions intensity reduction

- We use the base year, target year and percentage reduction over the target lifetime to calculate an annual yearly target ambition level, and rank the company with the highest annual emissions intensity reduction target first.

Metric 1d) Performance against target

- Building on the methodology used in metric 1b, we compare company target pathways against their actual emissions intensity performance in 2015. Emissions intensity was a metric covered in the Transition Risks section of the report and is applied again here. Companies that have 2015 emissions intensities below levels implied by their target pathway rank highest.

- Where 2015 is also the base year of the company's most substantive target, meaning it was impossible to assess progress against it in 2015, we assessed what had previously been their most substantive target, if they had a prior target.

Important notes:

- Our assessment of the emissions reduction targets should not be interpreted as an indication that any individual company's target would be approved as being 'science-based' by the Science Based Targets initiative.

- We assess company targets on an emissions intensity basis. Where companies disclosed intensity-based and absolute targets with a similar scope, we analyzed the most comprehensive intensity-based target in order to avoid a need to make assumptions about future electricity production in converting the absolute target into an intensity. Where there is no intensity target, we converted the absolute target to an estimated intensity target.

Metric 2) Board climate responsibility

- We assessed the level of climate expertise among board members. A 'climate experienced individual' was considered to be someone with direct experience of climate-related issues within business, policy or academia. We ranked companies on the percentage of their board members that were considered to be 'climate experienced individuals'.

- A scorecard was developed to assess the levels of climate change risk management throughout a company. Companies were initially scored based on their responses to CDP climate change questionnaire CC1.1 and CC1.1a. Further information was acquired from company's own public reporting and this allowed for a quantitative assessment. 25% of the weighting of this was attached to answers to specific questions over the level of climate change risk management at board level. 75% of the weighting related to a qualitative assessment of the disclosure of climate change responsibility across the company, from board to operational level.

- The weighted rank for this metric is calculated by applying a 50% weight to the board level climate expertise section and a 50% weight to the board climate responsibility section.

Metric 3) Climate-related remuneration

- We assessed companies based on responses to CDP climate change questionnaire CC1.2 and CC1.2a on incentives for the management of climate change issues, including the attainment of targets. We scored companies based on these responses and sought further information from the company's own public reporting. The focus was on the CEO's remuneration, examining both the short term and long term climate-linked metrics that comprised the annual remuneration scheme as well as the long-term incentive plan. The climate-linked metrics focused on indicators such as company performance against emission reduction or energy intensity targets.

- The weighted rank for this metric is calculated by applying a 40% weight to the short-term remuneration and a 60% weight to the long-term remuneration.

Metric 4) Low carbon strategy

- We developed a scorecard based on responses to CDP climate change questionnaire CC0.1, CC2.1a and CC3.1b for indications of a low carbon strategy and climate-risk understanding and preparation. We also sought further information from company's own public reporting. All metrics are weighted equally.

- The weighted rank for this metric is calculated by applying a 100% weight to the low carbon strategy and risk scorecard.

Metric 5) Use of an internal carbon price

- We collect data on the use of internal carbon prices from companies' responses to question CC2.2c-d from the 2016 CDP climate change questionnaire.

- We adopt a scorecard approach to assess companies based on their application of an internal price on carbon. Companies that disclose that they apply an internal carbon price of a sizeable disclosed magnitude in capital investment decisions, apply multiple discrete scenarios for carbon prices, have senior level oversight of the price setting process, and frequently update the prices based on new policy and market developments rank higher.

- Companies that do not provide evidence of applying internal carbon prices significantly higher than current EUA prices score lower, while companies that disclose no use of an internal carbon price rank last.

Metric 6) CDP Climate Change Program Score

- The scoring methodology is a means to assess the responder's progress towards environmental stewardship as communicated through the company's CDP response. The methodology ultimately yields a score based on the evaluation. The scoring methodology assess the level of detail and comprehensiveness in a response, as well as the company's awareness of environmental issues, its management methods, and progress towards environmental stewardship. CDP is committed to transparency and as such provides the full scoring methodology for every program online, alongside webinars and explanations.

Metric 7) Carbon regulation supportiveness

Our CDP carbon regulation supportiveness metric uses InfluenceMap's total score which combines the company organization score and relationship score according to their proprietary algorithm. A full description of InfluenceMap's detailed methodology can be found on its website. Its methodology comprises three stages: (a) aggregation of suitable data sources (SEC disclosures, legislative consultations, CDP responses etc.); (b) assessment (via raw scores) of those data sources using suitable queries; and (c) input of the raw scores and other factors into its algorithm to arrive at comparable metrics of regulatory supportiveness for corporations. It analyzes these data sources with a series of 12 queries relating to various aspects of climate change policy and legislation. It then scores each data source/query intersection (or cell) on a 5-point scale, with clearly consistent evidence and guidelines.

- Organizational score is computed over 96 scoring cells by InfluenceMap's proprietary algorithm that accounts for weightings and irrelevant data sources/queries. The organizational score is expressed as a percentage, with 100% representing very supportive influence on climate policy.

- Relationship score is a reflection of a corporation's climate influencing activities through its influencers (i.e. trade association etc.). The relationship score is also expressed as a percentage, with 100% representing very supportive influence over climate policy.

- The weighted rank for the metric is calculated by applying a 100% weight to InfluenceMap's total score.

Limitations

- Judgement of professional climate experience was made using publicly available biographies and Board of Director profiles. These searches could have inadvertently failed to identify some relevant director backgrounds.

- The breakdown of both the short-term and long-term remuneration schemes was often not disclosed very clearly or in some cases was not disclosed at all. This led to some assumptions being made (eg. equal weighting between four listed factors if individual weightings were not disclosed) and if there was a real lack of disclosure then a score of zero was awarded.

Notes:

Design and production:

Printing:

bicyclebutter@gmail.com

CDP Investor Research

Tarek Soliman, CFA
Senior Analyst
+44 (0) 20 3818 3961
tarek.soliman@cdp.net

Drew Fryer, CFA
Senior Analyst
+44 (0) 20 3818 3935
drew. fryer@cdp.net

Luke Fletcher
Analyst
+44 (0) 20 3818 3951
luke.fletcher@cdp.net

Tom Crocker
Analyst
tom.crocker@cdp.net

James Smyth
Analyst
james.smyth@cdp.net

CDP contacts

Frances Way
Co-Chief Operating Officer

Rick Stathers
Head of Investor Initiatives
+44 (0) 20 3818 3956
rick.stathers@cdp.net

Cynthia Simon
Senior Manager,
Investor Initiatives North America
+1 646 517 1469
cynthia.simon@cdp.net

Emma Henningsson
Senior Account Manager,
Investor Initiatives
+46 (0) 705 145726
emma.henningsson@cdp.net

Agnes Terestchenko, CFA
Senior Manager,
Investor Initiatives North America
+1 646 668 4186
agnes.terestchenko@cdp.net

Brendan Baker
Senior Manager,
Investor Initiatives
+44 (0) 203 818 3928
brendan.baker@cdp.net

Henry Repard
Account Manager,
Investor Initiatives
+44 (0) 203 818 3928
henry.repard@cdp.net

Sebastian O'Connor
Senior Project Officer,
Investor Initiatives
+44 (0) 20 3818 3900
sebastian.oconnor@cdp.net

Dr. Paul Griffin
Energy Data Analyst, CDP Technical Team
paul.griffin@cdp.net

CDP Board of Trustees

CDP UK
71 Queen Victoria Street
London EC4V 4AY
United Kingdom
Tel: +44 (0) 20 3818 3900

@cdp
www.cdp.net
info@cdp.net