FTI·CL Energy

Assessment of the impact of the French capacity mechanism on electricity markets

Report for RTE

Presentation to the Commission accès aux marchés - CURTE

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1 – Context and objectives of the study

Context and objectives of the study:
Background on the French CM and EU Commission investigations

Context and objectives of the study

Drivers of the French CM implementation:

- Concerns over security of supply have emerged in France as well as in a number of EU member states.
- In order to provide better incentives to keep the power system balance, the government decided in 2010 to establish a capacity mechanism (CM). The CM regulatory framework has been set up by a Decree in 2012 and detailed rules in 2015.

European Commission investigations:

- The EU Commission is now investigating capacity mechanisms across Europe and opened an in-depth investigation into the French country-wide capacity mechanism.
- The CM is assessed as a public intervention and the Commission is particularly sensitive to the impact on prices and energy markets insofar as it may affect the Internal Electricity Market.

A need for supportive quantitative evidence:

- In the case of capacity mechanisms, it has been frequently heard, without quantitative demonstration, that such mechanisms would have a major impact on prices in France and in neighbouring countries
- There are few studies providing quantitative modelling of the impact of a capacity mechanism in the French and neighboring markets

In this context, FTI-CL Energy has been asked by RTE:

- To assess the French CM and its impact on the electricity market, based on a dynamic modelling from 2017 to 2040; and
- To compare the French CM impact with the impact of other public policy interventions.

2 – Modelling approach

Modelling approach:
A counterfactual 'energy only' scenario has been built to evaluate the CM impact

Scenario and sensitivities description

The 'energy-only market ' (EOM) scenario considered to evaluate the impact of the CM:

- **In the EOM**, other market conditions being equal, in the EOM, available capacity is driven by economic decisions of rational players taking into account the current price cap in the day-ahead market (3,000€/MWh) and taking into account revenues in other market segments (balancing and reserve markets). The EOM does not guarantee the reliability standard set by the government is met.
- **In the CM**, market participants have to meet the capacity obligation so the available capacity is optimised while respecting the reliability standard set by the government taking into account the potential revenues in the capacity mechanism.

A realistic and dynamic modelling approach over the period 2017-2040:

- We use a realistic model of the French and neighboring markets calibrated to reproduce historical market prices
- For each year, we optimise market participants operational and investment /retirement decisions based on their expected costs and revenues
- We assume perfect competition and no asymmetry of information for market participants, but include some degree of risk aversion
- The CM is modelled as a centralised auction to simplify the modelling

We also consider a range of other public policy interventions to provide some context:

- In order to provide some context, these effects are then compared to the impact of a range of other public policy interventions in European electricity markets.
- The objective is not to evaluate these policies, but to provide some elements of comparison with the effect of the French CM as regards their impact on energy prices

Modelling approach

Geographic scope and key features of FTI-CL Energy in house model

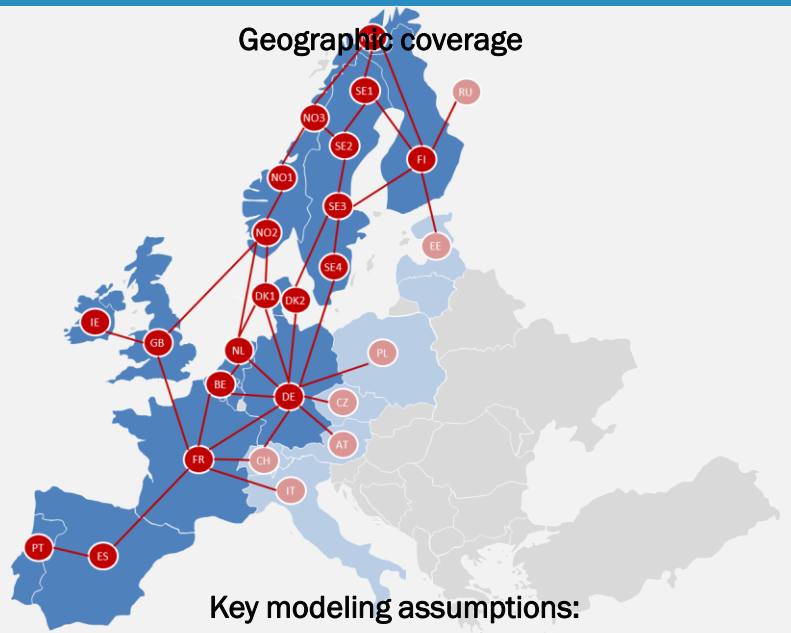
Presentation and geographical scope of our dispatch model

