How European Utilities Can Capitalize on New Emission Limits to Drive Decarbonisation

The Case of Endesa

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Executive Summary

Two of Europe's biggest utilities, Enel and Engie, are on track to becoming modern, progressive energy companies with their focus on decentralised, digital technologies that save money, cut emissions and serve customers.

However, Enel's Spanish unit, Endesa, still has one foot in the past, as it argues for the benefit of keeping older fossil fuel generation online for another 15 years.

Enel and Engie are large, diversified, multinational utilities with progressive plans to boost renewable generation, customer service and reliability through digitalisation and, ultimately, to exit coal generation. In its present strategic programme, Engie has said a driving theme will be "low carbon power generation." Enel's CEO said last year that "renewables will become the backbone of generation of modern utilities going forward." Both utilities have significantly out-performed indices of European utility stocks year to date, likely due at least in part to these progressive policies.

But both utilities remain trapped to some extent by their coal generation legacy.

Enel's 70 percent-owned Spanish subsidiary, Endesa, is planning to invest €400 million into environmental upgrades at three older, more polluting coal-fired power plants, to bring them into compliance with new European Union air emissions standards. This strategy is inconsistent with Enel Group's over-arching vision of shutting down coal. The three power plants are called Litoral, AS Pontes and Alcudia. ,

Meanwhile, Engie recently started up two brand new coal-fired power plants (Rotterdam and Wilhelmshaven in the Netherlands and Germany) that have weighed on the company's financial performance. Engie also sold, instead of closed, its Polaniec coal-fired plant in Poland in 2016. That plant, at the time its dirtiest generating facility, is still operating under a new owner, which could have a negative reputational impact for the French firm going forward.

Tighter EU air pollution limits that take effect in 2021 present Enel, in particular, with a strategic choice: hang onto the past or move forward aggressively with its coal phaseout plans, using funds saved from coal-related environmental upgrades to pay for renewables growth and other strategic objectives such as grid digitalisation.

Following are our main findings and concerns:

- The Endesa investment is likely to end up stranded if the EU, as expected, proceeds with commitments related to the 2015 Paris Agreement on climate change. The Agreement effectively mandates the phaseout of coal-fired generating on the continent by 2030 or soon thereafter. Mandated coal power plant retirements, or related policies which raise carbon prices, would reduce the opportunity for Endesa to recoup its investment on the environmental upgrades. For example, at the time of publication, Britain had confirmed a coal phaseout date of 2025. And the Netherlands had just introduced a new phaseout plan, targeting 2030, which directly impacts Engie's new coal plant at Rotterdam. Endesa has an opportunity to avoid such impacts, at its planned new investments in Litoral, AS Pontes and Alcudia. The utility should not look the other way.

- Under a regulation introduced in 1997 at a time of rapidly rising demand, the Spanish government prevents the mothballing of idle generation. The regulation, now used by a government seeking to block coal power plant closures, is redundant in an electricity system with substantial over-capacity. Spanish electricity demand has fallen over the past 10 years, and in Spain and in Endesa's fleet alike there is plenty of under-used capacity.
- Enel Group has made clear that it plans to close two other, even more polluting Endesa coal power plants, Teruel and Compostilla, that traditionally burned subsidised Spanish coal. These subsidies are scheduled to end in 2018, which would make the plants uneconomic. Yet Endesa has indicated it would like to continue operating Teruel, if political support (that is, additional subsidy), was forthcoming. We see no strategic fit for Teruel and Compostilla in Enel's plans going forward, in the context of pending air emissions rules, coal economics and decarbonisation trends.
- Prices for supplying renewable energy have fallen sharply in recent years and are predicted to continue dropping, making wind and solar power a compelling choice. The funds for the planned coal modernisation efforts at Litoral, AS Pontes and Alcudia, which covers more than 3 gigawatts of capacity, inevitably will crowd out other investments, slowing Endesa and the wider Enel Group's more progressive efforts in forward-looking alternatives, including renewables, digitalisation and customer services.

The tighter EU air pollution standards that take effect in 2021 offer Engie, Enel and Endesa a strategic opportunity to break with their coal legacies and move forward with their stated plans to build more renewables generation.

Endesa's decision to upgrade Litoral, AS Pontes and Alcudia poses a special challenge for parent Enel, which says it is one of the world's largest producers of clean energy, and which intends to be carbon neutral by 2050. Endesa's plans to upgrade its coal-fired fleet, for years of continued operation, poses reputational and regulatory risks for Enel and its leadership.

A close look at Endesa's financials for the first half of 2017 adds to the economic argument against the upgrade investment. The company's coal generation climbed in the first half of 2017, but earnings fell due to lower margins and the costs of coal-generated carbon emissions. According to company documents, its costs to comply with the EU emissions trading scheme rose by €30 million.

As we show in this report, Enel Group would do well to turn the page on its coal legacy, and close the three Endesa power plants in question, Litoral, AS Pontes and Alcudia, as well as Teruel and Compostilla, whose SOX and NOX emissions are all far above the new EU limits.

Endesa itself already has progressive plans, winning two renewable energy tenders in Spain earlier this year. The projects, a 540 MW wind facility and a 339 MW solar unit, should produce "low-double digit" returns, the utility said. That is almost certainly superior to returns it can expect from investing in aging coal plants in the over-supplied Spanish power sector that is becoming increasingly connected to the broader European electricity market , and is less exposed to risks stemming from tighter policies on air quality and climate change.

Introduction

In April 2017, European Union member states agreed to a new round of revised pollution controls for large combustion plants (LCP), written in a Best Available Techniques Reference Document (BREF). EU member states must incorporate the new, stricter pollution rules into permitting criteria for new and existing power plants, with full implementation no later than 2021.

This report follows our earlier assessment of the Revised LCP BREF (henceforth referred to as BREF), which identified some of the most affected fossil fuel and biomass power plants.[1] Specifically, we identified more than 100 installations where emissions are more than 40 percent higher than the new BREF limits for SOX and NOX.

What is BREF?

BREF refers to the Best Available Techniques (BAT) that large combustion plants must use to improve their efficiency and cut emissions of toxic pollutants such as oxides of sulphur (SOX) and nitrogen oxides (NOX) under the European Union's Industrial Emissions Directive (IED). BREF also imposes limits on emissions of mercury and particulate matter (PM), and sets standards for energy efficiency. The underlying goal of BREF is to improve air quality. NOX can react with organic carbons in the atmosphere to form ground-level ozone, a dangerous cause of respiratory diseases. Both SOX and NOX contribute to the formation of secondary particulate matter (PM) in the atmosphere. In Europe, PM and ground-level ozone are the air pollutants most damaging to human health.

This report examines the impact of revised BREF air pollution standards, agreed to by a committee of European Union member states on April 28, 2017. BREF is significant, because its associated emissions levels (AELs) set the reference emissions levels for permitting large combustion plants (LCP), which includes all plants larger than 50 megawatts, by member state regulators across the EU. These permits determine whether a new power plant can be built, and whether an existing power plant can continue to operate.

The revised BREF was developed over the past several years by a technical working group (TWG) nominated by a forum comprising representatives of industry, environmental groups, EU member states and the European Commission. The updated standards take into account the development over the past decade of new technologies and processes to curb pollution.

