Accelerating decarbonation with a minimum CO2 price for electricity in Western Europe

A realistic low-cost measure with immediate effects

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In the wake of the announced withdrawal of the United States from the Paris Agreement, and the de facto reappropriation of leadership on climate issues by Europe, and in particular France, now is the time to launch bold measures to more vigorously combat climate change.

Steps to wean electricity off coal are urgently needed to decarbonize power generation in Europe. The European policy to reduce greenhouses gases decided in 2005 as a way to attain this goal **has given very insufficient** results to date and **the outlook for revising the EU emissions trading system (ETS) and the associated carbon price foreshadows only weakly effective action up to 2030.** Proposals put forward by the European Commission, the EU Parliament and Council for a revised ETS up to 2030 are currently being discussed in tripartite "trialogue" negotiations.[1] **These proposals would have a limited impact on the price of CO_2 and on reductions that can be expected from electricity producers and industry.**

In this context, the authors of this note present a measure to establish a minimum CO_2 price for the electricity sector in several voluntarily participating countries – to start, France and Germany – with the objective of decarbonizing electricity generation in Europe.

This proposal is consistent with the position announced by French president Emmanuel Macron after US president Donald Trump declared the United States would withdraw from the Paris Agreement,[2] and with the roadmap outlined by French environment minister Nicolas Hulot on 6 July 2017, aimed at lowering the carbon content of the electricity mix and closing all coal-fired power plants in France by 2022. The measure discussed in this note provides a way to meet these objectives, at the least cost, while mobilizing neighbouring countries to avoid carbon leakage.

The measure we propose would reaffirm the leading role taken by France and Europe in the fight to mitigate climate change.

[1] The "trialogue" is a process of informal talks between representatives of these three institutions to arrive at a compromise text

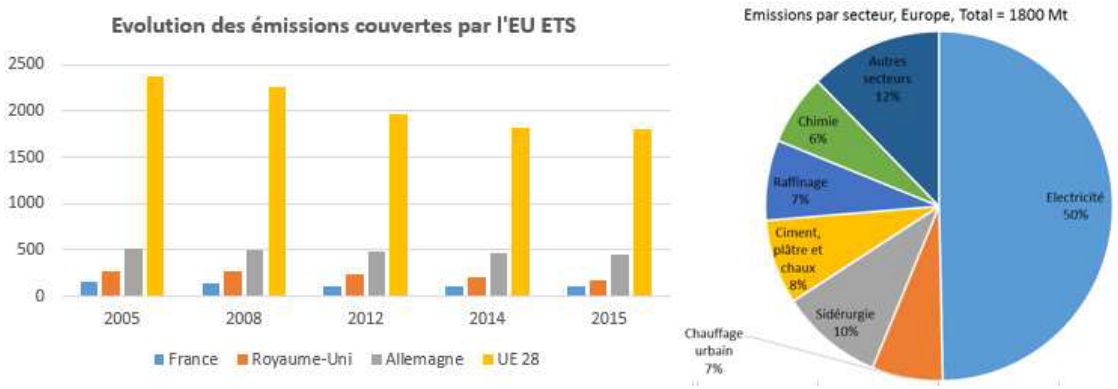
[2] Macron Seeking Stiff Carbon Costs to Avert Climate Change, Bloomberg, June 2017.

Power production, a sector in excess capacity, accounts for 50% of greenhouse gas emissions from heavy industry in Europe

The EU system of allowances, the European Trading System (ETS), covers all CO_2 emissions from energy production and heavy industry. As of this writing these emissions represent roughly 45% of all greenhouse gas emissions in the European Union. The volume of these emissions has been steadily falling since 2005.

Among these sectors, electricity is the biggest emitter, accounting for over 50% of CO_2 emissions.

FIGURE 1: Left: CO_2 EMISSIONS COVERED BY EU ETS (million tonnes) Right: CO_2 EMISSIONS BY SECTOR IN EUROPE 2015 (Source: DIRECTION GENERALE DE L'ENERGIE ET DU CLIMAT, DGCC)



The European electricity market currently has excess production capacity. This can be seen through a number of indicators, and first of all in low prices on wholesale power markets.

Excess capacity in Europe is due to the combination of growth in installed capacity (+20% between 2008 and 2015) and a fall in electricity consumption (-5% between 2008 and 2015). This conjunction jeopardizes the economic equilibrium of many generating assets and will entrain the closing of power plants across Europe. **It should be a priority to close coal-fired plants, the biggest polluters.[3] In 2016 coal-fired plants accounted for 68% of CO_2 emissions in the electricity sector, and 15% of all greenhouse gases in the European Union.**

[3] This note does not consider the specific case of coal-fired plants equipped with carbon capture and sequestration technology. These long-term solutions could benefit from price signals for a robust high price for CO2, bolstering and consolidating research and development activity.

The European plan for the 2021-2030 carbon market is not ambitious enough

The ETS market is now in the process of revising the mechanisms for its fourth phase that runs from 2021 to 2030. Trialogue negotiations involving the European institutions started up on 4 April 2017 to discuss the proposed revision, and these talks are expected to continue through the autumn of this year.

The positions of the EU Parliament and the Council on this post-2020 revision of ETS diverge on the three main points intended to make this system more ambitious.

- **Raising the linear reduction factor (that determines the progressive reduction of emission allowances)** to 2.2% per year in the Commission's proposal, or to 2.4% after 2024 in the Parliament's proposal. This higher linear reduction factor is not high enough, however, to reach the long-term objective of cutting emissions by 90% by 2050 in the sectors covered by the emissions trading scheme. Analysis shows that a factor of 2.4% between 2021 and 2030 and 2.6% from 2031 onwards is necessary to reach this goal.[4] **Furthermore, the 2030 target itself is shown to be lower than what is required to reach the 2050 target.** This would lead to much higher constraints after 2030.

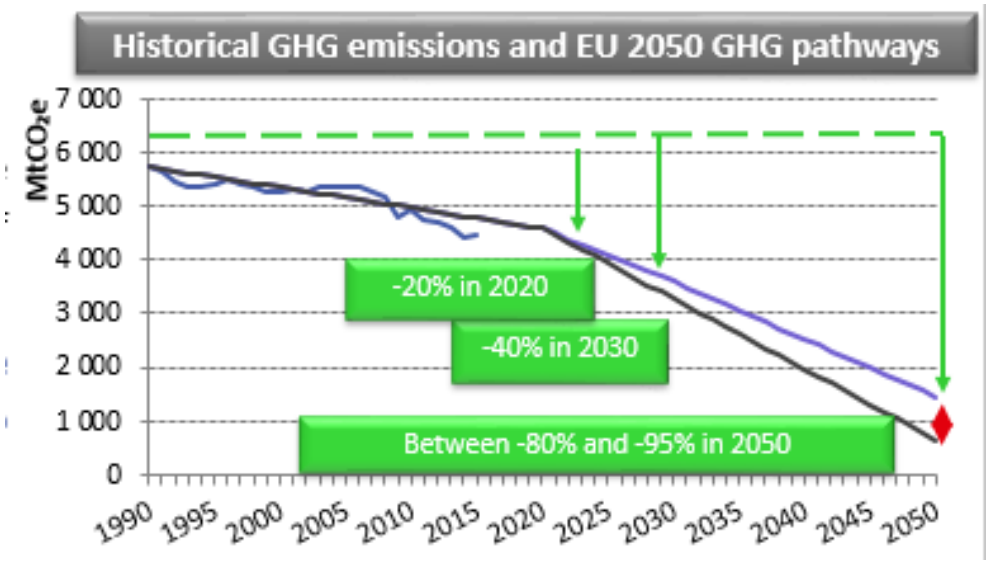
- **The market stability reserve** that is designed to absorb some of the surplus allowances accumulated in previous years.[5] The Commission initially proposed to set the withdrawal rate at 12% per year, while the Parliament and the Council want to raise this rate to 24% by 2021 or 2024.