- **FTI-CL Energy's in-house dispatch and capacity model:**
  - Accounts for each unit connected to the grid, demand fluctuations, renewable output and its variability, specificities of hydro power and interconnectors
  - Based on a well-established optimisation platform Plexos® and calibrated to reproduce historical prices
  - Provides a hourly optimal dispatch taking into account operational constraints, simulatee the capacity market, and computes optimal investment / retirement strategies

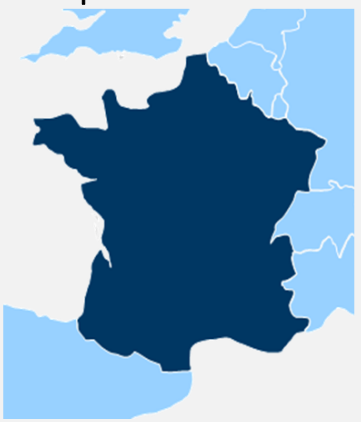
- **Our model covers a large geographical scope:**
  - GB, Ireland, France, Belgium, the Netherlands, Germany, Denmark, Norway, Sweden, Finland Spain and Portugal
  - Countries beyond this geographic scope are modelled at an aggregated level

- **The key modelling assumptions are set according to RTE "Diversification" scenario (BP2014, updated with BP2015 for the medium-term)**, as well as on ENTSO-E data and the International Energy Agency for commodity prices and capital costs

