A climate and socio-economic study of a multi-member state carbon price floor for the power sector

EPRG Spring Research Seminar

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Content

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1 Context and objectives of study

Study context and FTI-CL Energy mandate

- **The European Commission has reaffirmed and increased its commitment to decarbonise its economy** with the ratification of the Paris agreement on 5 October 2016
- **The power sector has a key role to play in the decarbonisation of the European economy**:
  - An efficient and sustainable transition would avoid lock-in in thermal plants, …
  - and facilitate investment in capital intensive low carbon technologies.
- **With this background in mind, FTI-CL Energy has been mandated by a group of sponsor companies to:**
  - Assess the EU ETS price outlook and resulting progress against EU objectives; and
  - Identify the possible contribution of a CPF to an accelerated decarbonisation of the power sector.
  - Using fact-based modelling, and assumptions based on third parties recognized independent studies.

Study committee members

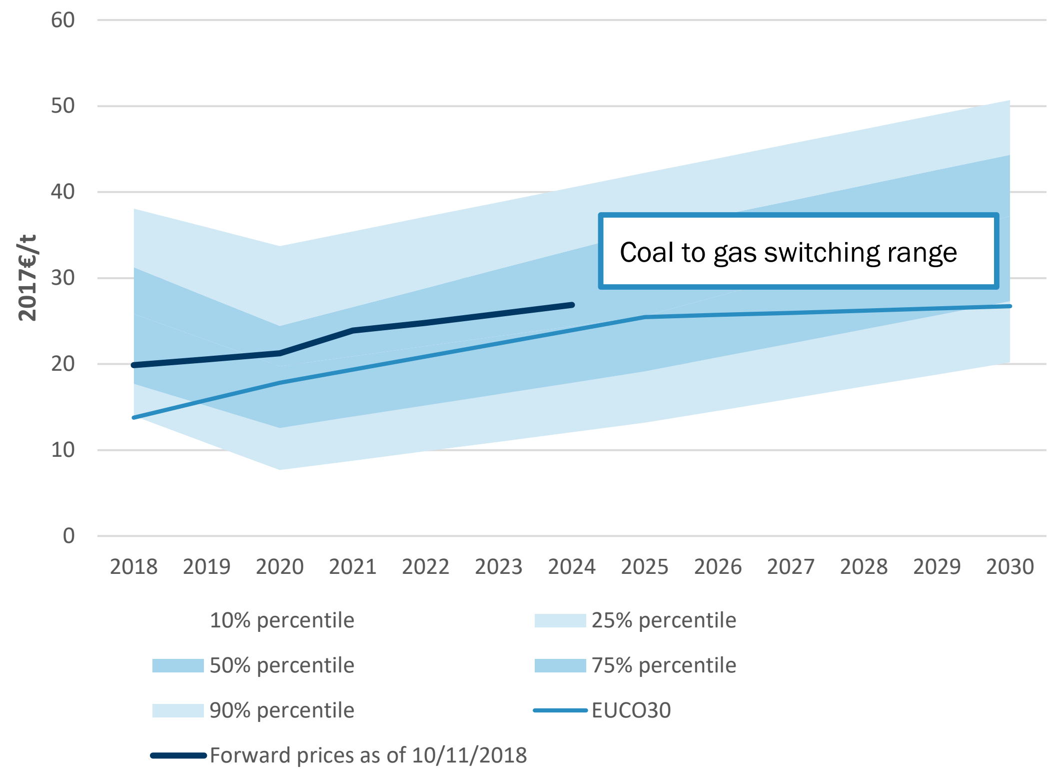
Eneco
SIEMENS Gamesa
EDF
Ørsted
edp
IBERDROLA
Vestas
Shell
ENGIE
EnBW

ETS prices are insufficient in the short term to drive an efficient decarbonisation of the EU power sector

ETS reform is helping but not enough

- Current prices around €20/t are due to the **ETS reforms**, market fundamentals, and hedging behaviour.
- However **parallel policies** such as energy efficiency, RES support, nuclear support, coal phase outs reduce the prospects for a sufficient carbon price.
- **Sustained coal and lignite to gas switching** across Europe would require prices around €15-35/t in the near term, but in the 2020s would require around €20-50/t according to our analysis.
- Current **forward prices are too low** to:
  - Drive a full switching between coal and gas units
  - Incentivize large scale renewables to be developed on a merchant basis

EU ETS carbon price pathways (real 2017)



Source: EEX, European Commission

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Carbon price risks affect investment decisions

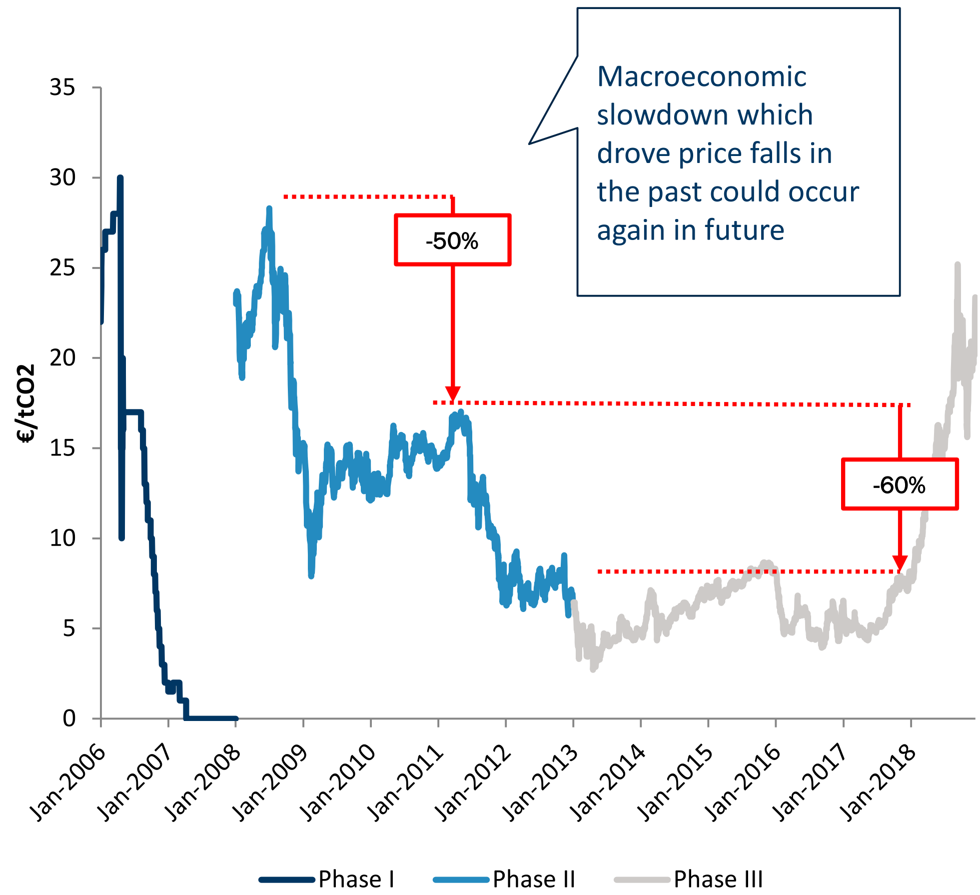
Investors in clean technologies see falling technology costs, but increasing market risk

- **Technology costs** are coming down, improving the business case for renewables investment
- But **revenues are increasingly uncertain as** greater reliance on power prices (and carbon prices as they affect power prices) **increases investor risk**

Investors focus on the *expected* carbon price and the risk that the price in the future may be lower than anticipated

- **Anticipated carbon prices** included in investors' business plans include a significant discount compared to base case projections reflecting the risk of a future price shock / decrease
- It is efficient for Governments to **protect investors against policy risk** which markets cannot accurately price

ETS prices 2006-2018, a history of price falls (downside risk)



… at a time when most competitive renewables are increasingly bearing market risk

Renewable projects and the "merit order effect"

- Renewables are **low marginal cost** – they push out fossil generation from the merit order
  - **Wholesale prices fall** as a results of increased renewables penetration

- But investors see a **correlated revenue risk** (referred to as 'cannibalisation of revenues')
  - The **captured prices** by wind and solar projects refers to the price achieved during half-hours when wind and solar are generating

- **Carbon price risk** amplifies power price risk and is driven by hard to predict policy decisions
  - The effect on wind and solar revenues will **become worse over time** as renewables penetration increases
  - Additional **storage and other forms of flexibility** on the system would act to smooth out prices

Merit order effect and RES Captured prices

(France to 2030)

2 Our modelling approach

We model the impact of a regional Carbon Price Floor (CPF)