- **Cancellation of market stability reserve allowances:** the EU Parliament proposes cancelling some 800 million allowances, while the Council proposes to cancel each year a number of allowances greater than the volume of allowances auctioned the previous year, starting in 2024.

To conclude, according to the analysis done by the Institute for Climate Economics (I4CE), whatever the proposal ultimately chosen, these trialogue talks are not likely to lead to a EU ETS that delivers an effective CO_2 price incentive and integrates the constraints of the emission reduction targets for 2050. [6] The cancellation of allowances, a higher linear reduction factor and a higher rate of withdrawal of allowances for transfer to the stability reserve **will have only a limited impact on prices and on emission reductions in phase IV.** Emission reductions engendered by energy efficiency and renewable energy policies would suffice to comply with the EU ETS objective of a 43% reduction by 2030, but if this target level is not raised **emissions would have to fall drastically after 2030 to attain the 2050 objective.**

[4] Source: Propositions pour des prix du carbone alignés avec l'Accord de Paris. This is referred to the Canfin-Mestrallet-Grandjean Report in this note.
[5] The stability mechanism is supposed to reduce surplus allowances below a given level, and to put them back on the market if the overall volume proves to be insufficient.
[6] "What role for the EU ETS in the 2030 climate and energy package?", I4CE, in press (2017).

FIGURE 2: CO_2 EMISSIONS COVERED BY EU ETS AND REDUCTION TARGETS FROM 2020 TO 2050 (million tonnes) (Source: I4CE)



Beyond the scope of the current revision, the problems of the EU ETS are more broadly structural, and tied to inadequate governance from the beginning.

- **Absence of a common political vision shared by the different Member States** regarding the ETS market and especially how ambitious it should be;

- National policies, most notably in support of energy efficiency and renewable energy, that can significantly impact the price of carbon in Europe, making it very difficult for stakeholders to anticipate price levels;

- **A market that integrates both sectors exposed to competition from outside of Europe, and sectors that are not subject to this competition,** e.g. electricity; these sectors face dissimilar constraints and **a single solution cannot apply to all;**

- **The inherent complexity of the system.**[7] By way of illustration, the 2015 decision to postpone allowances (backloading) had little impact on market prices, after 18 months;[8] in December 2016 the forward price for CO_2 in 2025 stood at €5.7/tonne;[9]

- **Absence of a sufficiently flexible governance mechanism** that would make it possible to adjust the quantities of allowances issued to economic and technological changes (economic growth, cost of low-carbon technologies, etc.). [10]

It therefore appears very difficult, and even impossible, to reform the European ETS on the short term.

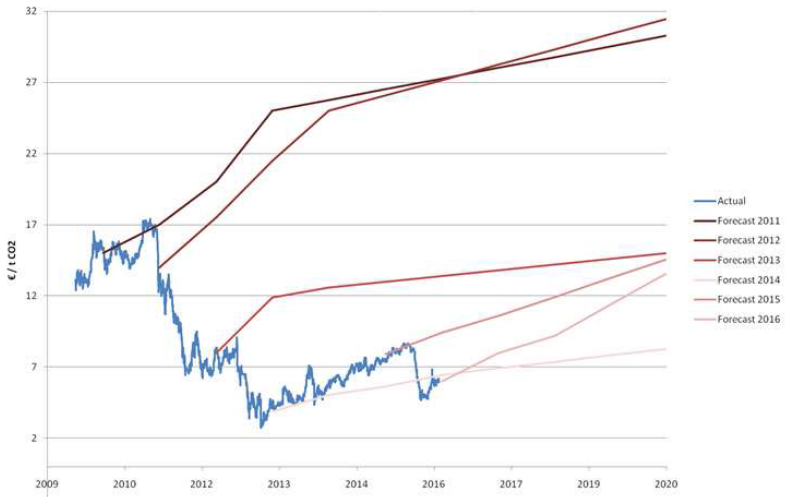
[7] To be adopted changes must be approved by at least 16 countries representing over 65% of the population of the EU.
[8] Source: Canfin-Mestrallet-Grandjean report.
[9] Source: State of the EU ETS Report, ERCST, Wegener Center, UNIGRAZ, Nomisma Energia, I4CE, ICTSD, 2017; referred to as "2017 Report on the ETS market" in this note.
[10] The market stability reserve projected for the 2021-2030 phase is intended to provide more flexibility, but the size of this reserve will be greatly insufficient.

This lack of ambition will impede decarbonization of the electricity system

The market prices that determine the relative competitiveness of power generation plants, in particular the cost of coal, gas and CO_2 respectively, **offer no incentive at present to use less carbon-emitting generating plants, notably gas-fired, instead of coal-fired plants.** Coupled with the excess generating capacity in Europe, there is a risk that between 2020 and 2030 the **electricity system will retain many coal-fired plants, while gas-fired plants will have been decommissioned.**

Power production depends on very capital-intensive equipment that has a long life span.[11] The evolution of power plant generating capacity needed to substantially reduce emissions by 2050 **will be decided today on the basis of long-term economic signals, in particular the price of CO_2.** Today the future prices for CO_2 continue to be low, in the range of €10-12/t in 2020 (Thomson Reuters, 2016 *Nomisma Energia* 2017, drawn from the 2017 Report on the ETS market[12]), and between €5 (Barclays, 2016) and €30 (Thomson Reuters, 2016) in 2030.[13]

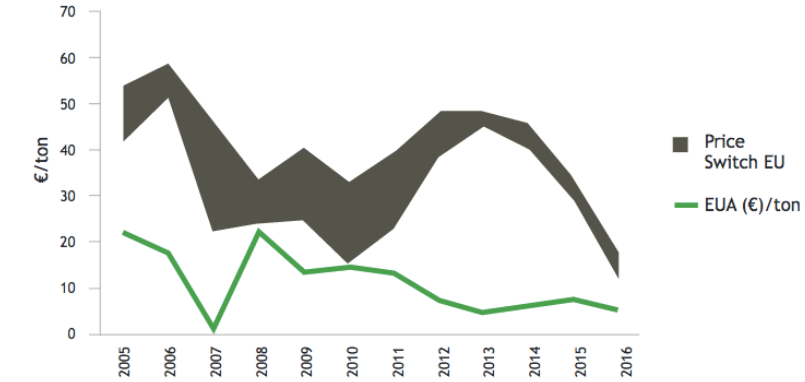
FIGURE 3: SPREAD BETWEEN PROJECTED AND ACTUAL PRICES
(Source: DGEC, based on analysts polled by THOMSON REUTERS, average of ten market analysts)



Studies based on modelling of generating capacity in Europe converge towards the conclusion that a floor price between €20 and €30/tCO_2 (depending on the relative wholesale market prices of gas and coal) would tip the scales in favour of combined cycle gas generation over most, if not all, coal-fired plants. Figures from RTE, the French electricity transmission operator, indicate that this substitution could occur with a carbon price of €30/tCO_2. The Canfin-Grandjean-Mestrallet report recommends that **the floor price be set initially between €20 and €30/tCO_2 in 2020.** [14]

[11] A typical power plant takes between 4 and 10 years to build, and has a useful life of between 25 and 50 years.
[12] 2017 State of the EU ETS Report, ERCST, Wegener Center, UNIGRAZ, Nomisma Energia, I4CE, ICTSD.
[13] Propositions pour des prix du carbone alignés avec l'Accord de Paris. Canfin-Mestrallet-Grandjean Report, July 2016.
[14] Propositions pour des prix du carbone alignés avec l'Accord de Paris. Canfin-Mestrallet-Grandjean Report, July 2016.