Geographic coverage



Key modeling assumptions: a snapshot view in 2030

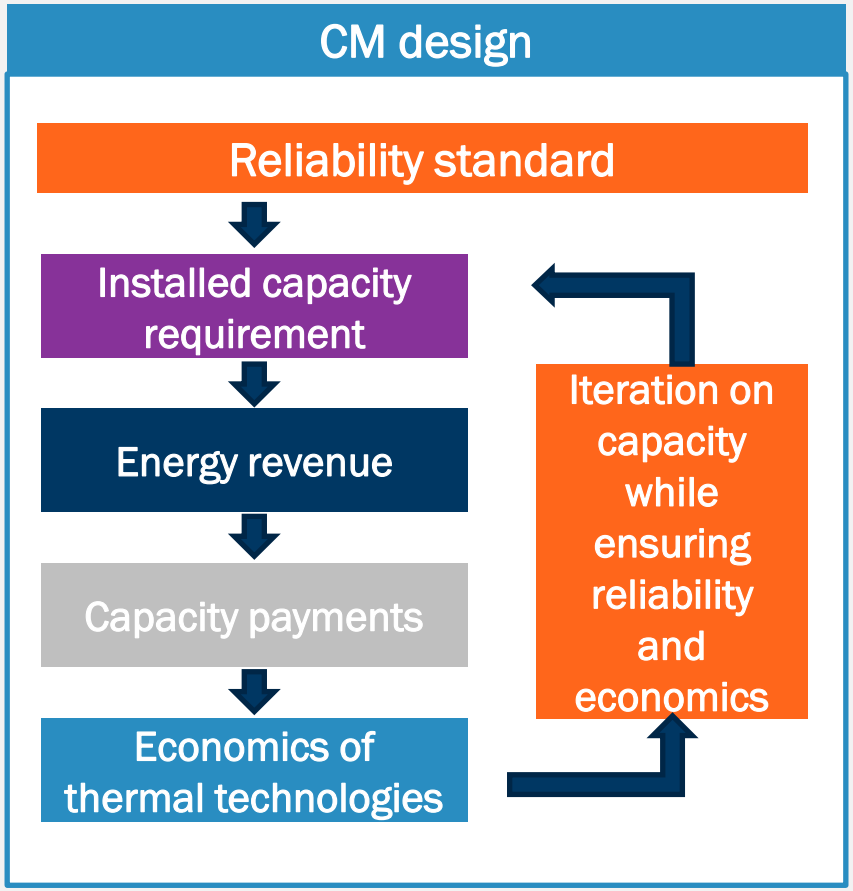


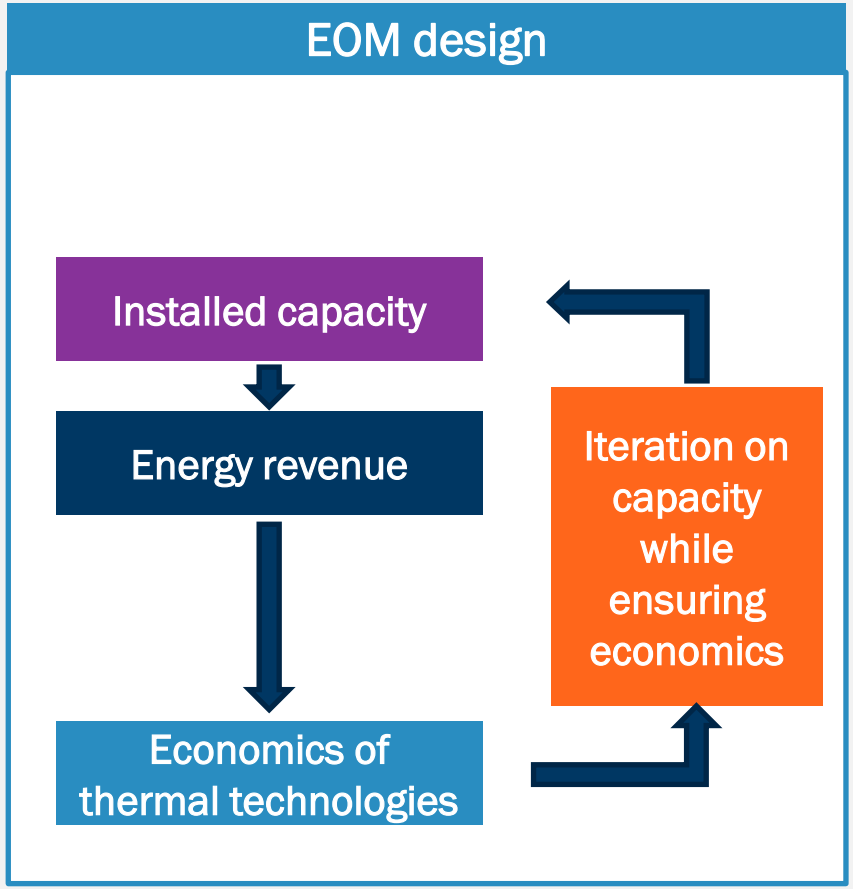
Nuclear 47.6 GW by 2030	**Annual demand** 501 TWh by 2030
Onshore Wind 24.4 GW by 2030	**Peak demand** 105 GW by 2030
Offshore Wind 5.5 GW by 2030	**Commodity** WEO 14 New Policies
Solar 16.4 GW by 2030	**Transmission** Line extension according to ENTSO-E

Modelling approach

In both CM and EOM, available capacity is optimized for plants to breakeven (while meeting the reliability standard in the CM)

Optimization of both market designs





- Available capacities are optimized within the dispatch model based on a perfect market functioning.
- The model "endogenises" economic decisions of market participants by ensuring plants do breakeven (based on their avoidable costs) either only with energy revenue in the EOM or with energy revenue plus capacity revenue as in the CM.