The revised BREF limits that take effect in 2021 will take the place of existing controls agreed to in 2010 under the IED. Under these controls, utilities have three choices: meet the emissions limits from January 2016 ("opt in"); commit to run no more than 17,500 hours and then close by 2023 ("opt out"); or meet the limits over time and no later than June 2020 (under a "Transitional National Plan"). Most Endesa coal power are in the Spanish TNP. Alcudia was allowed more time to meet the IED limits under a different derogation, as a power plant on an isolated island grid.

[1] http://ieefa.org/wp-content/uploads/2017/05/Europe-Coal-Fired-Plants_Rough-Times-Ahead_May-2017.pdf

Non-compliant combustion plants have until 2021 to comply with the revised BREF, or else close the facilities, or sell the assets to other interested operators. It is beyond the scope of this paper to examine the detailed economic implications of BREF for individual power plants and utilities. However, we note that in the case of SOX control, the applicable technologies include flue gas desulphurisation (FGD) and dry sorbent injection (DSI). In the case of NOX control, technologies include selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR). The U.S. Energy Information Administration recently published data on the cost and installation time of these technologies.[2] For the most-involved upgrades, using SCR and FGD, these costs exceed $70/kW capacity, and installation time tops 45 months. Given this extended installation period, utilities must decide immediately whether to proceed with upgrades to meet the 2021 BREF deadline. If they opt to go forward, these investments would obviously compete for scarce capital funds, and force the utilities to wait until the new systems were up and operating in 2020-2021 before beginning to recover their costs.

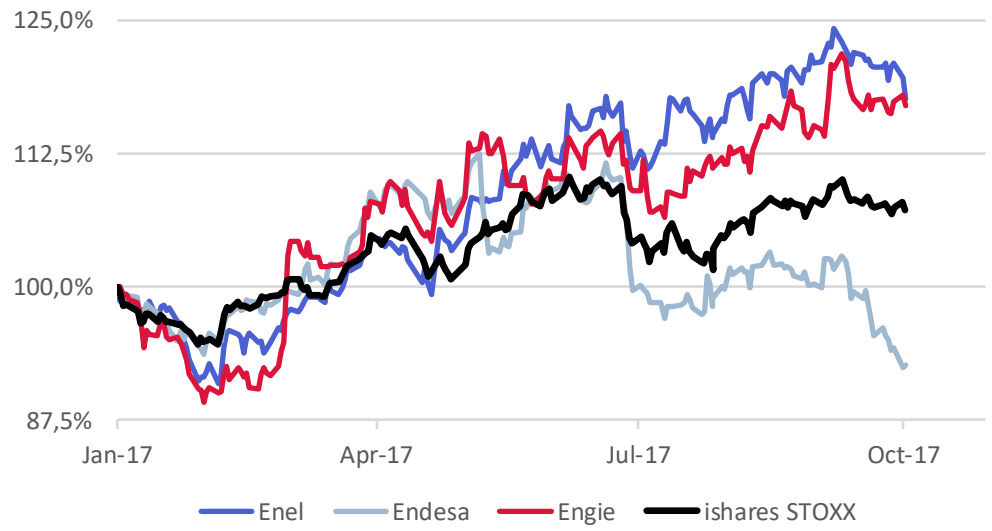
Focus Utilities

This follow-up report investigates BREF impacts on two utilities, Enel and Engie. We focus on these as two aspiring low-carbon utilities with active strategies to exploit trends in decarbonisation and digitalisation. Both plan an exit from coal power generation to renewables. We also include a separate analysis of Endesa, Enel's 70%-owned Spanish subsidiary, given its distinct profile from Enel.

This report explores whether it makes economic, financial and strategic sense for each utility to use the new BREF standards to drive a faster transition by closing or selling their most polluting coal-fired power plants. We note that their decarbonisation and digitalisation strategies already position Enel and Engie as relatively progressive utilities, and they have significantly out-performed the iShares index of European utilities year-to-date (see Figure 1). Their outperformance over the more coal- and nuclear-oriented Endesa is also noteworthy. Given such out-performance, it would seem logical for both utilities to adhere closely to their existing coal-exit strategies.

[2] https://www.eia.gov/todayinenergy/detail.php?id=32952

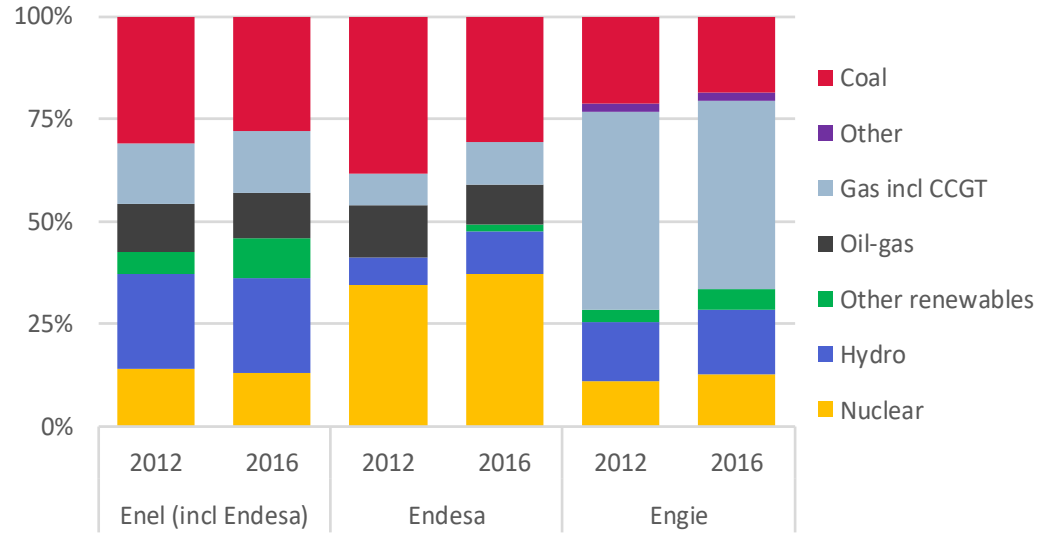
Figure 1. Share price change YTD: Enel, Endesa, Engie and iShares Europe Utilities ETF



Source: Own elaboration on Yahoo Finance data; Note: 1/1/2017 = 100% for all series.

Figure 2 summarises recent trends in the generation profile of the two utilities plus Endesa. The table shows that coal's share of the three companies' generating profile has declined since 2012, while the amount of non-hydro renewable generation has climbed, although hardly at a record-setting pace. Overall, Engie is still a gas-heavy generator, while Endesa's assets remain largely coal and nuclear. Enel's generation base is more evenly split, but it still relies on coal for more than 25 percent of its generation.

Figure 2. Generation profile, Enel, Endesa and Engie (% of TWh)



Source: Own elaboration on company financial data.

Points of similarity between Enel and Engie include:

- They have targets to reduce coal power. Enel has a target to be fully decarbonised by 2050, and is presently decommissioning 13 GW of older thermal generation in Italy. Engie is presently eliminating some "coal, merchant and non-core assets" in a €15 billion (by net debt) disposal programme.
- They have "digitalisation, decarbonisation, decentralisation" strategies targeting growth in renewables and downstream customer services.
- They have global diversified generating portfolios including renewables, coal, gas and nuclear.
- They have a large international presence. Enel has generation and distribution assets in Europe; Latin America; North America; and Russia. Engie's focus is Europe, but the utility has more than a tenth of its business (by EBITDA) in Latin America, followed by North America.

Points of contrast include:

- Engie has a gas exploration and production business, and unlike Enel, explicitly sees gas as a central part of its energy mix going forward.
- Enel's Spanish subsidiary, Endesa, highlights a need for Enel to expand its environmental leadership and ambitions beyond Italy.