FIGURE 4: PRICE OF CARBON ALLOWANCES AND COAL-GAS SWITCH PRICE
(Source: 2017 Report on the ETS market).



Source: NE elaboration on ICE and Platts data

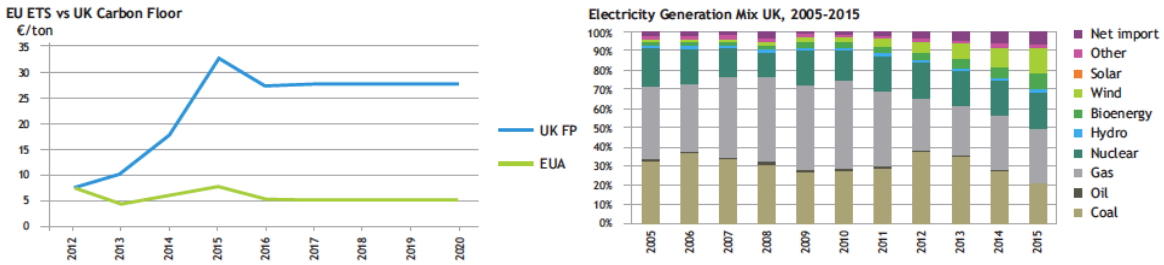
This price level cannot be attained in the short term under the EU ETS revision now underway. **There is an urgent need to draw up a solid complementary instrument that will be effective, and able to attract fairly wide political support, in order to tackle coal-fired power production.** This segment is one of the most significant, if not the most significant, in terms of tonnes of CO_2, and therefore the most efficient way, in cost per avoided tonne, to reduce emissions of greenhouse gases in Europe.

The UK decision to institute a floor price for carbon helped reduce coal-fired generation

In 2013 the United Kingdom set up a scheme, limited to power generation, in the form of an ex-post tax on electricity production. The tax was intended to compensate for the difference between prices on the European ETS market and the floor price set by the UK government. This floor price was initially set at a level close to the price on the European market, and started to rise to £30/tCO_2 by 2020, and perhaps up to £70/tCO_2 in 2030.[15]

Coal-fired generation was strongly affected by the decision, and fell sharply, **and the share of gas-fired generation rose between 2012 and 2015.** It is also worth noting that the share of imported power increased in the electricity mix.

FIGURE 5: Left: EU ETS VS UK FLOOR PRICE Right: UK ELECTRICITY MIX (Source: 2017 Report on the ETS Market)

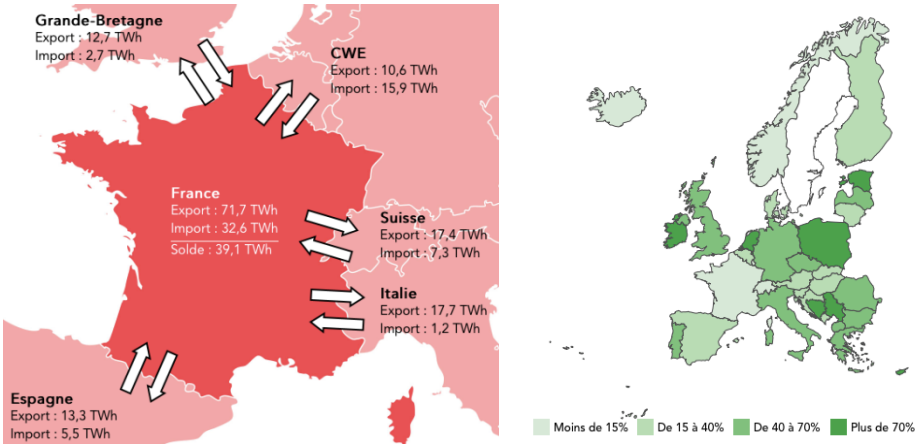


[15] The floor price was set at £16/t in 2013, £18/t between 2016 and 2020, and then £30/t from 2020 (average 100-day currency exchange rate as of 15 June 2017: £1=€1.16).

This measure was taken unilaterally, however, and as the European power markets are integrated, could lead to carbon leaks if fossil-fired generating capacity is more strongly solicited in neighbouring countries. Such a measure would have an analogous effect in France if adopted unilaterally.[16]

The effect would be the same, however, if French coal-fired plants were closed in 2022 by regulatory decision. Even if closing French plants led to an overall drop in French and European emissions, it would also induce a rise in coal-fired generation in neighbouring countries, and thus to carbon leakage.

FIGURE 6: Left: NET CROSS-BORDER POWER EXCHANGE 2016 Right: SHARE OF CONSUMPTION PROVIDED BY FOSSIL-FIRED POWER GENERATION
(Source: RTE)



To curtail the undesirable effects of such a measure and align it with a dynamic integration of the European power market, the phasing out of coal-fired generation must be approached in collaboration with adjacent countries.

Can a French-German tandem be built to back a minimum CO_2 price for electricity?

a) France and Germany face different economic and policy challenges linked to phasing out coal

There are only five 600 MW coal-fired generating units in France, at four sites: three tranches belong to EDF (Cordemais, Le Havre) and two to Uniper (Gardanne, Carling). Following in the footsteps of the previous government in France, the roadmap outlined by environment minister Nicolas Hulot on 6 July 2017 calls for closing all coal-fired plants by 2022.