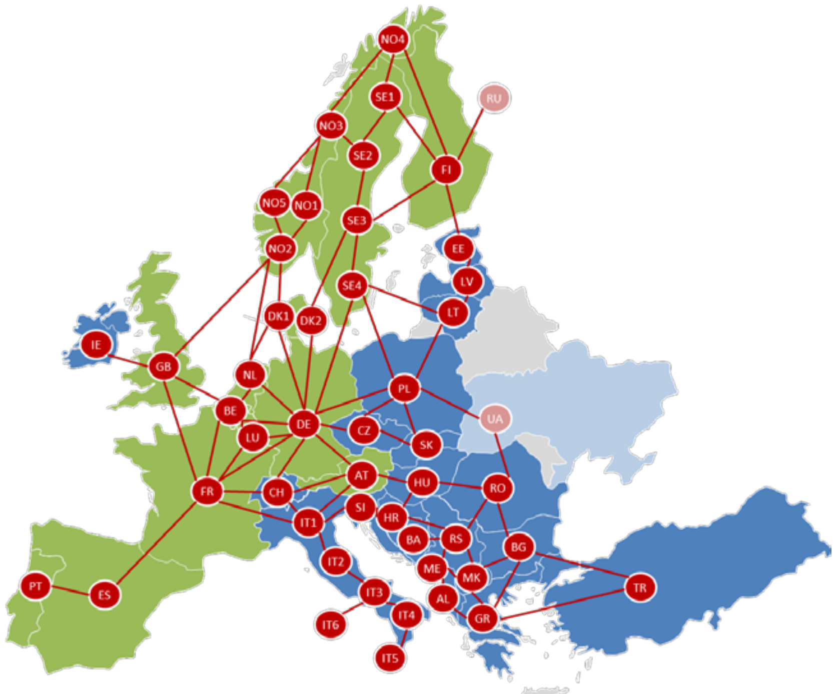
- A **Carbon Price Floor (CPF)** is a mechanism that Governments can use to create a minimum carbon price in their countries.

- **Different implementation models could be used :***
  - As a **top up tax** on the power sector above the EU ETS price (the UK model)
  - **Permit buy backs** – the Government or a market operator could commit to buying EUAs at a minimum price
  - As an **auction reserve price** – e.g. the Government could hold back permits from auction if the price went below a certain level

- In this study **we have not considered implementation questions**, but have assumed that the CPF is implemented in a way which is credible to the market and investors in a '**coalition of the willing' grouping 12 EU member states – in order to minimise unintended consequences such as carbon leakage**.

- In this study, we assume that:
  - The CPF is implemented in **12 Member States as a top up tax**
  - The CPF only impacts the **power sector**
  - **The MSR** will absorb some of the surplus allowances generated by the CPF - **Complementary policies** (such as EUA cancellations) are introduced and absorb the rest in order to maintain the effectiveness of the ETS and minimise leakage to the non-CPF Zone.

We have modelled a CPF introduced in 12 EU member states (the UK is assumed to keep its CPF)



CPF Countries: Germany, Austria, France, Spain, Portugal, Belgium, Netherlands, Luxembourg, UK, Denmark, Sweden, Norway and Finland.

- *Newbery et al (2018): When is a carbon price floor desirable? , EPRG Working Paper – Note permit buy backs would only work at EU level*
- *There is also another option whereby regulation would require companies within the CPF zone to surrender additional allowances*

To assess the potential role of a CPF, we have modelled a range of scenarios

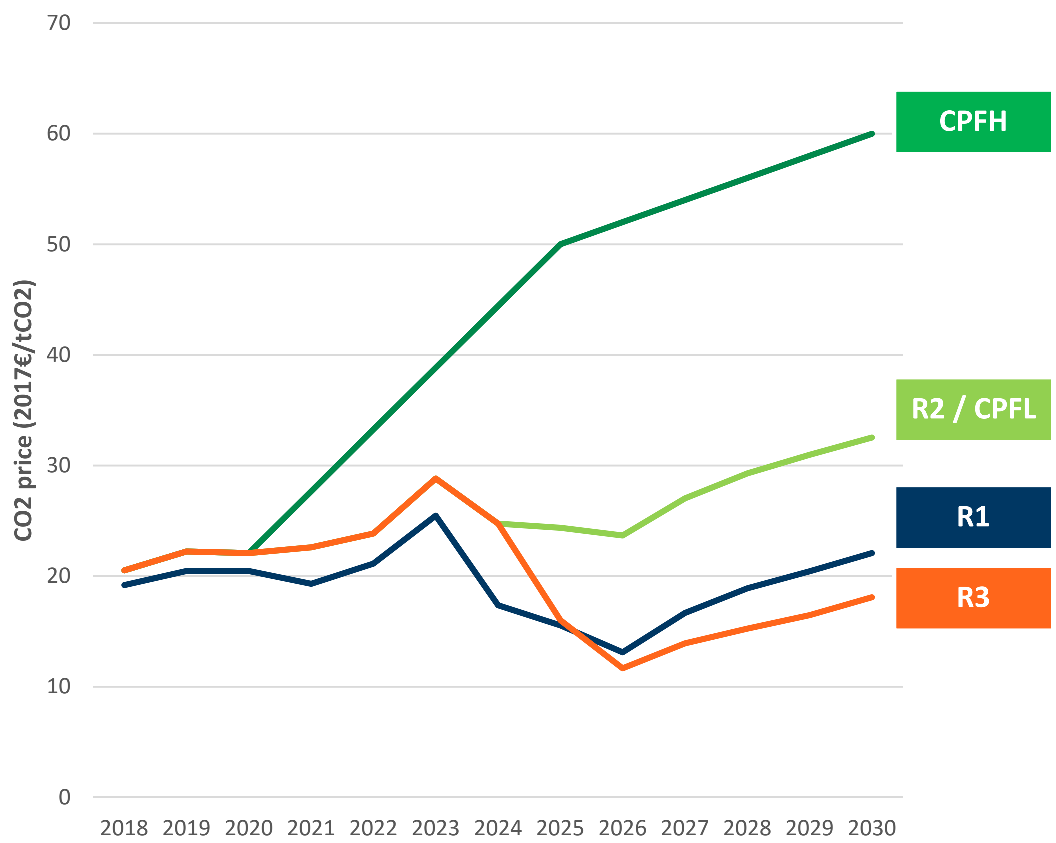
Contrast Scenarios

- **R1 scenario (ETS Low):** ETS prices remain low on the basis of current parallel national RES policies
- **R2 scenario (ETS High):** ETS prices are higher as a result of phasing out parallel RES policies and RES being more exposed to merchant price risk
- **R3 scenario (ETS Price Fall)** illustrates the plausible impact of a demand reduction on ETS prices (based on analysis of historical precedent)

Carbon Price Floor Scenarios

- **Carbon Price Floor High (CPFH)** sets the **CPF at €20/t in 2020 rising to €60/t in 2030.** This scenario illustrates a higher ambition world in which policymakers want to put a major policy emphasis on the carbon price instrument to meet their national RES objectives. The ETS price in the Non-CPF zone is assumed to be kept at the R2 level
- **Carbon Price Floor Low (CPFL)** sets the **CPF at €20/t rising to €30/t in 2030.** This illustrates the role the CPF can play even when set at a similar level to the expected ETS price, as an **insurance policy** against sudden ETS price falls. The ETS price in the Non-CPF Zone is assumed also to be kept at the R2 level

Carbon Price Scenarios to 2030



Note: (1) CPFH RES new capacities are set at R1 RES new capacities to meet national RES objective in CPF countries. (2) R2, R3 and CPFL RES new capacities are built based on a least cost capacity mix expansion optimization.

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Modelling approach: combination of ETS and EU Power Sector Models, based on public assumptions

FTI-CL's modelling approach is based on:

- FTI-CL Energy's in-house European power market model and EU ETS model , grounded in reputable modelling platform; and
- Background assumptions based on third party studies compatible with EU objective of (i) energy consumption reduction and (ii) decarbonisation of the EU wide economy.