Coal Power in Europe: Technological and Political Headwinds

Tougher pollution limits under BREF add to multiple headwinds facing fossil fuel power plants in Europe. Coal is the most carbon-emitting and polluting form of power generation, and multiple alternatives are already available at similar or lower cost. There are particular risks for coal in Europe: the European Union has been a world leader on climate action, with most member states acknowledging a moral imperative to cut carbon emissions faster than emerging economies; and the EU has an organised environmental movement that is highly motivated to highlight climate and health risks.

The impacts of technology change and climate action may include: further growth in renewable power; flat electricity demand growth on the back of greater moves on energy efficiency; higher carbon prices; and lower wholesale power prices. Impacts on coal power may include: higher costs; phaseout targets; reputation risk; and lower capacity factors. Under more ambitious climate action scenarios, unabated coal power generation simply has no future in Europe, even in the near term.

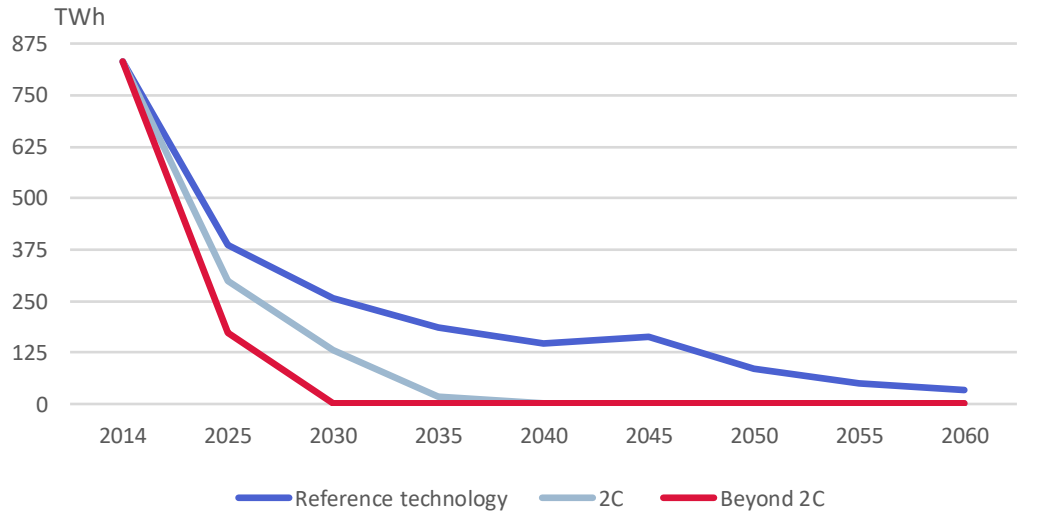
We note that at the time of publication, Britain had confirmed a coal phaseout date of 2025, and the Netherlands had just introduced a new phaseout plan, targeting 2030.

In a recent report, the International Energy Agency (IEA) described three scenarios for coal generation in Europe: present policy plans ("reference technology"); additional steps to limit global average warming to 2 degrees Celsius ("2C" scenario); and the further steps needed

to limit warming to 1.75C ("beyond 2C").[3] Under the international Paris Agreement two years ago, countries committed to limit warming to "well below" 2C. The IEA shows that such a goal would imply phasing out coal in Europe by 2030. Even its more modest "2C" and "reference" scenarios would see a collapse in generation (see Figure 3 below).

Such analysis underscores how ambitious climate action is incompatible with continued coal-fired power generation in developed economies. That in turn illustrates the risk of investing in significant environmental upgrades at power plants that may have to be retired soon after. Utilities should acknowledge in their retrofit cost estimates the risk that these power plants may have to close by around 2030. Such a compressed lifespan may undermine the retrofit investment case. If utilities do not acknowledge such risks, then investors should be aware that the retrofit investments may become stranded by climate action policies.

Figure 3. Coal generation in Europe under a range of IEA scenarios, TWh, 2014-2060



Source: IEA

[3] http://www.iea.org/etp/

Changing Utility Strategies: A BREF Perspective

Enel and Engie are changing their strategies to reflect these new headwinds. BREF adds a new challenge, but also presents an opportunity for the two companies to double down on their low-carbon strategies and accelerate planned technology and cost-driven shifts. Against the general backdrop of Enel's global strategic plan, the position of its Spanish subsidiary Endesa, merits a separate discussion.

Enel

Enel's 2017-2019 strategy is built around "seven pillars": digitalisation; operational efficiency; industrial growth; customer focus; group simplification; active portfolio management; and shareholder remuneration.

Enel's strategy fits within a previously announced goal to be globally decarbonised by 2050. In 2016, 46% of Enel's generation was zero emissions. Under the 2017-2019 strategic plan, that will rise to 56% by 2019. One initiative under the decarbonisation programme is a "13GW decommissioning programme" in Italy. The group is actively growing renewables, which account for by far the biggest share of growth capex in 2016.[4] The Group reports a 20 GW pipeline of non-hydro renewables.[5] However, it is noteworthy that the vast majority of this pipeline is in the Americas (70%), with just 1% in Italy, and 22% elsewhere in Europe, with the remainder in Africa and Asia.

Enel Group CEO, Francesco Starace (Dec 2016) states:

> "We think renewables will become the backbone of generation of modern utilities going forward, complemented by thermal generation for a couple of decades. Global thermal generation will be able to sustain this transition over the years, provided it is more efficient, less polluting and managed extremely well."

There are two items in Enel's strategy that are particularly relevant in relation to the new EU air pollution standards: reducing maintenance capex and portfolio management.

1. Reducing maintenance capex

In its 2017-2019 strategic plan, Enel has prioritised reductions in maintenance capex and operating expenditure. Maintenance capex competes directly for company cash with net growth capex. We note Enel's ambitious growth plans in its networks (smart meter rollout and digitalisation of generation assets) and renewables businesses. To achieve these growth goals, and assuming no additional recourse to debt, it will have to limit maintenance capex as far as possible. In fact, Enel says it will invest some €500 million in environmental upgrades of coal power assets through 2019, especially in Spain (see below).

[4] https://www.enel.com/content/dam/enel-com/investors/Enel_FY2016_consolidated_results_17Mar17.pdf

[5] https://www.enel.com/en/media/news/d201611-capital-markets-day-2016-enel-presents-2017-2019-Strategic-Plan.html

2. Active portfolio management

Under its strategic plan, Enel anticipates €3 billion in plant disposals, including thermal generation assets by 2019. For reputation and/or economic reasons, it may make more sense to implement a phased closure plan of more polluting assets, rather than to sell them. We note that Enel already has a forward-looking approach to coal retirement in Italy, under its Future-e programme, which aims to find new uses for 23 fossil fuel power plant sites including former coal power plants.[6]

Endesa

Endesa states that it is the leading company in the Spanish electricity sector and the second operator in the Portuguese electricity market. Enel currently owns 70% of Endesa. Crucially, for this report, Endesa owns more than half of Spain's 10 GW of coal fired power plants.