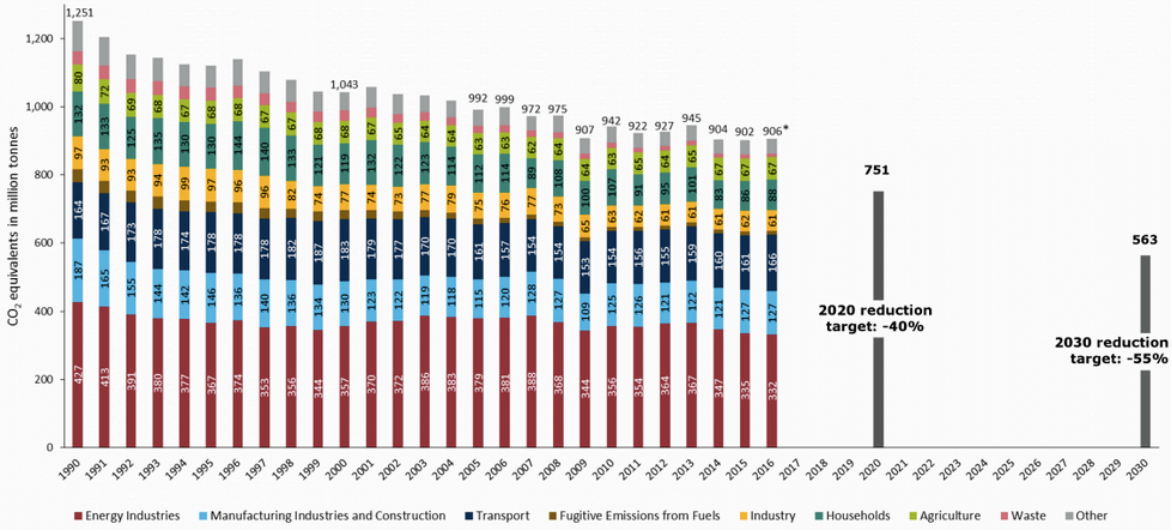
The weight of coal and lignite in the electricity mix in Germany, respectively 14% and 26%, and in the German economy is far greater than in France. Nonetheless, Germany's goal to reduce CO_2 emissions by 55% by 2030 (compared to the baseline in 1990) includes the objective of reducing energy sector emissions by more than 60% from 1990 levels (from 466 $MtCO_2eq$ in 1990 to 175-183 $MtCO_2eq$ in 2030). **This reduction means cutting energy sector emissions in half between 2014 and 2030.**[17]

[16] Propositions pour des prix du carbone alignés avec l'Accord de Paris. Canfin-Mestrallet-Grandjean Report, July 2016.
[17] Roughly 350 $MtCO_2eq$ in 2014, and between 175 and 183 $MtCO_2eq$ in 2030.

Closing a few lignite-fired plants by 2021, as decided in 2015 (see below), would avoid the equivalent of 11 million tonnes of CO_2 emissions per year. This figure does not take into account **electricity production transferred to the coal and lignite plants remaining in operation.** The German government is also counting on energy efficiency incentives to reduce annual emissions by another 11 million tonnes. However, it **appears extremely difficult to attain the objectives outlined above without severely restricting coal-fired electricity generation.**

Without strong measures it is unlikely that Germany will attain its climate objectives.[18] Energy sector experts in Germany are even more explicit and estimate that a floor price between €50 and €75/tCO_2 for the energy sector is necessary to attain the objectives set for reducing greenhouse gas emissions.[19]

FIGURE 7: GHG EMISSION OBJECTIVES AND TRENDS IN GERMANY 1990–2016 (Source: UBA 2017, provisional 2016 figures)



In light of this challenge, in the spring of 2015 Sigmar Gabriel, then the German minister for the economy and energy, first mulled the possibility of a surcharge on electricity.[20] In the face of resistance from labour unions, energy enterprises and mining companies, the government ultimately decided **to close no later than 2021 a few lignite-fired plants (2.7 GW) among the most highly polluting units.**[21]

Since then Sigmar Gabriel and the German SDP party have been much more reserved on the subject of phasing out coal in Germany, and refused to set a deadline. In May 2017, however, the SPD, now represented by Martin Schulz, once again included a proposal for a floor price in its draft campaign platform published ahead of legislative elections in September, only to go back on this proposal a few days later in the final version.

The CDU party, headed by Angela Merkel, published its campaign platform in July 2017, without being any more specific about phasing out coal, even while declaring a preference for "market-based" approaches to achieve climate objectives.

Phasing out coal represents very different stakes in France and in Germany. Both countries face major energy challenges, however. Given their historical and economic place in Europe, as well as in electricity production, it is of crucial

[18] A new era for the debate on coal phase-out in Germany, Felix Chr. Matthes, April 2016.
[19] What a CO_2 price floor can (and cannot) do for German climate goals, Carlos Perez Linkenheil, Simon Göss and Fabian Huneke, January 2017.
[20] Based on CO2 emissions, age and duration of operation of the plants.
[21] The electricity producers RWE and Uniper are among the four biggest emitters of CO2 in Europe.

importance to coordinate the energy transition trajectories of the two countries. This coordination could indeed serve as a model to improve energy and climate governance in Europe. It is a question of jointly addressing the economic, social and territorial consequences of electricity generation, in addition to evolution of the electricity mix in the two countries.

The proposal for a floor price for carbon in the electricity sector must be framed within this coordinated approach.

b) A floor price for CO_2 in the electricity sector – an effective way to reduce the share of coal-fired generation

We have seen above that no solution is forthcoming on the scale of the EU ETS market in the short term, and that a unilateral fiscal solution in France is not a desirable response.[22] **Inversely, a floor price for CO_2 in the electricity sector, applied in few volunteer countries, would be a good idea:** along the lines of the mechanism set up in the UK, it would institute a surcharge applied only in the electricity sector. The amount of this surcharge would be equal to the difference between the CO_2 price determined by the EU ETS market, and the target value of the floor price (€20 to €30/tCO_2). Implementation of this measure involves the creation of a tax in each of the volunteer countries, but does not in itself require modification of the EU ETS. **This mechanism would be an operational way to achieve the goal of closing coal-fired power plants in France by 2022, and to cut back emissions in Germany. In addition it would immediately reduce CO_2 emissions, without having to wait until 2022.**

One of the issues raised in the course of the work done by the Canfin-Mestrallet-Grandjean Commission in late 2016 was that a fiscal surcharge enacted only in France would possibly create the risk that coal and gas-fired electricity generated in France would be displaced by fossil electricity from neighbouring countries.

A uniform floor price in effect across a group of adjacent countries would eliminate potential carbon leaks between these countries, as electricity generation would be subject to the same constraints within the group of countries. This price would initially be much higher than the ETS price, but the latter would eventually catch up with the floor price, when a true reform is enacted at the European level. **The floor price would therefore be an insurance mechanism for the cost of CO_2 for electricity, and would be without effect as soon as the ETS market price reaches or exceeds the floor price.**

The German NGO EWI has written that this measure, on a European scale, would be the most economically efficient way to reduce CO_2 emissions, at an average mitigation cost of €24/tCO_2. On the scale of several countries, this measure would still be one of the most economically efficient approaches to limiting CO_2 emissions.[23]

To quantify the effects of such a measure the existing pool of generating plants must be modelled, taking into account, among others, the variable costs incurred by power plants and the price of CO_2, factors that determine their economic merit order.

It can be shown that the application of this measure on the scale of France and Germany would engender 40 MtCO_2eq in annual emissions reductions – much the largest share of reductions being in Germany. This volume is the equivalent of **more than 7% of all French and German emissions covered by ETS in 2016. In France this**

[22] A fiscal measure targeting only coal-fired plants would probably be flagged as discriminatory, and could be declared unconstitutional.