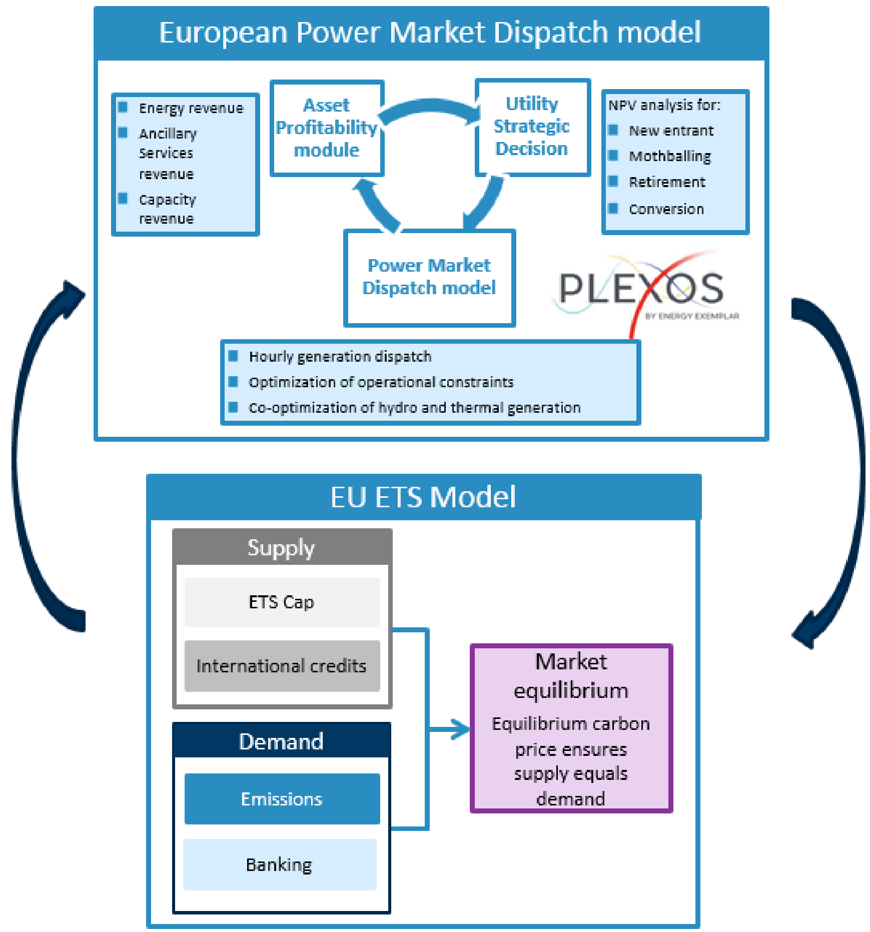
A two-step optimisation process is performed by our power market model:

- **Dynamic optimisation of the generation mix** based on the economics of RES, thermal plants and storage, to ensure security of supply and meet EC objectives at the least cost; and
- **Short term optimisation of dispatch** of the different units on a hourly basis.

This study has used our proprietary models to investigate:

- The ETS price outlook and resulting progress against EU objectives
- The possible contribution of a CPF to an efficient decarbonisation of the power sector

We have used our EU power market model and our EU ETS model

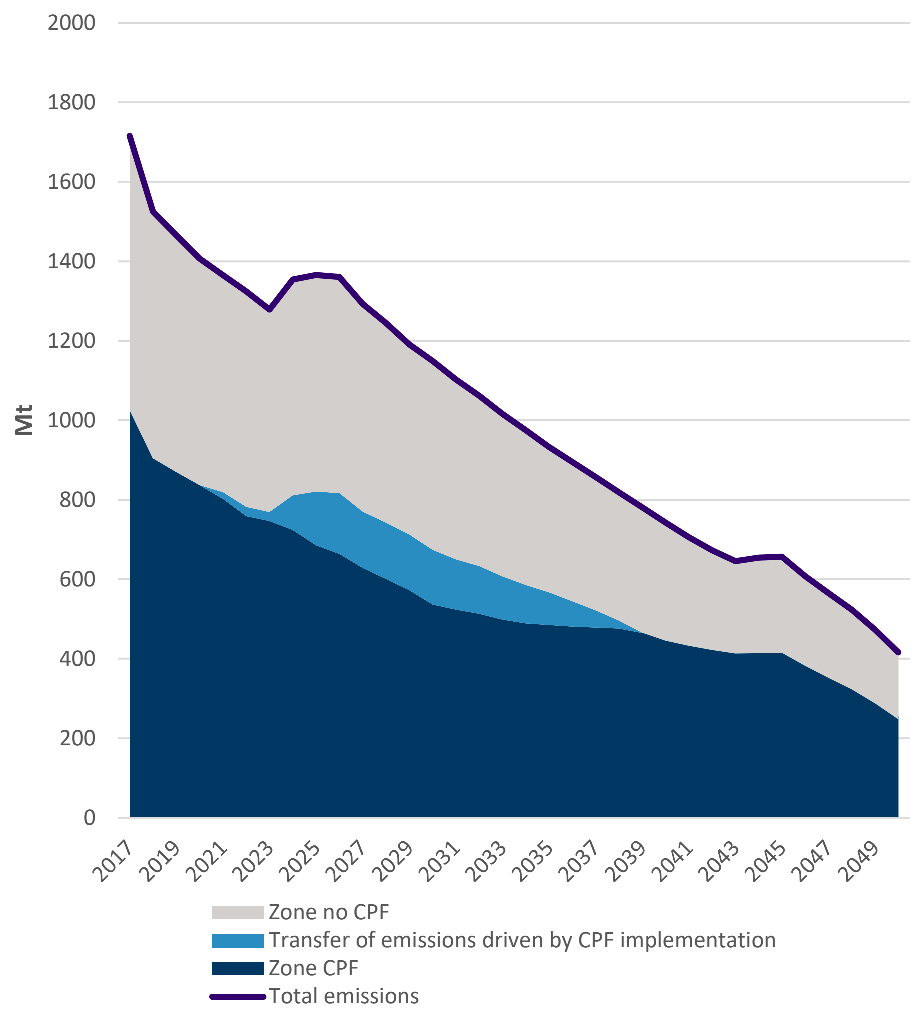


Complementary measures can be implemented so as to counter the “waterbed effect” and reduce the total level of emissions

- The introduction of a CPF in the CPF zone will reduce **the total emission in CPF zone by 1662 Mt between 2021 and 2039**.
- This abatement in the CPF zone would create a surplus of EUAs within the EU ETS, which would be at least partially absorbed by the MSR.
- However, as the MSR is unlikely to absorb the entire surplus a large amount of allowances could be **sold into the no CPF zone to balance the EU ETS market** during the period 2021-2039, creating much lower prices for the EU ETS.

- To offset the impact on the EU ETS market, specific **complementary policies** could be implemented with the aim of tightening the supply of credits so as to adjust to the drop in demand.
  1. **Voluntary cancellation mechanism** by member states to cancel an amount of allowances corresponding to the additional abatement driven by the CPF in the CPF area.
  2. **Adjustment of the market cap** or the linear reduction factor.
  3. **Adjustments of the MSR parameters**: intake rate, period, cancellation of surplus, etc.
- We consider these further below

EU ETS emissions for each zone



** Notes: The emission reduction is based on the current EU ETS LRF (2.2%) and therefore doesn’t reach the 2050 Targets (GHG 80-95% -100Mt).*

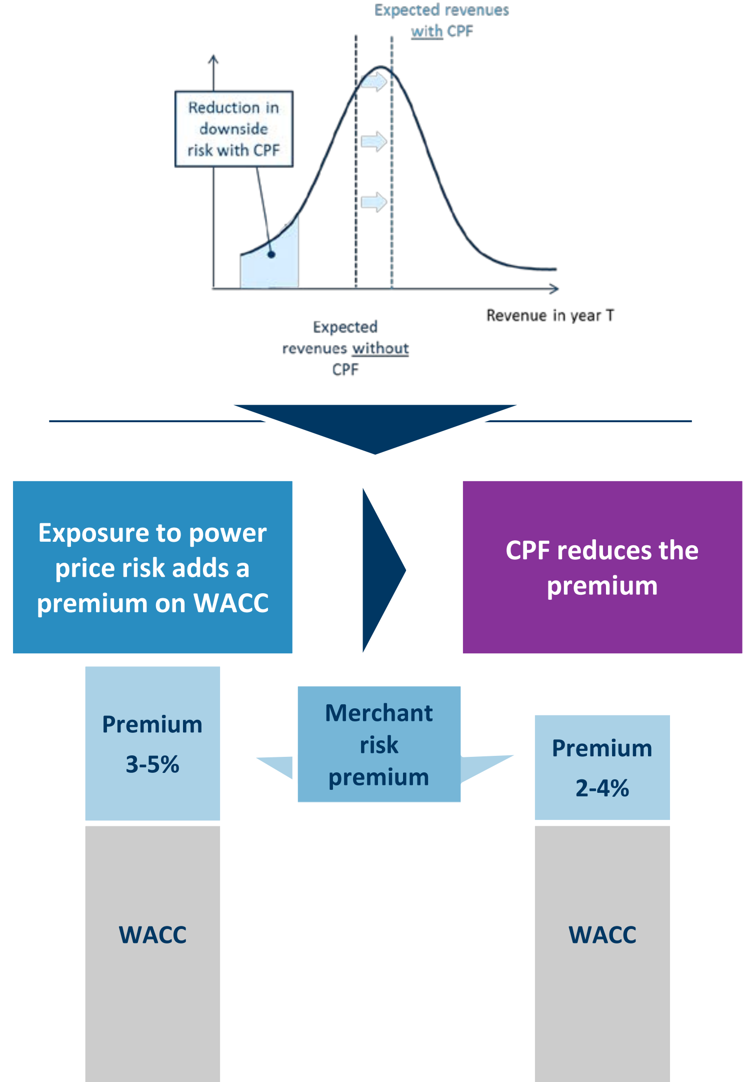
Reduced CO2 price risk reduces energy revenue volatility and thus reduces cost of capital

We have used a range of evidence sources to understand the impact of a CPF on financing conditions and costs

- **Literature review/benchmarking** – we reviewed a range of studies that suggested that **exposure to full merchant power price risk could add around 3-5%** at least onto the WACC for power plant investments, and a **CPF could reduce this by 1.5%.**
- **Industry interviews in the finance sector** – we have conducted structured interviews with 7 banks and other investors
- **Financial modelling** – we have used **financial modelling** to estimate the cost of **carbon price insurance** based on the Black Scholes model for pricing derivatives.