In some ways, Endesa's 2017-19 strategy fits Enel's, for example targeting more than €1 billion investment in a digitalisation strategy, rolling out smart meters and automated grid control. Endesa also is expanding its renewable capacity, winning contracts to build 540 MW of onshore wind and 339 MW of solar PV in two Spanish auctions in 2017 to date.[7] Endesa stated that it expects to achieve a "low double-digit" internal rate of returns on these extremely cost competitive renewables projects.[8]

However, a conflict appears regarding Endesa's support for coal power. Endesa sees a benefit from keeping older fossil fuel generation online beyond 2030 in order to integrate renewables. As noted in its strategic plan: "Conventional generation is key to secure a successful and smooth transition. (We must) keep nuclear and efficient thermal plants beyond 2030 to secure a smooth transition avoiding new inefficient fossil investments."

The authors of this report confirmed with the Endesa Investor Relations team that the company plans to invest €400 million in upgrading three Spanish power plants, Litoral, AS Pontes and Alcudia. These upgrades are intended to achieve IED and BREF compliance ("life extension") beyond 2020 and 2021 respectively. The IR team expected the upgrades to extend the life of the power plants to 2030-2035. The planned investments break out like this:

- Litoral -- €100 million approved in 2014; IED compliance work to be complete in 2017; life extension to be complete by 2021; improvements include denitration system in both units and improvement of an existing desulphurisation system in Unit 2;
- AS Pontes -- €200 million approved in 2016; IED compliance work to be complete by 2020; investment includes installation of denitration system and a desulphurisation system; and
- Alcudia -- €100 million; to start in 2017 and to complete by 2021; investment includes installation of a denitration system and improvements to an existing desulphurisation system.

We see several arguments undermining Endesa's argument for supporting coal. First, from an environmental perspective, coal is an important source of carbon emissions and other

[6] https://www.enel.it/en/futur-e.html
[7] https://www.endesa.com/content/dam/enel-es/home/prensa/noticias/documentos/2017/05/endesa-energia-eolica-subasta-renovable.pdf and https://www.endesa.com/content/dam/enel-es/home/prensa/noticias/documentos/2017/07/endesa-se-adjudica-339-mw-capacidad-solar.pdf
[8] http://streamstudio.world-television.com/CCUIv3/frameset.aspx?ticket=184-185-18505&target=en-default-&status=ondemand&browser=ns-0-1-0-0-0&stream=html5-audio-32

pollutants. The environmental law think-tank, IIDMA, showed that between 2007 and 2015, Spanish coal power plants were responsible for half of the country's industrial sector carbon emissions; some 63% and 46% of SOX and NOX respectively; and 67% of particulate matter emissions.[9]

Second, from a grid security perspective, Endesa's CCGT power plants operated at exceptionally low capacity factors in 2017. Capacity factor refers to actual generation compared with the theoretical maximum. Endesa's CCGTs operated at a 12% average capacity factor during the first half of this year, notwithstanding a 208% increase in CCGT output compared with the same period the year before.[10] Similarly low capacity factors also affect other Spanish CCGTs.[11] In other words, there is ample existing gas generating capacity, both for Spain and for Endesa, to accommodate coal power retirements, without having to resort to building new gas power infrastructure. Greater penetration of zero marginal cost renewables will also hollow out the coal-fired power plant load profiles and hence operating rates, progressively undermining profitability.

Third, growing interconnection with France can be expected to increase available capacity and reduce wholesale power prices in Spain, further rebutting energy security arguments for supporting coal, and undermining the investment case for environmental retrofits of older coal-fired power plants to comply with BREF (see Box 1).

[9] https://www.elaw.org/system/files/attachments/publicresource/A-Dark-Outlook_Report_IIDMA.pdf

[10] We calculate this figure from the published first-half data for CCGT output of 3,052 GWh, from a capacity of 5.678 GW, which has a theoretical maximum output of 24,870 GWh over the six-month period. https://www.endesa.com/content/dam/enel-es/endesa-en/home/investors/financialinformation/financialresults/documents/2017/second_t/Consolidated%20Management%20Report%2030%2006%2017.pdf

[11] Spain's CCGT capacity factors were 20% or below in the first eight months of 2017, show data from the grid operator: http://www.ree.es/es/estadisticas-del-sistema-electrico-espanol/boletines-mensuales

Box 1. Spain case study: Power market politics

To inform our discussion of Endesa's power generation portfolio, we describe briefly the political and market context in Spain.

First, regarding the political context, Spain lacks a truly independent energy regulator. The present regulator, the Comisión Nacional de Mercados y la Competencia (CNMC), is responsible for enforcing competition law in multiple sectors, including energy, and says that some of its former powers have been reduced or taken by the industry ministry.[1]

Two political interventions in the Spanish power market are especially relevant to this report.

1. The Spanish government has subsidised domestic coal extraction and burning. Last year, the government agreed in a deal with the European Union to cease support for uncompetitive coal mines in 2018, but lobbies continue to press to extend such support. Spain also supports coal plants that burn imported coal through a capacity market.
2. Spain introduced a regulation in 1997 that prevents the mothballing of idle generation. The regulation had some relevance two decades ago, at a time of rapidly rising power demand. However, Spain's electricity demand has fallen over the past decade, and the power system now has significant over-capacity.

The combined effect of these two regulations has been to protect thermal power plants including coal. Contrary to Enel's goals, Endesa has continued to seek support for its two plants that burn domestic coal, Teruel and Compostilla. Subsidies for that domestically produced coal are scheduled to end in 2018, which would make the plants uneconomic. But Endesa's CEO Jose Bogas stated in July that he would be "very happy" to extend the life of these old and highly polluting power plants, if the Spanish government provided new support. Leaving aside the subsidies, the two plants are Endesa's most polluting (see charts at end of report) and either would have to be closed when BREF takes effect in 2021 or upgraded at significant cost.

Turning to Spain's market context, two features are especially relevant in this report: the country's over-capacity, and EU pressure to drive a more integrated power market that will require Spain to build more cross-border cables, called interconnection, with France.

1. Over-capacity. Capacity margin measures the excess of power supply over peak power demand. Grid operators generally target a capacity margin of 10-15%. In Spain, the capacity margin is presently 35%.[2] The result is that much capacity is idle, and in particular the country's CCGTs. Such over-capacity indicates that closing the country's most-polluting coal-fired power plants would not pose an energy security threat.
2. Increasing interconnection between EU countries is favoured by the European Commission to more efficiently match supply and demand and reduce power prices. Spain has one of the most isolated grids in Europe, and some of the highest wholesale power prices. The EU has set a target for member states to achieve interconnection equivalent to 10% of domestic installed generating capacity by 2020, and 15% by 2030. In Iberia (linking Spain and Portugal to France), the figure is presently 2.4%. That will rise to 4.1% in 2020, and projects are currently proposed to meet the 2030 target. By exerting downward pressure on power prices, and increasing available capacity, such interconnection will further disadvantage old, polluting coal, and rebut energy security arguments for continuing support.

[1] https://www.efe.com/efe/espana/economia/la-cnmc-pide-mas-competencias-y-poder-sancionador-plantea-retocar-ley/10003- 3072174

[2] http://www.europarl.europa.eu/RegData/etudes/STUD/2017/595356/IPOL_STU(2017)595356_EN.pdf

Box 2 below discusses the negative impact of coal generation on Endesa's profits in the first half of this year. This negative impact raises a question mark over the €400 million Litoral, AS Pontes and Alcudia upgrades, regardless of the above arguments over grid security, air quality, local health and Spain's decarbonisation targets.