[23] Source: Analysis of an EU-wide Carbon Price Support, EWI, January 2017.

measure would halve direct greenhouse gas emissions from the electricity sector (17.5 $MtCO_2$ in 2015).

c) The impact of a French-German floor price at €30/tCO_2

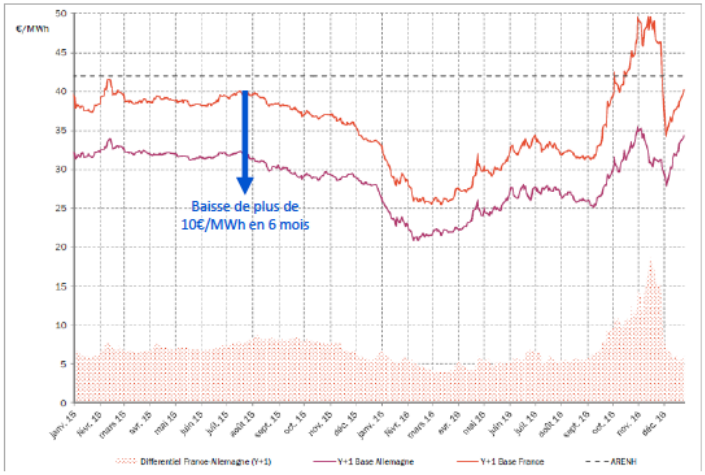
As seen above, a floor price at €30/tCO_2 **favours combined cycle gas generation over most, if not all, coal-fired plants**.

Where France is concerned, we have calculated some orders of magnitude to measure the impact of a minimum CO_2 price on gas-fired and cogeneration plants (see Annex).[24] Taking various parameters into account,[25] **this measure would be neutral or positive, on average, for gas-fired plants and for cogeneration, as well as for other generating plants other than coal-fired, all other factors being equal.**

Models based on a French-German floor price of €30/tCO_2 give an annual increase of €6/MWh for the price on the wholesale market.[26] This price variation would be comparable to natural fluctuation in prices in the electricity market.[27] It would represent an increase of 15% compared to the current price (roughly €36/MWh).

By comparison, the total average cost (including taxes) of electricity for a household comes to about €185/MWh in 2017.[28] In France, even if the wholesale price increase for electricity was fully passed on in retail prices, the increase for domestic consumers would be on the order of 4% (including taxes).

FIGURE 8: YEAR-AHEAD FORWARD PRICE FOR BASE ELECTRICITY IN FRANCE AND GERMANY (Source: EEX)



As for Germany, electricity generation continues to be a very large carbon emitter, with over half of power produced from fossil resources: 24% lignite, 16% coal, 14% gas.

[24] Plants producing both heat and electricity.
[25] These parameters include rising prices for electricity generated by gas-fired plants, remuneration on the capacity market, rising wholesale market prices, and the capture of a share of coal-fired production.
[26] In Germany the increase would be €11/MWh. This value is consistent with the figure given by EWI in its study, Analysis of an EU-wide Carbon Price Support (January 2017).
[27] Here we refer to the annual "forward" price quoted for baseload electricity supply; spot market prices vary much more widely.
[28] CRE, Observatoire des marchés de détail du 1e trimestre 2017

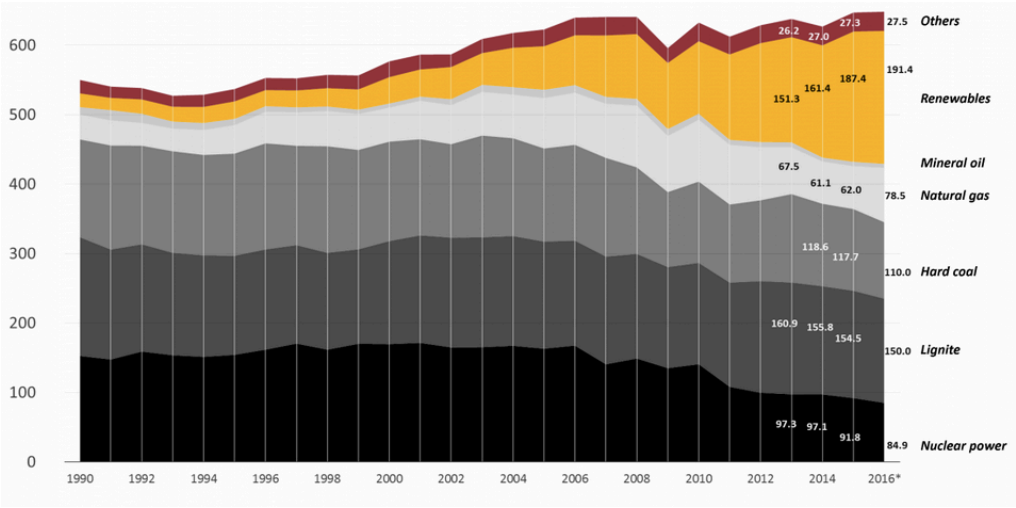
The growth in electricity generation is today mainly due to the rise in renewable energy, in parallel with the decline of nuclear power, while **fossil-fired power generation has been at the same level since 2009. Coal is the dominant fossil fuel, thanks to the negligible cost of CO_2.**

A distinction must be made between coal and lignite when referring to fossil fuels in Germany. Lignite emits slightly more CO_2 per KWh of electricity generated, but it is considerably cheaper then coal, so that a penalty of more than €50/tCO_2 would be necessary to disqualify lignite in the merit order.

Implementation of a floor price in France and Germany would lead to an increase of €10/MWh in Germany, an increase of 30% over current wholesale prices. The increase would nonetheless be small, on the order of 4% (including taxes), for residential consumers who pay roughly €300/MWh for electricity.[29]

In France as in Germany, the increase in electricity prices would be non-negligible for industry.[30] Compensation measures can be designed, however, to neutralize these effects. See the section devoted to compensation measures below.

FIGURE 9: GROSS ELECTRICITY PRODUCTION IN GERMANY 1990-2016 (TWh)
(Source: AG ENERGIEBILANZEN 2016, provisional data for 2016)



d) A floor price for CO_2 is preferable to administrative closure of coal-fired plants, although the transfer effects are different

Like a higher cost for CO_2, administrative closure of coal-fired plants entails financial transfers between electricity producers, consumers and States.

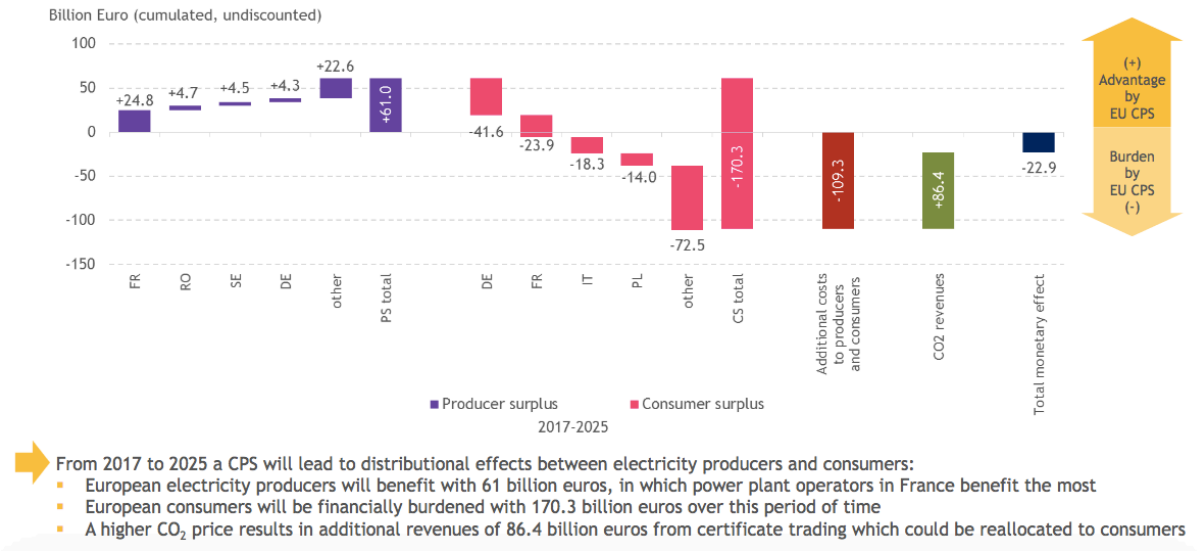
As explained above, implementation of a floor price would raise wholesale market prices, and thus would considerably boost the profit margin of power producers who use low or non-CO_2 emitting resources. Inversely, the floor price would reduce the margin of electricity suppliers who buy mainly on the market, as is the case for non-incumbent power utilities.