- Based on the above analysis, we have inferred that the enhanced predictability of future CO2 prices in a CPF scenario, **could reduce the cost of capital risk premium in a merchant world by 1%.**
  - This reduction is applied homogeneously to all investors profile (first mover investors and conservative investors)
  - This reduction of cost of capital translates into a reduction of overall RES levelized cost

Price risk reduction under Carbon Price floor



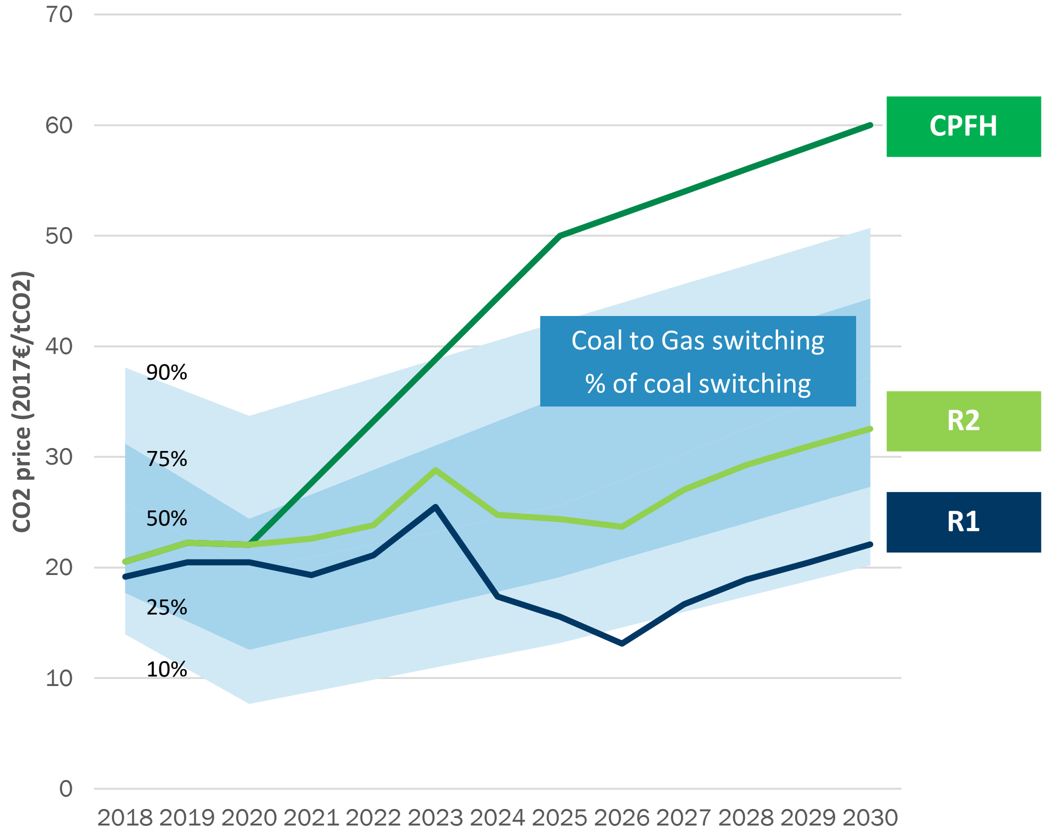
3 Study findings: A “high” Carbon Price Floor (CPF) to accelerate the power sector transition

The CPF High scenario rises from around €23/t in 2020 to €50/t in 2025 and €60/t in 2030 boosting coal to gas switching

- **Carbon Price Floor High (CPFH)** sets the CPF at €20/t in 2020 rising to €60/t in 2030. This scenario illustrates a world in which policymakers wanted to put a major policy emphasis on the carbon price instrument. (The CPFH line illustrates the CO2 price in the CPF Zone. The ETS price in the Non-CPF zone is assumed to be kept at the R2 level)

- **The high levels of the carbon price will enable an accelerated reduction of emissions in the CPF zone:**
  - The coal to gas switching will be boosted with a total switching expected by 2025 in the CPF zone.
  - High carbon prices will also support renewable investment.

Carbon Price Scenarios to 2030

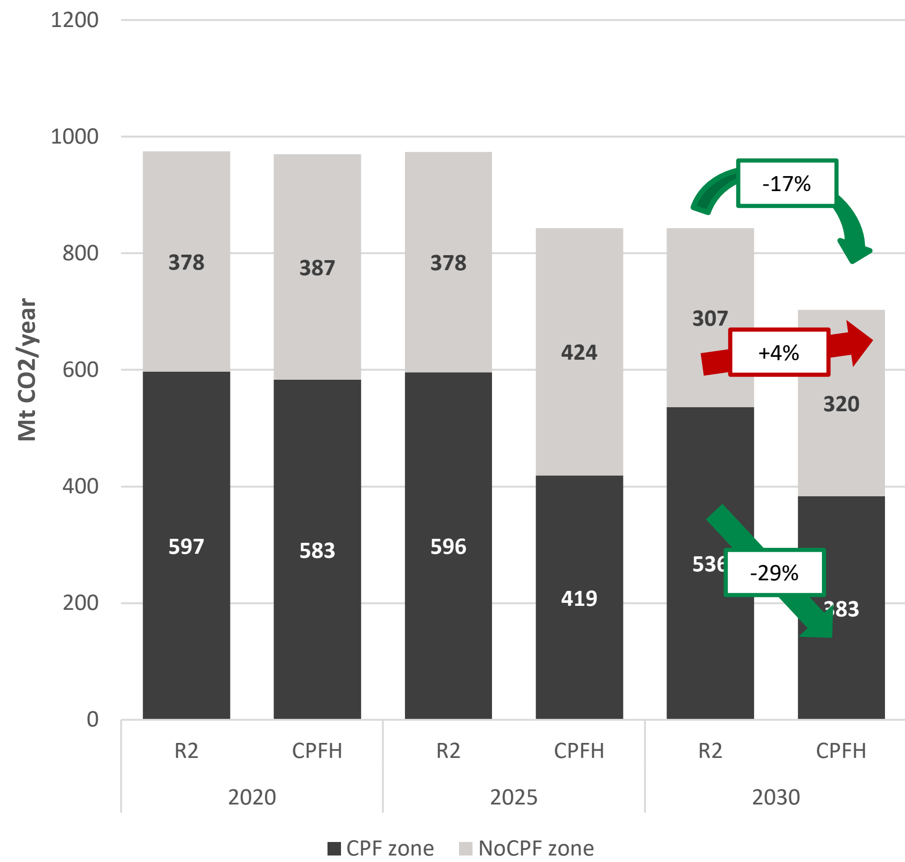


A High CPF would reduce power sector emissions at the EU level, despite electricity leakage to non-CPF countries

Emissions in the EU 28 are 17% lower in 2030 than in R2, and 7% lower than in R1

- A High CPF would reduce emission from the power sector at the EU level through **coal to gas switching**, as well as **renewable investment**.
- The introduction of a High CPF (CPFH) would reduce the emissions in the CPF zone by 29% compared to R2 due to more renewable generation and less thermal production.
- The emissions in the non CPF zone would increase by 4% driven by additional cheap thermal generation being produced into this zone.
- **Overall, the emission will drop by 17% compared to R2 scenario**.