Box 2. Endesa first-half 2017 results: less profit for more coal generation

Endesa's results show its mainland electricity production during the first half 2017 was 29,601 GWh, 21% higher than the first half 2016, as detailed below:

- CCGT power plants (3,052 GWh, +208.3%);
- Coal-fired plants (10,362 GWh, +82.2%)
- Nuclear power plants (13,096 GWh, +2.0%)
- Hydroelectric power plants (3,091 GWh, -38.1%)

Notwithstanding this growth in electricity output, overall year-on-year EBITDA (earnings before interest, tax, depreciation and amortisation) for the Generation and Supply segment was down sharply, by nearly €300 million (-41%). Importantly, 21% of this EBITDA came from renewable power, through Enel Green Power Espana (EGPE). It is telling that EGPE made a net positive contribution to the bottom line. Conversely, the company's coal-fired generation did not fare so well. In the first half of the year, according to Endesa, its fuel costs increased by 70% year on year, compared with a 50% rise in electricity prices. Hence, Endesa's profits fell the more coal and gas it burned to generate power.

It is worth noting that coal plants also contribute to global warming, and so are subject to the EU emissions trading scheme (ETS). The cost of carbon emissions permits has financial consequences for Endesa. In Endesa's H1 2017 consolidated results document, it highlighted that the "€30 million increase in the costs of carbon dioxide (CO2) emission rights, [is] mostly due to increased thermal production."

Why does Endesa want to hang on to its coal assets, if they are costly or under-performing?

First, Endesa's gas power margins are hurt by expensive oil-linked gas procurement contracts. In H1 2017 EBITDA, these contracts resulted in a €130 million impairment, from marking to market the gas portfolio. This is at a time when the trend in Europe is for generally cheap gas market prices to expose coal generation margins to further deterioration as CCGTs come into the money. However, these prohibitively expensive gas contracts will expire over time, increasing the competitiveness of gas-fired generation at Endesa, and thus loosening the present constraint on CCGTs. In turn, that will undermine any need for continued generation at the utility's oldest, most polluting coal power plants.

Second, Endesa has more customers than its own generation enables it to serve, and so it is exposed to unpredictable wholesale power prices. As a result, from the company's perspective it makes sense to want to hold on to its installed coal generation.

But is it worth it? How many gigawatts, in addition to Teruel and Compostilla, could Endesa afford to retire? Would it matter, for example, if the Litoral, AS Pontes and Alcudia, plants were closed instead of sinking a further €400 million into them to comply with the EU's new air quality standards? The following arguments support the closure of these three coal plants:

- It would be more in line with Endesa's parent company's global leadership and ambition. Enel should not fall short of its strategic environmental ambitions because of Endesa (see Box 1).
- It would help the environment, and prevent adverse health effects on local populations, and thus boost perceived corporate social responsibility.
- It may improve margins, given recent historical thermal performance (see Box 2).
- Retirement may have limited cost, given these assets are largely or fully depreciated. Table 1 in the Appendix shows that Teruel, Compostilla, AS Pontes, and the older units at Alcudia and Litoral will all be more than 35 years old in 2021, and so will have recovered most if not all their investment costs (i.e. they will be fully depreciated).
- It may improve company valuation. While such matters are not in the scope of the present paper, we point out that at the time of publication only 5 of 21 equity analysts rated Endesa a buy or overweight; the consensus is "hold".

Engie

Engie states that its present 2016-2018 strategy will "transform" the company. The present centrepiece is a disposal programme to reduce net debt by €15 billion, plus a corresponding programme of €15 billion growth capex. In addition, the 2016-2018 programme includes €7 billion maintenance capex.

The disposal programme is intended to exit non-strategic assets, and specifically "coal, merchant and non-core assets." The three growth themes are: "global networks," such as regulated gas infrastructure; "customer solutions," including district heating and cooling; and "low carbon power generation," prioritising gas and renewables.[12] Engie reports a renewables pipeline through 2021 of 11 GW and 7 GW of gas.

These three themes would receive around €12 billion in growth capex, with the remainder going to gas exploration and production (c. €2bln), and "legacy thermal" power assets (c. €1.5bln).

BREF Power Plant Analysis

In this section we analyse the most recent data for the emissions rates of power plants owned by Engie, Enel and Endesa, and we compare them with the revised BREF limits that take effect in 2021.

The power plant emissions analysis in this report is based on data from the EEA for emissions of air pollutants from large combustion plants, and it uses 2015 data – the most recent available – except for historical trends, where we use data for 2009-2015. We focused our assessment on power plants larger than 50 megawatts thermal capacity (MWth) that burn solid fuels, i.e. coal,

[12] http://www.engie.com/wp-content/uploads/2012/04/engie-iw2016.pdf

lignite (a very low-quality form of coal intermediate between bituminous coal and peat) and biomass.

We converted EEA emissions data, expressed in tonnes of SOX and NOX annually, into milligrams per standard cubic metre of flue gases (mg/Nm3), to compare with the new BREF limits, also in mg/Nm3. Our method for this conversion is described in the Appendix. We note that we took a conservative approach. For example, our emissions estimates for AS Pontes are generally lower than Endesa's own estimates.[13]

The bubble charts in this section compare the SOX and NOX emissions in 2015 of selected Enel, Endesa and Engie power plants. The aim is to show which power plants are most vulnerable to BREF, and perhaps should be targeted for retirement. In the charts, power plants are each represented by a bubble. The width of the bubble represents exceedance of BREF standards. The larger the bubble, the greater the pollution rate. The vertical axis marks annual flue gas volumes (in standard cubic metres, Nm^3). The horizontal axis measures actual emission rates (in milligrams per cubic metre, mg/Nm^3). The larger and further to the right a bubble is, the more polluting the plant. The higher the bubble, the greater the fuel burn (measured by flue gas emissions in Nm^3).

SOX Emissions

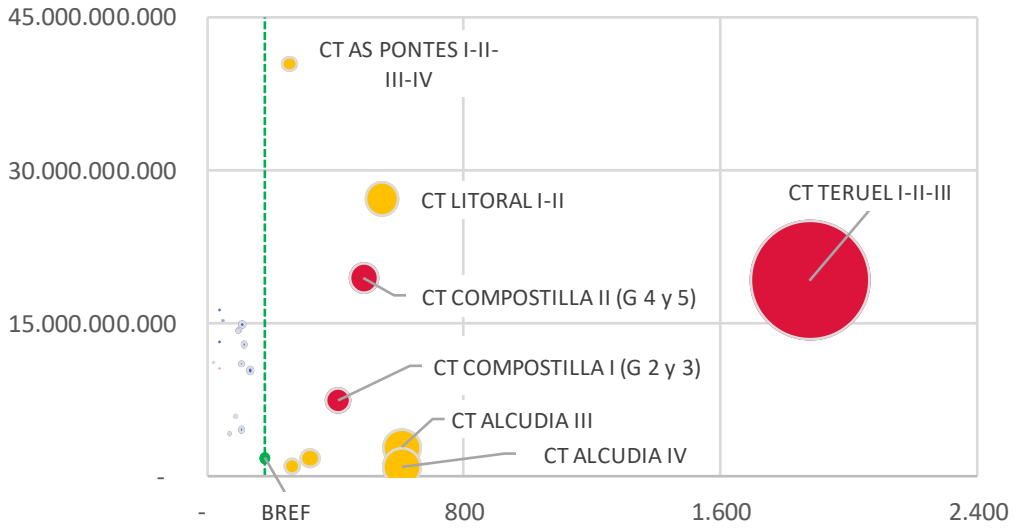
Figure 4 compares SOX emissions across selected Enel, Engie and Endesa power plants. The red bubbles show the power plants that Endesa expects to close: Teruel and Compostilla. The orange bubbles show the power plants Endesa has decided to upgrade, Litoral, AS Pontes and Alcudia. The far smaller, barely discernible blue bubbles belong to Enel, and the pink bubbles belong to Engie. The green bubble represents the BREF standard.