The floor price would induce significant financial transfers in Western Europe, between States, between utilities themselves, and between utilities and consumers.

[29] What German households pay for power, Clean Energy Wire, February 2017.
[30] As an example, the total cost of electricity supply for the steel industry in Germany is an estimated €55/MWh, so that the increase would be between 15% and 20%. Source: European electricity prices and their components, Fraunhofer, ECOFYS.

The diagram below outlines a theoretical explanation of the effects of a floor price on a European scale.

FIGURE 10: CUMULATIVE ECONOMIC EFFECTS FOR ELECTRICITY PRODUCERS AND CONSUMERS OF A EUROPEAN FLOOR PRICE 2017-2025 (Source: EWI[31])



These transfers are not tied exclusively to a floor price; they would occur in the same way if the ETS price were to rise to a level in keeping with the climate goals of the European Union. **Nonetheless, these financial flows must be acknowledged, and measures to accompany them must be shared between members of the floor price "coalition". These measures, financed by revenues from the floor price, might include support for employees in sectors undergoing change, for industrial consumers exposed to international competition who would face higher electricity costs, etc.**

The alternative to instituting a floor price for CO_2, i.e. administrative orders to close coal-fired plants, would represent a cost for public finances, in the form of compensation generally paid to plant owners that are closed before time. This option would entail a significant financial transfer from taxpayers to energy producers, without any guarantee that the compensation money would be used to finance employee training or reconversion of territories affected by plant closures.

Inversely, the floor price has two big advantages:

- **It generates direct fiscal revenue** that can be used to
  - finance measures to accompany employees working in the plants about to be closed;
  - neutralize the effects of the floor price on industrial consumers who face international competition;
  - buy back allowances no longer acquired by disaffected plants;[32]
  - support energy efficiency and the development of renewable energy.

[31] The Germany NGO EWI applies the French proposal to implement a floor price of €30/tCO_2 as of 2020, rising to €50/tCO_2 as of 2030 on the European scale. Source: Analysis of an EU-wide Carbon Price Support, EWI, January 2017.

- **It raises the market price of electricity, and thus reduces the gap that must be bridged by price support mechanisms for renewable energy, and lowers the amount of the State budget devoted to these mechanisms.** To illustrate this benefit, CRE has reported that in 2016 EDF acquired about 45 TWh under mandatory purchases at feed-in tariffs in effect in France. A €6/MWh increase in the market price would engender savings of €270 million.[33]

These benefits would arise in France, **and would be even greater in neighbouring countries such as Germany, where the annual subsidy accorded to renewable energy comes to approximately €24 billion**, due to the high volume of renewables and the low market price.

The minimum price for CO_2 in the electricity sector is thus an efficient way to decarbonize the power industry, at the cost of a moderate increase in electricity prices for residential consumers, and at a cost that can be compensated for industrial consumers. For the greatest possible efficacy, this measure would have to be applied in as many countries as possible.

Parallel talks with Italy and Spain

Italy and Spain are two countries adjacent to France that have strong ambitions to decarbonize their energy sectors, and where fossil fuels, coal in particular, are preponderantly used in electricity generation. It is imperative that these two countries be included in talks on a floor price, to mitigate the risk of carbon leakage.

Italy

The Italian electricity industry is the second largest sector in terms of CO_2 emissions, accounting for 32% of emissions in the country in 2014 (after the transport sector, 33%). Fossil fuels represent about 60% of the energy mix in Italy: 14% coal, roughly 39% gas and 6% fuel oil in 2014.[34]

In its 2016 review of Italy the International Energy Agency (IEA) projects that roughly 53% of emissions reductions related to energy consumption will come from the energy industry, with a 23% reduction in greenhouse gas emissions in this sector between 2015 and 2030.[35]

Emissions reduction strategy in Italy is based first and foremost on the development of energy efficiency and renewable energy. At the same time this strategy must also ensure that this development is carried out in parallel with **falling coal production, to be consistent with national climate change objectives.**

Spain

Spain strongly supports renewable energy and energy efficiency to reduce its CO_2 emissions. The electricity sector is the sector in which emissions fell the most between 2007 and 2013, dropping from 343 $MtCO_2$ in 2007 to 239 $MtCO_2$ in 2013, a decrease

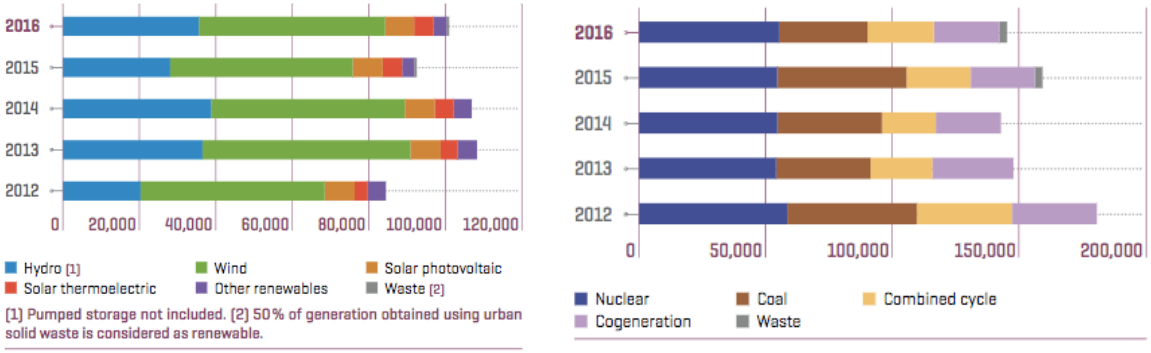
[33] Délibération de la CRE du 13 juillet 2017 relative à l'évaluation des charges de service public de l'énergie pour 2018
[34] Source: World Bank data published on The Shift Project data portal.
[35] Source: IEA and sectoral data: Industry (including energy), transport, residential, tertiary, agriculture etc.

of 30%.[36] **Despite this decrease coal-fired electricity still accounted for 20% of gross power production in 2015**(Source: Euracoal).

Economic analyses show that renewable electricity (not including hydropower) remained stable between 2012 and 2016; they reveal **no structural trends for coal and gas-fired electricity generation**.

It is probable that a drop in coal-fired generation would lead to higher consumption of gas in the country, and would partly offset the structurally low use of gas infrastructure in Spain, in particular methane tanker terminals.

FIGURE 12: Left: RENEWABLE ELECTRICITY PRODUCTION 2012-2016 Right: NON-RENEWABLE ELECTRICITY 2012-2016 (Source: RED ELECTRICA DE ESPANA)



Revenue generated by the floor price should be used to finance social transition and economic conversion of territories

In France as in Germany, and more broadly across Europe, social support for conversion of workers employed in the coal sector is key to a successful transition.