EU ETS Power Sector Emissions (MtCO2e/year)

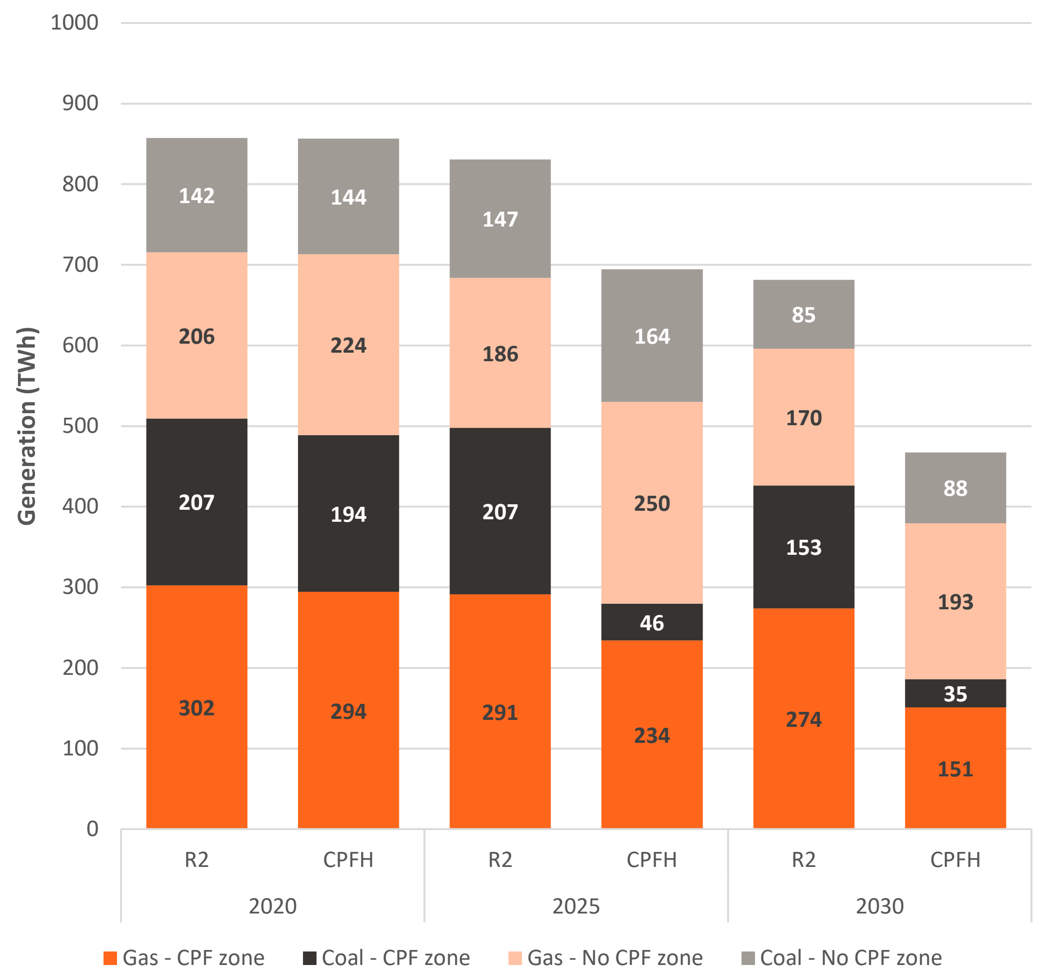


A High CPF would give an early signal to coal phase-out and avoid lock-in of thermal plants and stranded assets

A High CPF would give an early signal to coal phase-out and avoid lock-in of thermal plants

- **It would increase costs for high carbon fossil-fuel generation compared to lower carbon fossil fuel generation** in the short term optimisation of the power markets – coal to gas switching;
- **The results show that the introduction of a CPF could support the transition by sending stronger signals to thermal plant operators**
  - The High CPF (CPFH) features a lower total thermal generation, with a greater impact on high carbon fossil-fuel (Coal) generation than lower carbon fossil-fuel (gas) as illustrated when comparing R2 and CPFH
  - The High CPF (CPFH) features a lower installed capacity of high carbon fossil-fuel than the R1 and R2 scenarios driven by a high deployment of renewable capacity and a higher carbon price

Gas and Coal generation



A High CPF would support RES investment in the short term

A High CPF could boost renewables investment by reducing financing costs, and increasing power prices in the short term (to 2025):

- With the enhanced predictability and lower cost of capital impact, a strong CPF would incentivise low carbon generation over high carbon generation.
- The CPFH scenario also has higher carbon prices and higher power prices (in the short term to 2025) which will also affect the investment decision for renewables
- This translates into a higher penetration of RES in the generation mix – helping to meet RES targets

Renewable energy generation and 2030 targets

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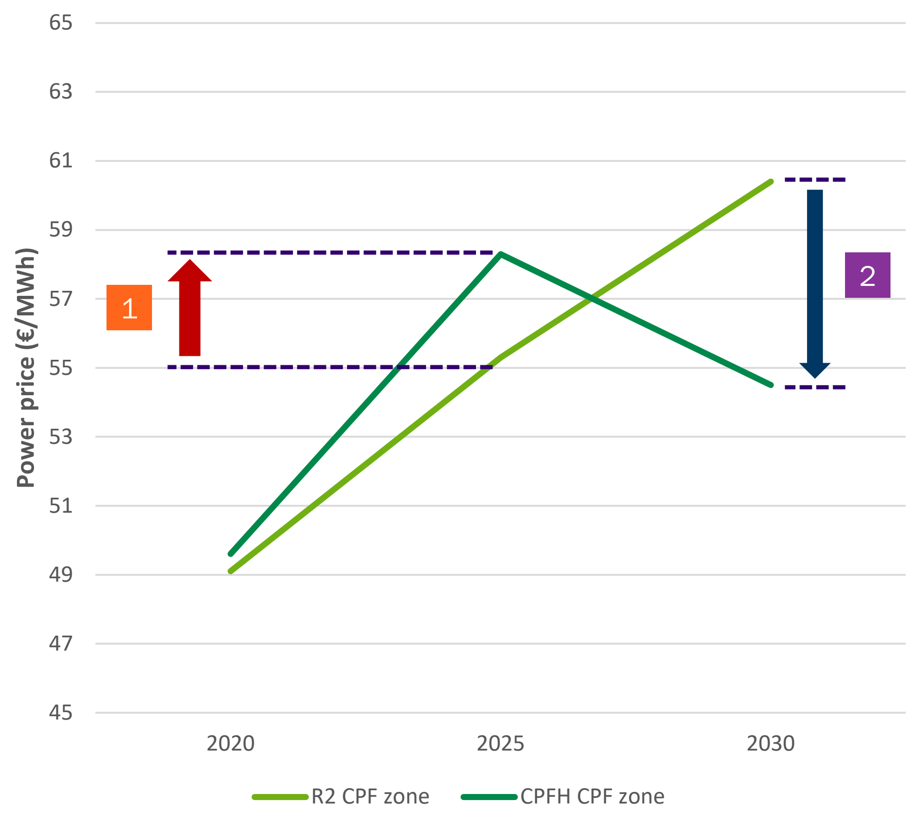
A High CPF could support the energy transition while mitigating power price increases for end consumers in the medium and long term

Power prices in 2030 are lower than in the R2 pure merchant scenario

- A higher carbon price signal would lead to higher power prices when set by fossil generation 1
- Higher power prices and lower WACC enables greater RES penetration which pushes down power prices (through the merit order effect). 2
- The results of this new equilibrium shows that under the High CPF price level - set at €60/tCO2 by 2030, twice as high as in the R2 scenario - power prices in the CPFH scenario are lower than the ones in the R2 scenario in 2030 owing to more renewable generation in this scenario.
- **The results show that the introduction of a CPF could support the energy transition while mitigating power prices increase for end consumers.**

Power prices in CPFH vs R2 – CPF Zone



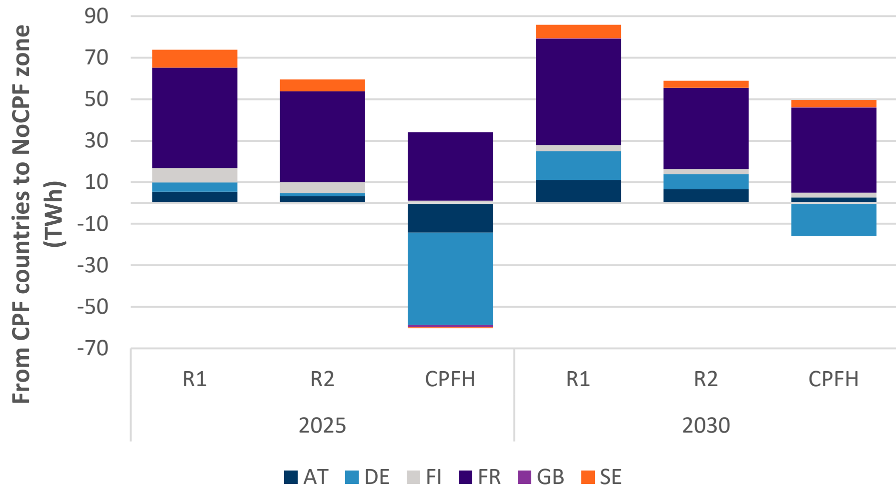
Note: Load-weighted average price in the CPF zone

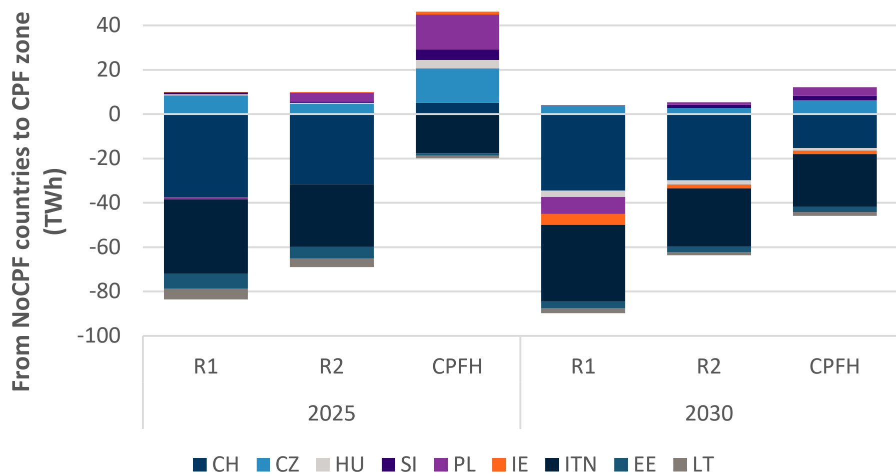
To minimise the effect of power flow leakage on emissions, a wider coverage of the CPF is preferable

The CPF Zone remains a net exporter of power, but volumes fall by 42% in 2030, and Germany becomes a net importer

- By penalizing thermal generation in the CPF zone compared to the non-CPF zone, the net export balance between both zones would materially change in CPFH.
  - The change would be specially important in 2025. Indeed, Austria and Germany will become net importers for this year driven by material carbon prices difference between the CPF zone and the non-CPF zone.
  - The trend will be reduced in 2030 because of the increased renewable generation in the CPF zone lower prices.