Teruel stands out, with monster SOX emission rates, more than 10 times the new BREF limits. The Compostilla units also stand out, their 2015 SOX emission rates being between two and three times the BREF standards approved earlier this year. It is not surprising, therefore, that Endesa has decided to close these units. The orange bubbles show that the power plants that Endesa has decided to upgrade, Litoral, AS Pontes and Alcudia, all exceeded BREF standards in 2015, with Litoral and two Alcudia units more than three times over the limits. Given Spain's over-capacity and its parent's coal phaseout plans, it is questionable whether Endesa's interest in upgrading these old plants makes economic sense.

Unlike Endesa, both Enel and Engie are in relatively good position relative to the looming 2021 standards. The chart suggests that most of the Enel (blue) and Engie (pink) plants are already in compliance with the new standards for SOX emission.

[13] Estimates for emissions rates by AS Pontes in 2014 (the latest published by Endesa):
This report: SOX 192mg/Nm3; NOX 248mg/Nm3;
Endesa: SOX 278mg/Nm3; NOX 365mg/Nm3

Figure 4. 2015 flue gas burn (Nm³) vs SOX emission rate (mg/Nm³)

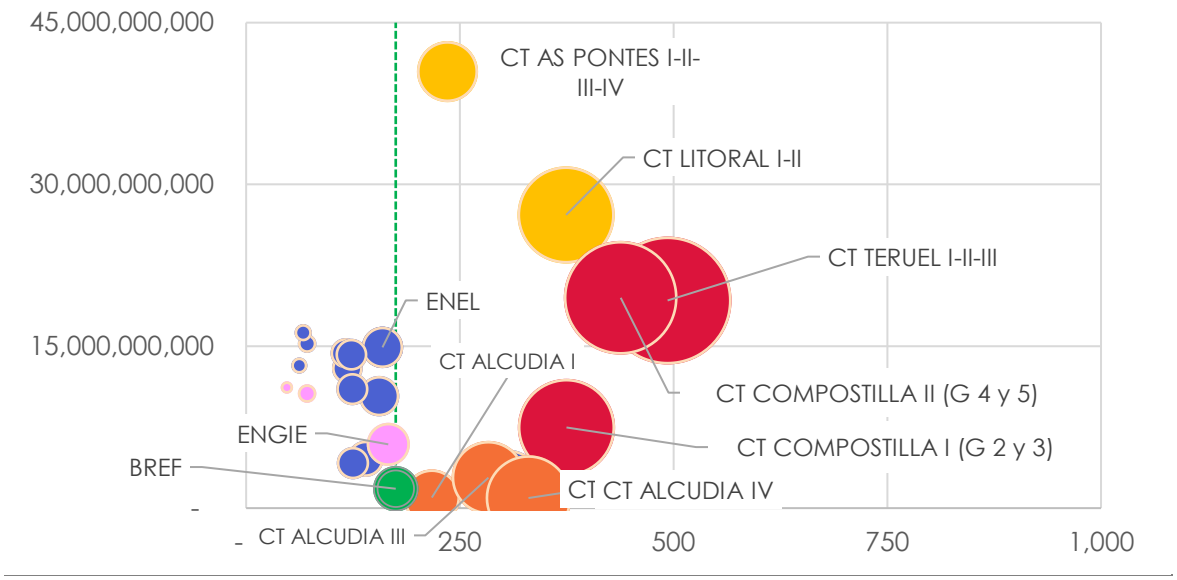


Source: Own elaboration on EEA, LCP and EPRTR data Note: bubble width shows exceedance over BREF limits – the larger and the more to the right a bubble is, the more polluting the plant. The higher the bubble, the higher the fuel burn (measured by flue gas in nM³).

NOX Emissions

Figure 5 below uses the same colour coding as above for NOX emission rates. In this case, the emissions rates of Endesa's (red and orange) power plants stand out even more, while most Enel (blue) and Engie (pink) plants in 2015 were already in line with the new standards. Again, Enel – which owns 70% of Endesa – seems to have a Spanish flue gas problem.

Figure 5. 2015 flue gas burn (Nm³) vs NOX emission rate (mg/Nm³)



Source: Own elaboration on EEA, LCP and EPRTR data; Note: bubble width shows exceedance over BREF limits – the larger and the more to the right a bubble is, the more polluting the plant. The higher the bubble, the higher the fuel burn (measured by flue gas in nM³).

Trend Analysis

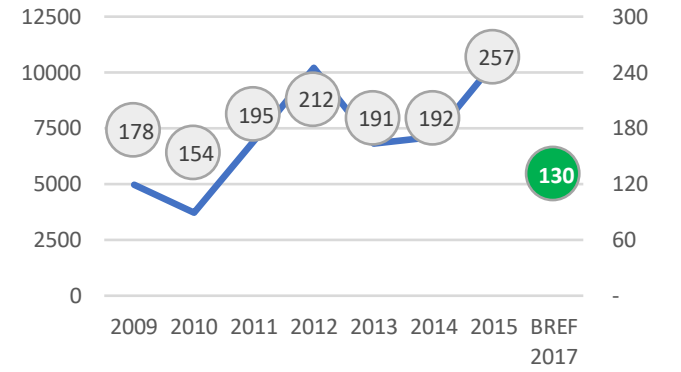
But just how "bad" are the power plants that Endesa plans to upgrade? Can we see an improvement in their environmental performance over the last several years? How do they perform against other European coal power plants?

The charts below examine the trends in SOX and NOX emissions rates at AS Pontes and Litoral, and compare them with EU coal power plants in general. We focus here on these two, because the emissions data are available as whole power plants, rather than the multiple Alcudia units, and therefore simpler to chart.

First, turning to AS Pontes, Figures 6a and 6b compare its performance over time with respect to the BREF standards.[14] These figures show that AS Pontes SOX and NOX emission rates from 2009 to 2015 are consistently above the revised BREF standards (130mg/Nm3 and 150mg/Nm3 for SOX and NOX respectively). These emissions rates explain the need for a costly retrofit to maintain BREF compliance. Figures 7a and 7b show that AS Pontes SOX and NOX emissions are roughly in line with the median for EU coal-burning installations in the EEA database.

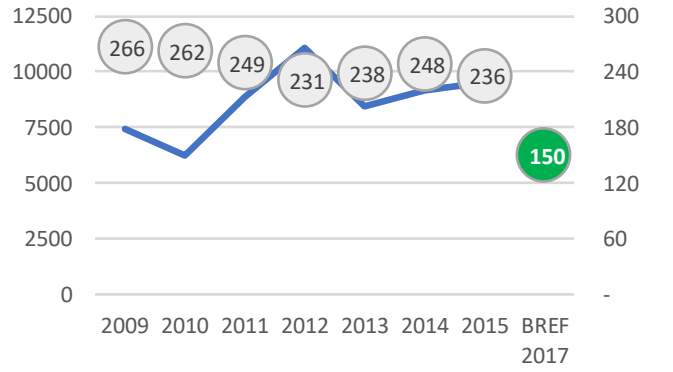
[14] Based on EEA LCP data

Figure 6a. AS Pontes vs BREF - SOX annual rate (mg/Nm^3) and volume (tonnes/ year)



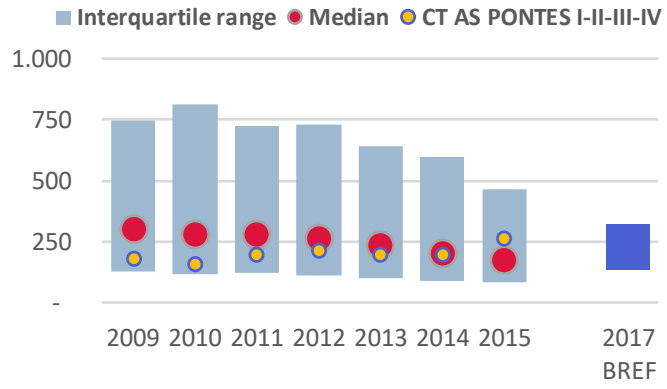
Source: Own elaboration on EEA data.