The energy transition is also a social transition, and will call for targeted support policies. It can be useful to draw lessons from transitions in the past or underway in other countries. In this respect a recent study from the Institute for Sustainable Development and International Relations (IDDRI) provides information on transformation of the coal sector in Poland, the United States and the United Kingdom. The mining sector in Poland lost some 230 000 jobs in nine years. In the Netherlands 75 000 jobs were lost in a similar lapse of time, ten years. In the 1980s 188 000 mining jobs disappeared in the United Kingdom.[37]

As mentioned, there are currently five 600-MW coal-fired generating units in France, at four sites: three tranches belong to EDF (Cordemais, Le Havre) and two to Uniper (Gardanne, Carling).[38] Counting slightly over 150 direct jobs per unit, a rough estimate gives a maximum of 800 jobs that will be affected.

The economic viability of these plants would be seriously jeopardized with a CO_2 tax of €30/tCO_2, which could lead to closing of the plants.

[36] Source: Energy Policies of IEA Countries, Spain, 2015 Review, IEA.
[37] Lessons from previous 'COAL TRANSITIONS', IDDRI, 2017
[38] There is also a 250-MW unit at Gardanne where a controversial biomass conversion project has been put forward.

Each situation should be closely examined in its context: it may be possible to shift some jobs to other activities in the electricity sector, and the full range of already available public support measures should be deployed.

In light of the small number of sites involved, public authorities probably already have the necessary support tools at their disposition, without even waiting for "transition contracts", a concept put forward in the campaign platform of Emmanuel Macron and reiterated in the roadmap published by Nicolas Hulot. The coal industry could provide an opportunity to draw up an inventory of existing public policy instruments, and thereby facilitate the design and future implementation of these "transition contracts".

As for Germany, where lignite is extracted from domestic mines and represents a significant number of jobs, a CO_2 price of €20 to €30/t would not lead to the immediate demise of lignite-fired plants (as seen above, a price of €50/tCO_2 would be necessary). It should be possible to plan a phased transition by outlining a trajectory for a floor price for CO_2.

The competitiveness of industrial sectors subject to international competition could be preserved

The 2017 Report on the status of the EU ETS and the Canfin-Mestrallet-Grandjean Report are in agreement in their analysis that effects on competitiveness would be marginal at a floor price of €10/tCO_2.

The effects of a carbon tax greater than €13/tCO_2 have also been examined in the literature, with different conclusions depending on the country and the economic sector. Furthermore, these analyses look at the direct effects of a price applied to industrial CO_2 emissions, whereas the measure recommended here would apply only to electricity production, and would affect other sectors only indirectly, via higher cost for the electricity consumed. The impact on competitiveness of a CO_2 floor price for electricity would be far less than the effect of a floor price covering all emissions within the ETS scope.

In addition, this indirect effect can be compensated, notably for electricity-intensive industries such as aluminium and chemicals exposed to international competition. Among existing options, allowances could be granted free of charge of the sectors most vulnerable to carbon leakage. This measure is already implemented in a number of European countries, including France and Germany. A second possibility is to set up specific compensatory measures for industries affected by higher energy costs.[39]

More broadly, Europe, or a group of European countries, should envision a protection mechanism for European industries, in the form of carbon border tax adjustements[40] to restore the balance with imports from countries with less advanced

[39] The French government has introduced a compensation mechanism for indirect costs. According to the French employers' group Medef, in 2016 €93 million in costs were compensated, at the rate of about €3/MWh (Source: UFE communiqué on the implementation of a strong price corridor in the framework of the European carbon market).

[40] On this topic see "Pour une stratégie climatique audacieuse – Des propositions pour agir sans attendre", François Berthélemy, Antoine Guillou, Terra Nova, November 2016.

fiscal policy regarding climate. **This long-term issue should in any event be examined for each sector as part of a reform of the ETS market up to 2030 and beyond.**[41]

A minimum price for carbon would be a prelude to a truly ambitious reform of the EU ETS market

As stated above, the carbon floor price mechanism would induce some coal-fired plants to reduce or halt their production. This lower level of production would weaken demand for allowances in ETS and in effect pull down the price of allowances. Work by the Chaire Economie du Climat research team shows that the European price for CO_2 could fall by about €4/tonne, assuming a French/German floor price of €30/t and emission reductions of 40 $MtCO_2$ as mentioned above.[42]

This is not a desirable effect because it loosens constraints on all the other industrial sectors covered by ETS. Two solutions can be imagined to avoid this effect:

- **States could voluntarily buy up some or all of the allowances that would no longer be purchased by power plants,** making it necessary to estimate this demand for allowances to be compensated. By way of illustration, the added charge for the budget in France would be on the order of €24 million, while revenues could be between €150 and €200 million.[43]

- **Quantities previously purchased by power plants** (on a historical basis) **could also be withdrawn from auction.** In this case the market stability reserve could be an appropriate way to withdraw these allowances from the market.

This solution is close to the proposal made by the Pöyry firm in a study carried out for a group of Scandinavian energy producers. This study recommends withdrawing from auction the excess allowances resulting from the public policies (national and EU) that are the most likely to disturb the ETS market, as determined by an evaluation beforehand and *ex post* monitoring .[44]

Terra Nova had already underscored the need for a way to adjust to a much greater extent the number of allowances auctioned, depending on economic conditions and the impact of other public policies, in a note published in November 2016. This note also emphasized that it was crucial to reform the governance of EU climate policy.[45]

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[41] It can also be noted that article 20 of the GATT accord allows implementation of border taxes to manage risks that threaten natural habitats. See "WTO rules and environmental policies: GATT exceptions", https://www.wto.org/english/tratop_e/envir_e/envt_rules_exceptions_e.htm

[42] Source: R. Trotignon, B. Solier et C. de Perthuis, Chaire Economie du Climat, Université Dauphine Paris, Policy Brief 2015-03.

[43] This cost is constructed on the basis of 7.3 TWh of coal-fired power generation in 2016, and an emission factor of 0.956 tCO_2/MWh (source: RTE). This is to be compared to a factor of 0.36 tCO_2/MWh for gas (combined cycle generation) and allowances prices at €6/tCO_2. Revenue is calculated on the basis of 20 TWh of gas-fired electricity generation (excluding cogeneration) in 2016, with an emission factor of 0.360 tCO_2/MWh (combined cycle) and a price differential of €24/tCO_2 between the floor price and the market price. The exact amount of revenue will depend on effective operations times, and should be evaluated with caution at this stage.

[44] Managing The Policy Interaction with the EU ETS, Pöyry, Fortum Oyj, Statkraft AS and Vattenfall AB, June 2017.

[45] "Pour une stratégie climatique audacieuse – Des propositions pour agir sans attendre", François Berthélemy, Antoine Guillou, Terra Nova, November 2016.

The floor price proposal aims to outline a pragmatic pathway for reducing CO_2 emissions in the electricity sector, a measure that could be implemented in the short term and that would show results right away. This measure does not, however, constitute a solution to the weaknesses of European climate policy and of the EU ETS mechanism, which must still be reformed.

Conclusion

The current governance of the EU ETS mechanism and its proposed reform are not a satisfactory response to EU climate objectives and commitments under the Paris Agreement. In their present form they will not suffice to channel long-term investment to low-carbon energy production, nor in the short term will they provide a way to exploit the largest reservoirs of GHG reductions at the least cost, by putting an end to coal-fired electricity generation.