Net power flows





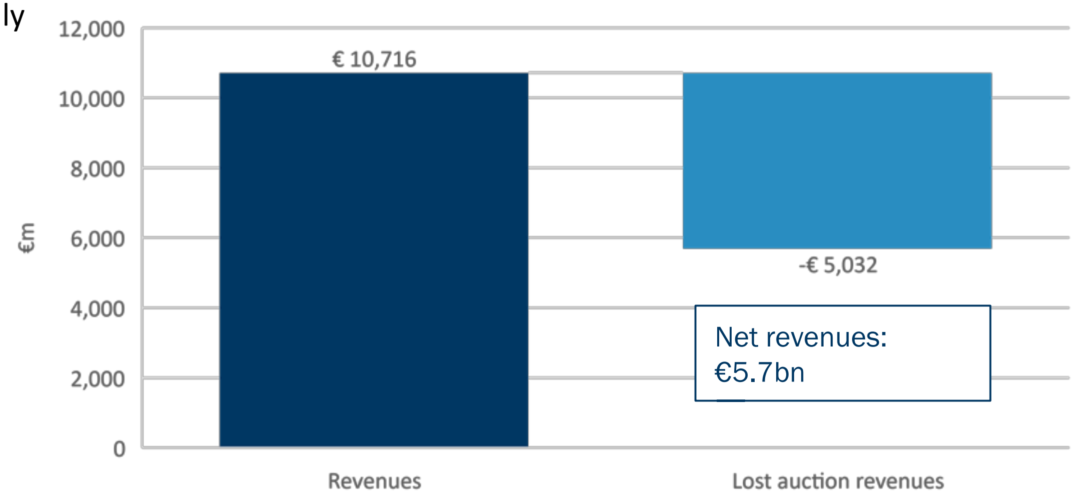
Socio-economic impacts from a CPF are moderate, and manageable with additional carbon revenues

Impacts on consumers

- The impact on consumers would depend on power prices – but also the effect on renewables support costs. In 2030 consumer costs are €37bn (6%) lower in CPFH than in R2, wholesale energy costs are lower though partially offset by somewhat higher RE support costs (as most RE support regimes are like CfDs where the support cost goes up if power prices go down and vice versa). The increase in RE support costs is €10bn.
- Lower power prices via the merit order effect could lead to lower consumer energy bills by 2030 (see modelling results below)

Carbon revenues and Energy Intensive Industry costs 2030

Government CPF Revenues - comparison of CPFH vs R2 scenario



CPF net revenues: €5.7bn > EII net costs: -€1.9bn

4

Study findings: A “Low” CPF acts as an insurance policy for low-carbon investors

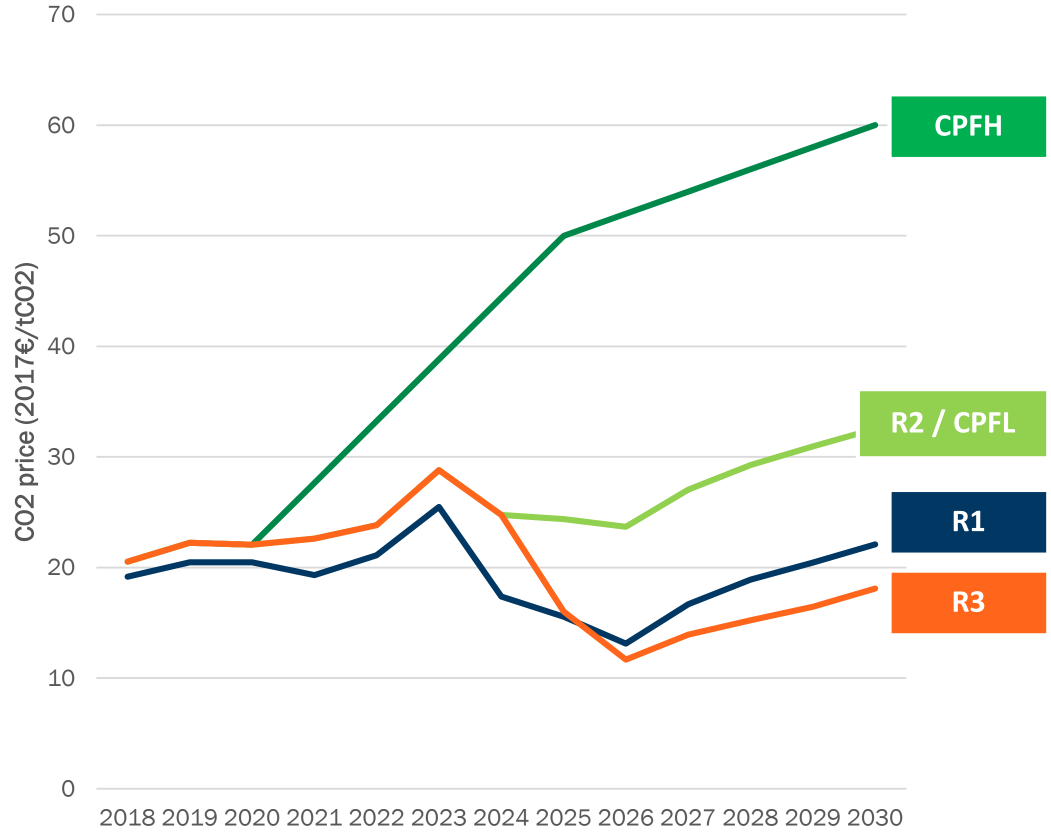
The CPF Low scenario rises from around €23/t in 2020 to €30/t in 2030, following the R2 Scenario as an insurance mechanism

Carbon Price Floor Scenarios

- **Carbon Price Floor Low (CPFL)** sets the CPF at €23/t rising to €30/t in 2030. This illustrates the role the CPF can play even when set at a similar level to the expected ETS price, as an insurance policy against sudden ETS price falls. (The R2/CPFL line illustrates the CO2 price in the CPF Zone and in the No CPF Zone (the ETS price)).

- **R3 ETS Price Fall** shows the impact on ETS prices of a sustained fall in prices such as could be caused by a regulatory intervention phasing out coal, or a new technology which dramatically reduced demand for emissions from the industrial sector.