Modelling approach

In the EOM, uncertain energy revenues is translated into a higher risk premium and higher WACC

CCGT / OCGT revenue

- In reality, investors do not have perfect foresight on future energy revenues.
- To take risk aversion into account, the value assigned to a potential investment is therefore given by the expected revenue from which a risk premium is subtracted.

$$Inv\ value = Expected\ revenue\ - \alpha * Risk\ Premium$$

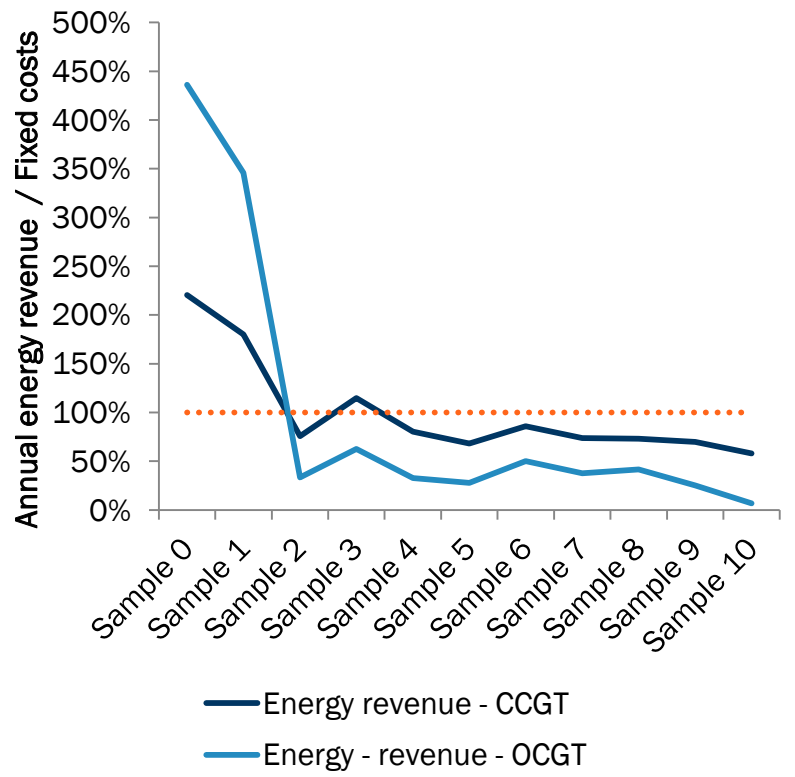
where α weights the relative importance given to risk

- The risk premium depends on the distribution of energy revenues.

$$Risk\ premium = \frac{semivariance\ (Revenue)}{2 * Expected\ revenue}$$

- In the EOM, we assume that plant operator will consider an additional risk premium compared to the CM scenario with a weight of $\alpha = 2.5$

Energy revenue distribution



- The inclusion of the risk premium in the EOM increases the WACC by 1 point for CCGTs (7% to 8%) and by 3 points for OCGTs (7% to 10%)
- In a sensitivity analysis, we gradually reduce the risk premium to zero to test the robustness of the results to different degrees of risk aversion

Modelling approach

The CM impact on power market has been assessed using a range of criteria and indicators

Key metrics assessment

- In order to assess the CM impact on power market, a range of criteria and indicators have been analysed:

Security of supply criteria:

- To assess the impact of the CM on security of supply, the Loss of Load Expectation (LOLE) has been computed in the CM and EOM designs. The reliability standard defined by the French public authorities is 3hrs of LOLE.

Energy cost criteria:

- To assess the impact of the CM on energy cost, the power price, the total customer cost and the social surplus have been computed in the CM and the EOM designs.

Available capacity criteria:

- To assess the impact of the CM on the available capacity, the installed capacity resulting from the different market designs and regulations have been compared.

CO2 emissions criteria:

- To assess the impact of the CM on CO2 emissions, the total CO2 emissions from the CWE countries have been computed in the different scenarios and sensitivities.

Cross-border flows criteria:

- To assess the impact of the CM on cross-border flows, the total imports/exports between the CWE countries have been computed in the different scenarios and sensitivities.