To address these shortcomings it would be timely to institute **by 2020 a floor price for CO_2 for electricity in Western Europe, set at a level between €20 and €30 per tonne of CO_2.** This mechanism would serve as an insurance policy for the price of CO_2 emitted by electricity generation, and would automatically become without effect when the EU ETS has been adequately revised.

The floor price would displace coal-fired power, which would be replaced by electricity from gas-fired plants. The variable costs of gas-fired plants would rise **but overall the economic situation of gas-fired plants would remain stable or improve over today's prevailing conditions.**

This measure provides a way to meet the objective of closing coal-fired plants in France by 2022, as announced by environment minister Nicolas Hulot. To be fully effective this measure, like plant closings by regulatory order, would have to be **jointly deployed by neighbouring countries, first Germany, followed by Italy and Spain and then the Benelux** countries (plus the United Kingdom, where such a measure is already in place). **This floor price mechanism can be initiated by a few countries, and later extended to a larger group.** This decision-making process would be much less cumbersome than the EU ETS process.

Like other European countries, these countries have set major objectives for reducing greenhouse gas emissions, and for the most part plan to use renewable energy on a large scale to achieve these reductions.

Due to an economic context that is favourable to coal and to the inherent weakness of the EU ETS, emissions from the electricity industry continue to be high.

These countries will have to cut back on coal-fired power generation if they hope to attain their 2020 and 2030 targets for climate change mitigation. A floor price for CO_2 in the electricity sector would help them achieve these objectives, and at the same time support development of renewable energy.

Although the floor price will not suffice to resolve the weak governance of EU climate policy and of ETS, it would be compatible with the indispensable future wide-ranging reforms.

A minimum carbon price in Western Europe is the quickest and the most effective solution, both in terms of the decision process and from an operational standpoint: it targets the largest reservoir of potential emission reductions in Europe, and these reductions also among the least costly to obtain.

Annex: The impact of a minimum CO_2 price of €30 per tonne in Western Europe on gas-fired electricity and cogeneration plants in France

Impacts on gas-fired combined cycle generating plants

1. **The impact could potentially be negative, but is more likely to be neutral, with the sale of the energy produced on electricity markets.**

A minimum CO_2 price of €30/tonne for power generation covering all of Western Europe should encourage use of combined cycle gas generation (CCG) in France. Compared to the current situation, CCG plants would continue to be competitive in this regional market in relation to CCG plants located close to borders with other countries (subject to identical regulations). They would gain competitive advantage over coal-fired plants, particularly the least efficient plants.

In our analysis below we assume that the load factor for CCG plants in France would remain at the level observed for 2013-2016, that is about 25%.[46] Modelling exercises show that this assumption is consistent with the expected impacts of a regional implementation scenario limited to France, Germany and Italy.

On the basis of a 400 MW gas-fired plant, we calculate 0.9 TWh of energy production, generating direct emissions of about 350 000 tCO_2eq[47] and an **added cost of €8.4 million per year corresponding to the price differential of €24/tCO_2** between the floor price (€30/tCO_2) and a hypothetical ETS price on the order of €6/tCO_2.

This added cost would be offset by higher revenue from the sale of electricity on the French wholesale market at the times the CCG plants are in operation. These modelling exercises show that under our assumptions (implementation in France, Germany and Italy), the average increase in market prices would be €7/MWh[48], but this price would likely be closer to €9/MWh at the peak hours when the CCG plants would be in operation. **In this hypothesis, the resulting increase in revenue is estimated at between €6.3 million and €8.1 million if the plants run only at peak times.**

2. **In all cases sufficient added revenue is guaranteed, ensuring the viability of the generating capacity needed for secure supply**

The first auction of capacity guarantees took place on the EPEX SPOT platform on 15 December 2016: 22.6 GW of capacity were auctioned, on the basis of a unit price of about €10 000/MW.

The revenue generated by this mechanism raised the economic value of all the generating capacity certified. For a certified 400 MW CCG plant, this remuneration

[46] Assumptions: average load factor 25%, i.e. the equivalent of 2 000 hours at full capacity annually, consistent with annual production of 12 TWh for installed capacity of 6 GW. (Source: RTE, available consolidated and definitive national éCO2 mix data) https://opendata.rtefrance.com/explore/dataset/eco2mix_nationales_cons_def

[47] An average emission factor of 0.46 tCO_2/MWh is integrated for gas-fired plants (Source: RTE éco2mix).

[48] Estimation for base load: + €7/MWh in France, +€12/MWh in Germany and +€10/MWh in Italy

comes to about **€4 million**, on top of the revenue from energy sales on wholesale markets.

As this is a very recent mechanism there is not yet enough feedback available to make detailed projections on its functioning. Consequently, the projected level of this remuneration may fluctuate.

Despite this, it can be noted that in any event this additional remuneration will *at the very least* cover the fixed costs of plants that must be kept in operation in order to ensure secure supply.

Likewise, and even in the unlikely case that the proposed price measure were to temporarily erode the net profit from the sale of energy produced by a CCG plant, the continued viable exploitation of the plant would not be jeopardized as long as the plant is needed to ensure secure supply.

3. Results

The floor price measure would on average be neutral or positive for gas-fired plants, all other factors being equal.

The model presented above includes an increase in the minimum wholesale market price based on implementation of a floor price for CO_2 for electricity generation, in France, Germany and Italy. Integration of other countries (Netherlands, Belgium, Spain, etc.) would further raise the rents for the non-coal electricity sector, *and all the more for gas-fired plants.* **The mechanism could be initiated by a few countries, and later extended across a wider area.**

This view based on a broad average of gas-fired plants only partially reflects what might actually happen, because in fact combined cycle generating plants would predominate, as these are the most economically efficient plants.

In any case a technical assessment will have to be conducted to precisely project the effects of the floor price measure in participating countries.

Impacts on cogeneration

Exposure of French cogeneration plants to a floor price for CO_2 needs to be examined. These plants are for the most part gas-fired and produce in all about 15 TWh of electricity (and 22 TWh of useful heat). This activity represents some 30 000 jobs.[49]

Two typical cases are to be considered:

- Installations of under 12 MW capacity are granted regulated contracts for the sale of their electricity; price indexation will protect them from the higher cost of emissions when they are subject to ETS. Installations of under 5 MW are not covered by the ETS market.
- Large installations (36 industrial sites, over 2 GW installed capacity) sell their electricity on the wholesale market and pay for their emission allowances. The floor price discussed in this note would apply only to electricity production, and to the share of emissions imputed to this production. ATEE estimates specific emissions of 256 kg of CO_2 per MWh of electricity. This is logically much lower than CCG emissions because conversion losses are lower. The carbon

[49] Source: Association Technique Énergie Environnement (ATEE), conférence sur la cogénération du 4 mars 2015, http://atee.fr/sites/default/files/2015-03-04_confetat_des_lieux_et_perspectives_cogeneration_en_france_pcanal.pdf

penalty, passing from €6/tCO_2 under the ETS mechanism to a €30/tCO_2 floor price, would be raised by about €6 per MWh of electricity. This is the same increase as seen for the market price of electricity in the case of a French-German floor price.

The implementation of a floor price would not change the economic equation for cogeneration plants.