Figure 6b. AS Pontes vs BREF - NOX annual rate (mg/Nm^3) and volume (tonnes/ year)



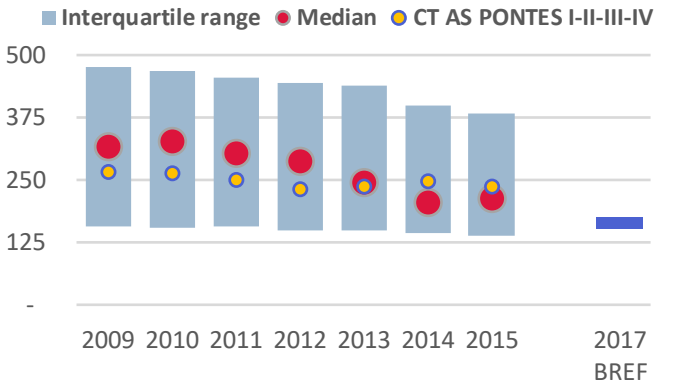
Source: Own elaboration on EEA data.

Figure 7a. AS Pontes vs EU installations, SOX emission rate (mg/nM^3)



Source: Own elaboration on EEA, LCP and EPRTR data Note: sample contains all EU coal burning installations larger than 300MWth.

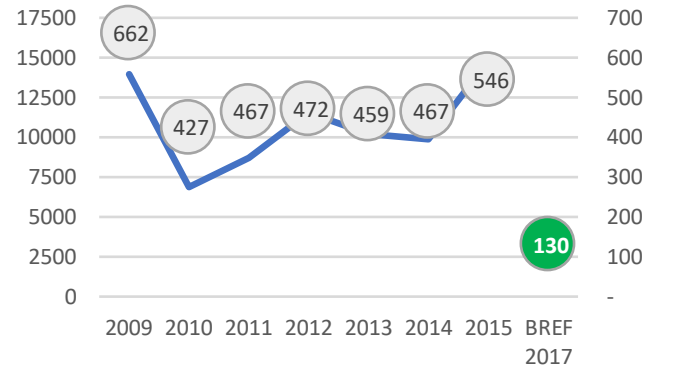
Figure 7b. AS Pontes vs EU installations, NOX emission rate (mg/nM^3)



Source: Own elaboration on EEA, LCP and EPRTR data Note: sample contains all EU coal burning installations larger than 300MWth.

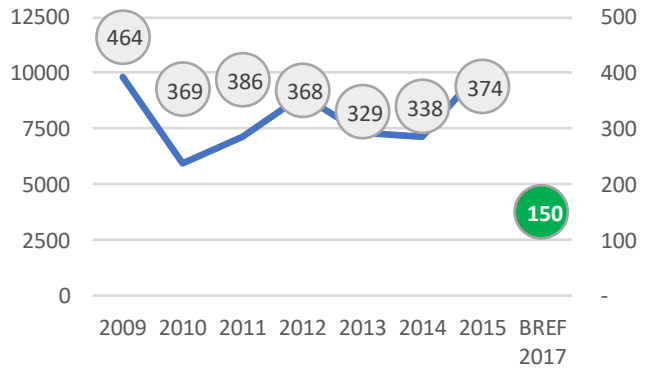
The following charts apply the same analysis to the Litoral power plant. Figures 8a and 8b show that Litoral's SOX and NOX emission rates are consistently above BREF, by a factor of three or four times, and have been rising in recent years. Figures 9a and 9b show that Litoral has always been above the median, and in 2015 exceeded the interquartile range for SOX, and was at the top of the range for NOX (in other words, the power plant was in the top 25% of polluters).

Figure 8a. Litoral - Volume (tonnes) and SOX rate (mg/nM^3)



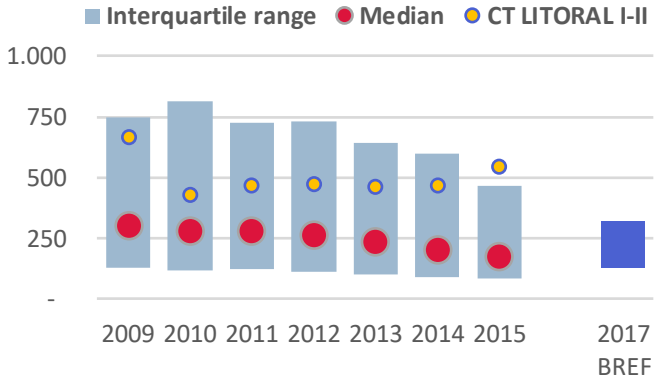
Source: Own elaboration on EEA data. Note: in 2009 plant size was equal to 3034MWth, plant size in 2010-15 was 2490MWth.

Figure 8b. Litoral - Volume (tonnes) and NOX rate (mg/nM^3)



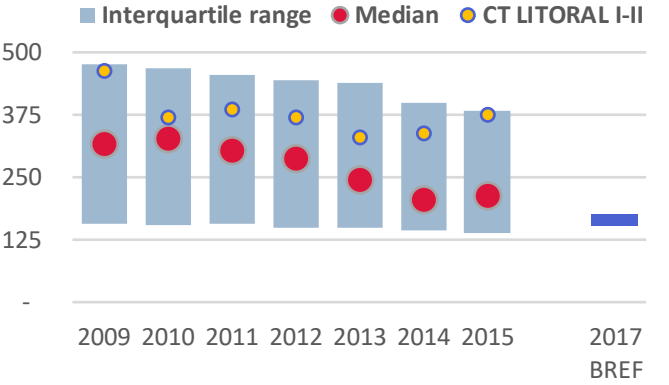
Source: Own elaboration on EEA data. Note: in 2009 plant size was equal to 3034MWth, plant size in 2010-15 was 2490MWth.

Figure 9a. SOX emission rate (mg/nM^3) for Litoral vs the EEA sample



Source: Own elaboration on EEA, LCP and EPRTR data Note: sample contains all EU coal burning installations larger than 300MWth.Litoral note: in 2009 plant size was equal to 3034MWth, plant size in 2010-15 was 2490MWth.

Figure 9b. NOX emission rate (mg/nM^3) for Litoral vs the EEA sample



Source: Own elaboration on EEA, LCP and EPRTR data Note: sample contains all EU coal burning installations larger than 300MWth.Litoral note: in 2009 plant size was equal to 3034MWth, plant size in 2010-15 was 2490MWth.