Carbon Price Scenarios to 2030



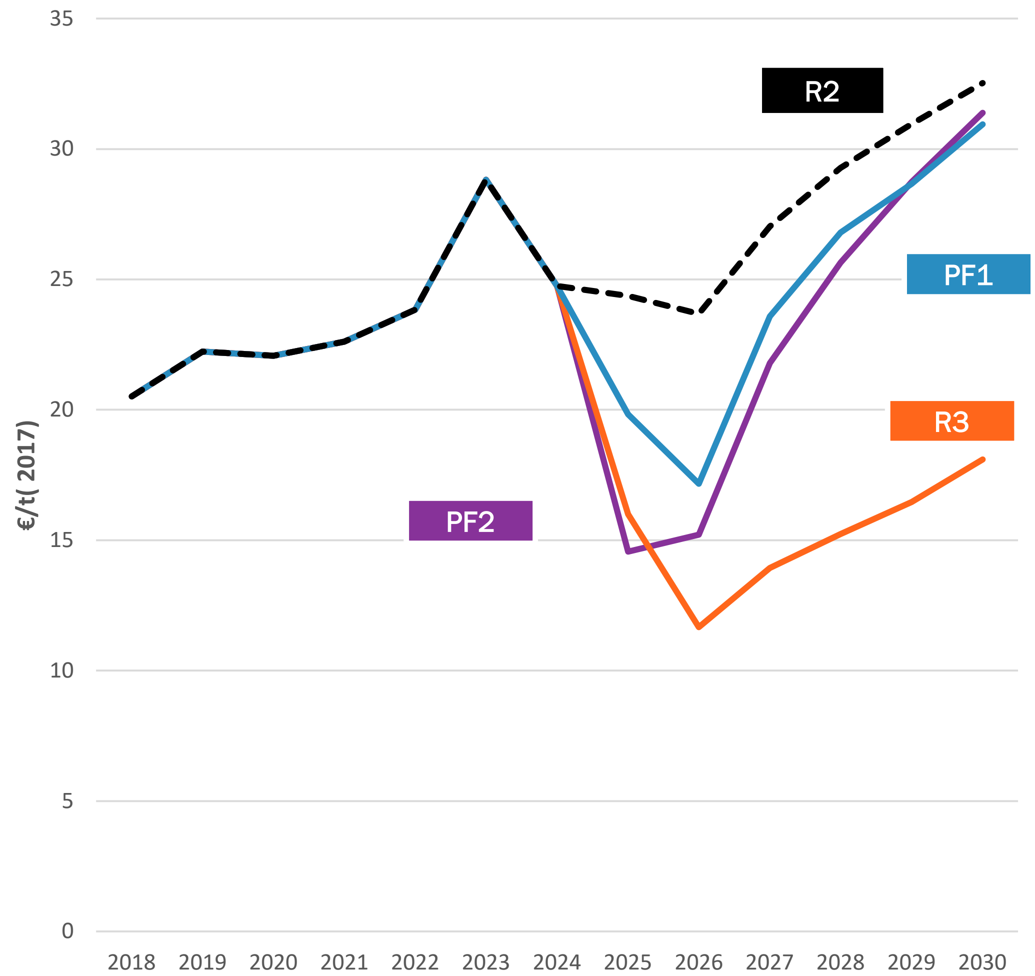
CPF Countries: Germany, Austria, France, Spain, Portugal, Belgium, Netherlands, Luxembourg, UK, Denmark, Sweden, Norway and Finland.

Historically plausible falls in EUA demand show such events could have a material impact on the ETS price

Price falls in the EU ETS is a plausible risk

- We have modelled stress test scenarios with price falls in the EU ETS for a range of plausible events based on historical precedent
  - **Economic recession (PF1)** : 330 Mt reduction in demand for credits in 2026 then following impact of the crisis.
  - **Energy efficiency technology (PF2)** : 400 Mt reduction in demand for credits in 2025, progressively reducing to 0 Mt in 2030.
  - **Regulatory intervention (PF3 – R3 scenario)** : For example the gradual closing of all coal fired power stations. Progressive reduction in demand for credits, from 0 Mt in 2025 to 400 Mt in 2030.
  - **Slower electrification of heat and transport**: this could lead to lower electricity demand than expected, and lower demand for EUAs

EU ETS carbon price (real 2017)

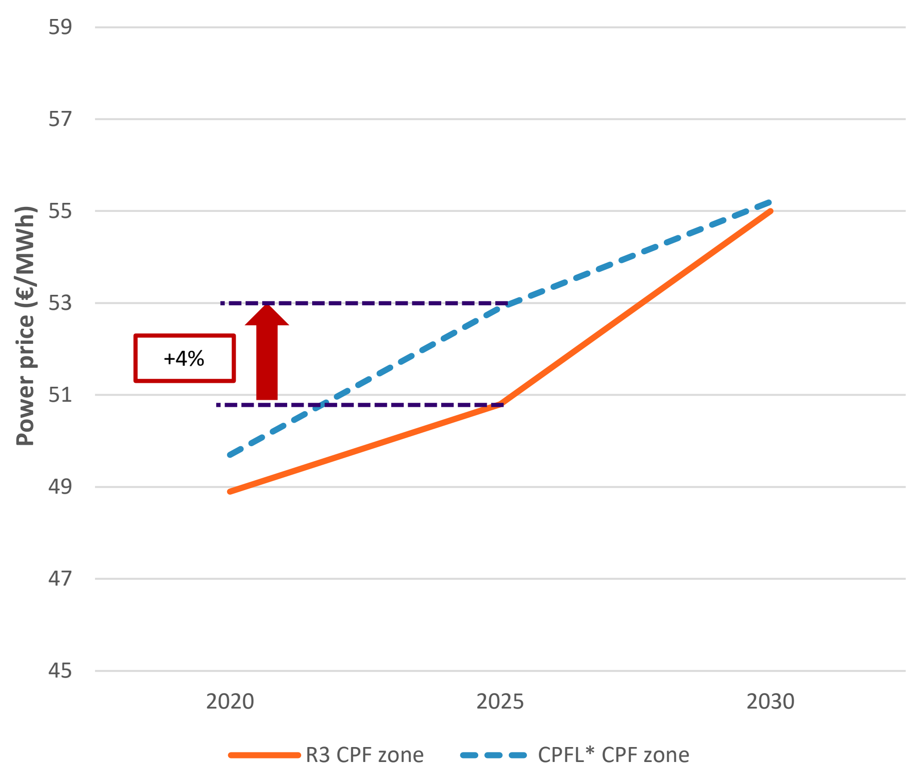


A low CPF would act as an insurance policy against very low carbon and power prices, reassuring investors in renewables

A sudden fall in ETS prices would affect power prices

- The R3 scenario shows that with ETS price falls down to €10-15/t, the impact is that the power price is kept lower
- This would affect revenues and the investment case for renewables
- By contrast in the CPFL* scenario with the same ETS price drop power prices in the CPF zone are 4% higher in 2025 and slightly higher in 2030
- **The results show the value of the Low CPF as an insurance mechanism – maintaining stable levels of renewables investment even if there are unexpected and material falls in the ETS price.**

Power prices in R3 vs CPFL* - CPF zone



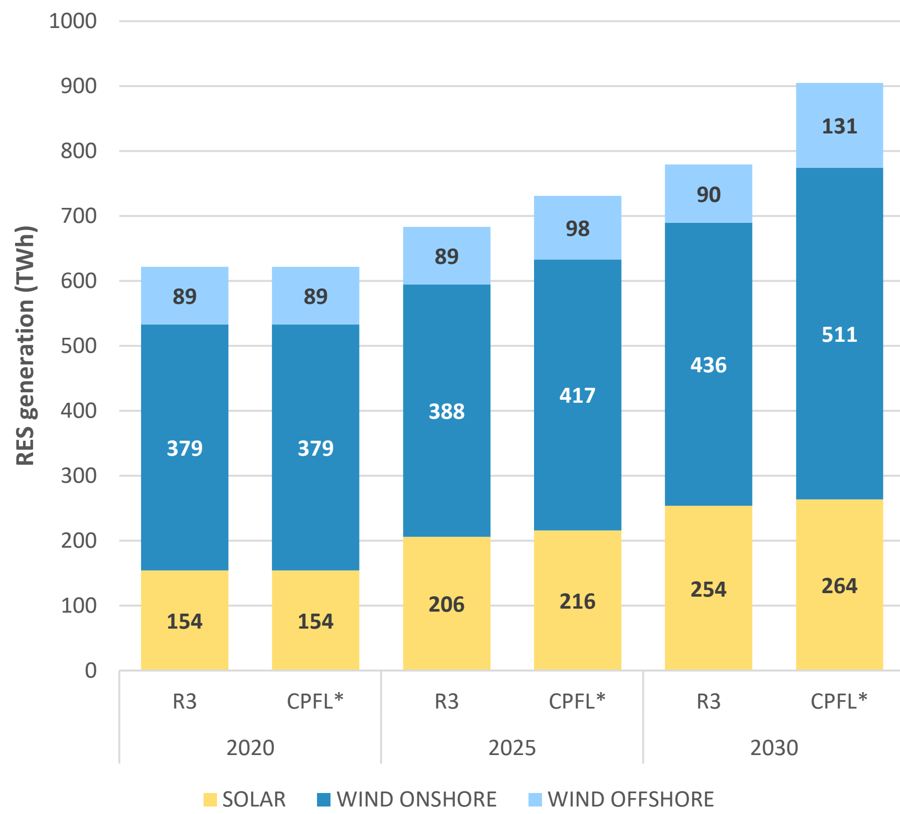
Note: Load-weighted average price in the CPF zone

In the Low CPF scenario, renewables investment is sustained, despite the fall in ETS prices

The benefit of the low CPF as an insurance mechanism is also seen in RES deployment and generation

- The R3 scenario shows that investment in renewables slows down between 2025 and 2030
- The CPFL* scenario shows how a low CPF policy instrument could help in the case of an R3 type fall in the ETS price
  - Offshore wind generation in 2030 is 46% higher in the low CPF scenario
  - Onshore wind is around 17% higher
  - Solar is around 4% higher
- This illustrates the material contribution a low CPF insurance mechanism could make to meeting the 2030 **renewable energy target**