Conclusions

Endesa plans to invest €400 million in Litoral, AS Pontes and Alcudia for environmental upgrades that will make them IED and BREF compliant, extending their life beyond 2021. The above analysis suggests that Endesa could profitably divert this investment to more strategic growth activity, rather than investing in power plants that began operating in the 1970s and early and mid-1980s and that – when it comes to air pollution – sit well above newly established environmental standards.

We believe Endesa should reconsider its €100 million capex plans for Litoral given that its emissions rate sits above the median for European coal-fired power plants, and far above the new BREF limits. AS Pontes is no worse than many European plants, sitting around the median of EU coal-burning installations for SOX and NOX emissions. But it is well above the new BREF standards, and coupled with its age (43-46 years in 2021) and low implied energy efficiency, expensive upgrades to meet the new rules simply may not be economically justifiable. We see ample economic, reputational and social factors arguing against its €200 million upgrade. The emissions rates at Alcudia power plant, like Litoral, are far above the revised BREF limits and the median of EU power plants. Again, we would argue against its upgrade, while acknowledging the uniqueness of its island location and possibly limited alternatives in the near term.

Appendix

Power Plant Data

Table 1. Engie, Enel and Endesa European coal-fired power plants by age, type and size

Owner	Plant name	Country	Start date	Electrical capacity	Thermal capacity	Implied energy efficiency	SOX emissions rate	NOX emissions rate
				MWe	MWth	%	mg/Nm3	mg/Nm3
Engie	Centrale Rotterdam	Netherlands	2015	800	1600	50.0%	19	48
Engie	Wilhelmshaven Nord	Germany	2015	726	1685	43.1%	38	71
Engie	Farge	Germany	1969	350	875	40.0%	89	166
Enel	Centrale Eugenio Montale (La Spezia)	Italy	1967	552	1540	35.8%	135	156
Enel	Federico II (Brindisi Sud) Unit 1	Italy	1991	607	1640	37.0%	108	124
Enel	Federico II (Brindisi Sud) Unit 2	Italy	1991	607	1640	37.0%	116	118
Enel	Federico II (Brindisi Sud) Unit 3	Italy	1991	607	1640	37.0%	98	123
Enel	Federico II (Brindisi Sud) Unit 4	Italy	1991	607	1640	37.0%	98	116
Enel	Centrale Andrea Palladio (Venezia) Unit 1	Italy	1970	160	415	38.6%	70	125
Enel	Centrale Andrea Palladio (Venezia) Unit 2	Italy	1970	160	431	37.1%	108	140
Enel	Centrale Andrea Palladio (Venezia) Unit 3	Italy	1972	320	1586	20.2%	111	159
Enel	Centrale Di Torrevaldaliga Nord Unit 1	Italy	2009	607	1420	42.8%	39	62
Enel	Centrale Di Torrevaldaliga Nord Unit 2	Italy	2009	607	1420	42.8%	50	71
Enel	Centrale Di Torrevaldaliga Nord Unit 3	Italy	2009	607	1420	42.8%	41	67
Endesa	Teruel (Units 1, 2 and 3)	Spain	1979	1055	3000	35.2%	1879	493

Endesa	Litoral Unit 1	Spain	1985	577	n/a	n/a	546	374
Endesa	Litoral Unit 2	Spain	1997	582	n/a	n/a	546	374
Endesa	Compostilla I (Units 2 & 3) [15]	Spain	1966-1972	485	1332	34.6%	409	375
Endesa	Compostilla II (Units 4 & 5)	Spain	1981-1985	715	1960	34.8%	489	438
Endesa	Alcudia Unit 1	Spain	n/a	135	360	37.5%	265	217
Endesa	Alcudia Unit 2	Spain	n/a	135	360	37.5%	322	304
Endesa	Alcudia Unit 3	Spain	n/a	130	345	37.7%	607	283
Endesa	Alcudia Unit 4	Spain	n/a	130	345	37.7%	607	330
Endesa	AS Pontes (Units 1-4)	Spain	1975-1978	1,469	3774	37.2%	257	236

Source: EEA, Enel, Endesa, Engie, IEEFA/ Acousmatics calculations.

Methodology

The EEA provides data for emissions of NOX and SOX, in tonnes annually, for all large combustion plants in Europe. Unfortunately, there is no such centralised reporting of emissions flow rates, in milligrams per normal cubic metre (mg/Nm3) of flue gases. BREF limits are expressed in such flow rates. It was therefore necessary to convert tonnes of emissions into mg per Nm3 of flue gas. To do this, we used EEA and other, unpublished, estimates for the flue gas volumes associated with burning biomass and different fossil fuels. These estimates do not account for excess oxygen in the flue gas, which we correct for by making certain, standard assumptions for excess oxygen associated with burning particular fuels. We note the assumptions involved in this calculation process, and the impact that the highly variable moisture content and calorific value of certain fuels, such as lignite and biomass, will have on flue gas volumes. We take a conservative view on the calorific value, and therefore the fuel gas volumes associated with burning lignite. The values we use to convert TJ of fuel burned into cubic metres of flue gas are shown in Table 2 below. These values were then used to convert tonnes of SOX and NOX emitted into milligrams of SOX and NOX emitted per cubic metre of flue gas (mg/Nm3).

[15] Note: Unit 2 closed on March 2016

Table 2. Steps used to convert TJ of fuel burned into Nm3 of flue gas

Fuel	Dry flue gas vol per MJ	After allowing for surplus O2	Converting to Nm3/TJ
	Nm3/MJ	Nm3/MJ	Nm3/TJ
Biomass	0.35	0.49	490,000
Hard coal	0.27	0.38	379,561
Lignite (high NCV)	0.35	0.49	490,000
Lignite (average NCV)	0.53	0.74	742,000
Lignite (low NCV)	1.10	1.54	1,540,000
Heavy fuel oil	0.25	0.29	290,500
Natural gas	0.24	0.83	826,000
Other gases	0.54	0.63	626,500

Source: EEA,[16] IPCC [17]

Since there have been both corporate changes and plant ownership changes since 2015, we further refined our sample of Enel, Endesa and Engie power plants to exclude plants that have since been closed or have changed ownership (e.g. Engie's Polaniec). When we compare Endesa's AS Pontes and Litoral power plants with the general population of European large combustion installations (Figures 6a and 6b; 8a and 8b, respectively), we are referring to a subset of the EEA database comprising nearly 300 European power plants (in 2015), each larger than 300 MWth, that burn solid fuels (coal, lignite and biomass).

[16] http://www.eea.europa.eu/publications/reducing-air-pollution-from-electricity
[17] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf

BREF Emissions Limits

Table 3. Selected BREF emissions limits, for existing power plants over 300MWth

Pollutant	Fuel and capacity	IED, from 2016	BREF, from 2021	Selected BREF exceptions (in all cases, does not apply where power plants operate < 1,500hr/year)
		Mthly average	Upper annual average	
		mg/Nm3	mg/Nm3	
NOX	Lignite, or Coal (fluidised bed combustion, FBC) > 300 MWth	200	175	The upper end is 175 mg/Nm3 only for FBC boilers put into operation before 2014. Otherwise the upper limit is 150 mg
	Coal (pulverised combustion, PC) > 300 MWth	200	150	N/A
SOX	Coal & lignite FBC > 300 MWth	200	180	Where specifically designed to fire indigenous lignite fuels, and can demonstrate that cannot achieve these values for techno-economic reasons, the upper limit is 200 mg/Nm3 for new FGD systems, and 320 for an existing FGD.
	Coal & lignite PC > 300 MWth	200	130	

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