Renewables investment and output is kept high

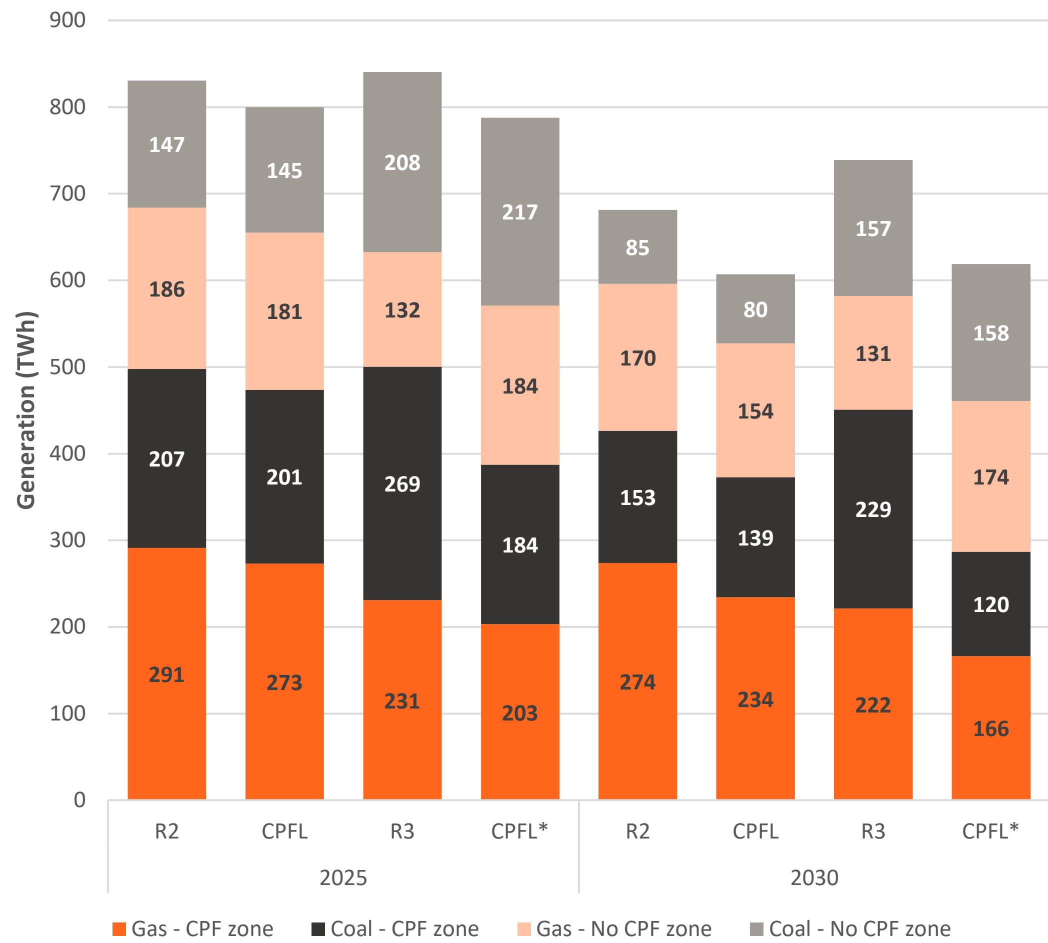


A low CPF does not provide a strong signal to fossil generators – but higher RES investment would impact fossil generation

The CPFL carbon price signal would not drive significant coal to gas switching or retirements

- As the carbon price is at the same level as in R2, there is no increase in coal to gas switching or retirements
- However **CPFL increases RES generation from 2025 onwards,** and therefore **reduces fossil-fuel generation** as well as emissions
- Furthermore, a low CPF level would **be robust in the event of an ETS price fall**.

Gas and Coal installed generation



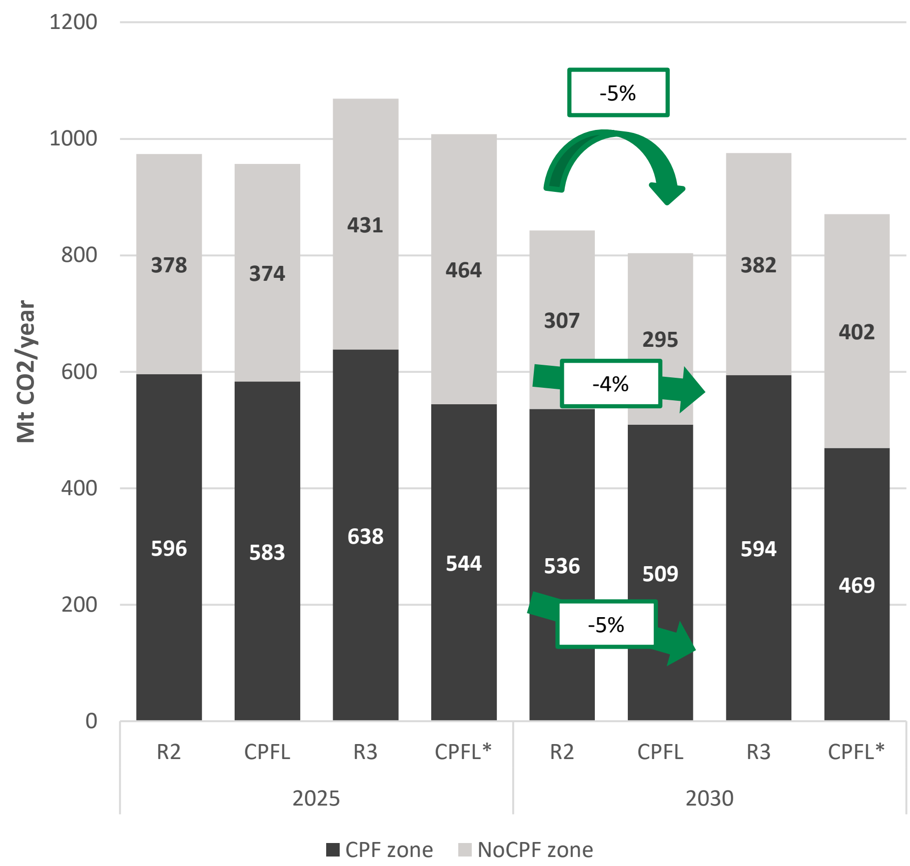
Notes: Coal represents coal and lignite generation

A low CPF would reduce power sector emissions at the EU level, despite some electricity leakage to non-CPF countries

A low CPF would reduce power sector emissions at the EU level, despite electricity leakage to non-CPF countries

- A low CPF would reduce emission from the power sector at the EU level by replacing thermal generation by renewable generation.
- The introduction of a Low CPF would reduce the emissions in the CPF zone by 5% compared to R2 due to more renewable generation and less thermal production.
- The emission in the no CPF zone are expected to decrease by 4% driven by additional low carbon exports from CPF zone to non-CPF zone.
- **Overall, the emission will drop by 5% compared to the R2 scenario**.

Emissions per zone in the four scenarios



5 Conclusions

Conclusions: Our study shows the limitations of the recent ETS reform and the potential benefits from a Carbon Price Floor (CPF)

- **The problem: The ETS reforms will not deliver sufficient investment signals for an efficient decarbonisation of the power sector**
  - The EU ETS CO_2 price – despite the boost from recent reforms – is insufficient in the short term to drive significant coal gas switching , creates a risk of lock in of fossil plants, and does not provide a strong and credible enough signal for renewables investment in the medium to long term
  - The ETS price is volatile with significant downside risk – this raises the cost of capital (WACC) and reduces access to finance
  - The impact of the ETS price risk on electricity prices compounds this uncertainty – which could undermine investment at a time when clean technologies are increasingly bearing market risk

- **A Carbon Price Floor (CPF) would enhance the efficiency of the power sector transition**
  - CPF acts as an insurance mechanism for investors, protecting them against sudden ETS price drops caused by a significant demand/supply imbalance, and against potential weak macroeconomic conditions
  - Emissions in the CPF countries could be significantly reduced in 2030, and indeed reduced across the EU as whole as long as the waterbed effect is addressed
  - Electricity and emissions leakage through cross-border flows can be minimised by the MSR as well as complementary policy to maintain ETS demand levels, and through ensuring that the CPF zone is of a minimum acceptable size
  - Renewables investment would be supported through a lower cost of capital in a world where projects are increasingly exposed to merchant price risk
  - A CPF would drive greater coal to gas switching, and provide a clearer investment signal to avoid lock-in of fossil plants
  - Power price impacts depend on the interaction of two effects – the CPF would increase power prices to the extent and for as long as fossil fuel plants remain on the system and set market prices. This is counterbalanced by the "merit order effect"- if the CPF encourages higher renewables penetration, this shifts the merit order and lowers market prices
  - Impacts on consumers and Energy Intensive Industries (EIIs) may be positive insofar as power prices are lower with a CPF
  - If there were additional costs, these can be mitigated using Government revenues raised from the CPF

Thank you for your attention

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