3 – Assessment of the impact of the capacity mechanism in France

Assessment of the CM in France

Summary of the key results

Key findings of the modelling of the French market with and without CM results :

- As early as 2017 and for all subsequent years, the reliability standard is not met in the EOM due to the closures of unprofitable plants. This results in increased costs for consumers (curtailment)
- The CM allows to meet the reliability standard in all years
- The cost of the CM appears to be lower than its benefits for consumers: the costs of lost load would exceed the capacity remuneration

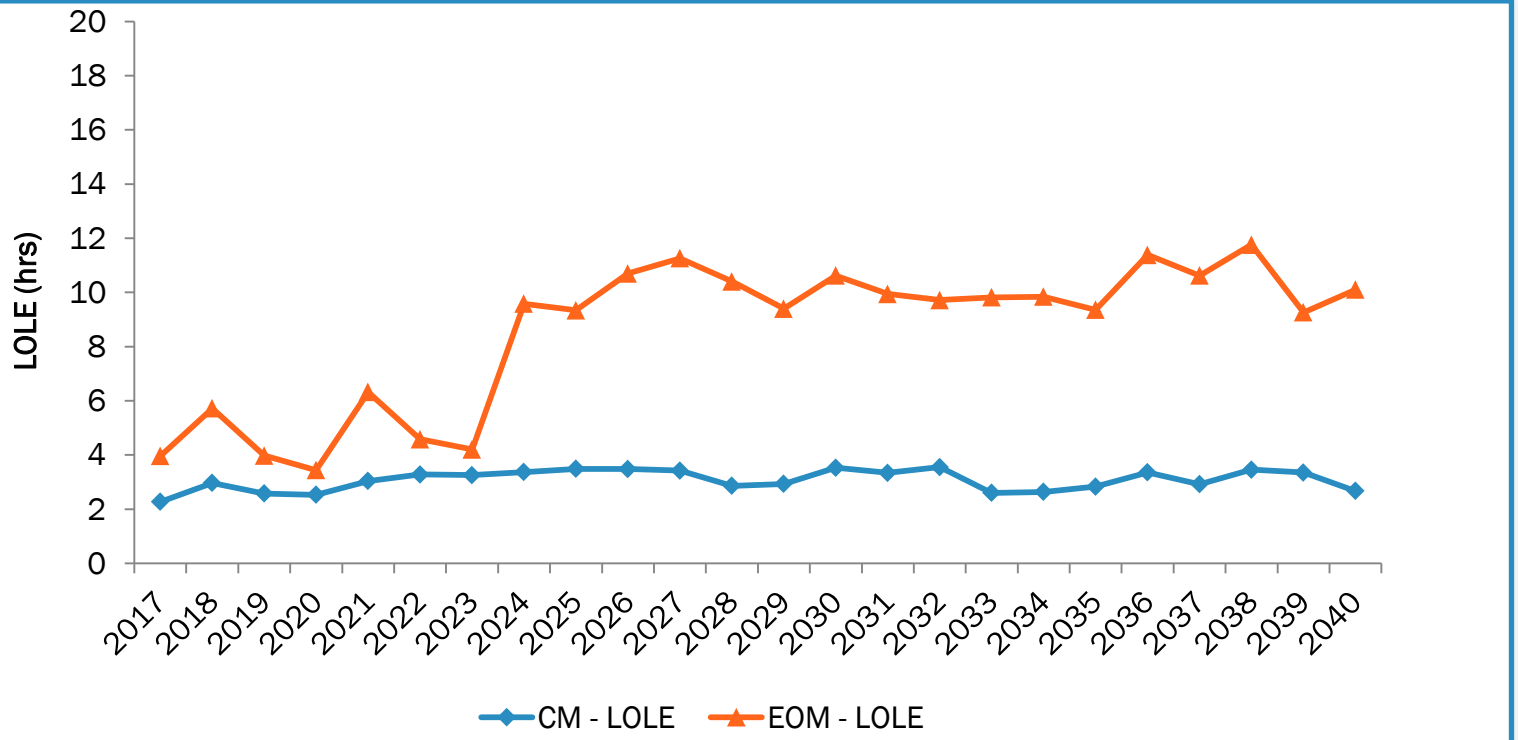
The modelling of the French market shows two main periods with a differentiated impact of the CM:

- 2017-2022
  - In the EOM scenario, significant closures or mothballs in thermal capacity. In the CM scenario, these closures still intervene, but the CM has a positive impact on available capacity (~+2GW), which is sufficient to meet the reliability criteria.
  - Our assumptions suggest that this extra capacity will be provided by DSR but depending on actual costs of the different technologies, the return of mothballed CCGTs might also be possible.
- 2022-2040.
  - The gradual reduction in the nuclear generation share requires new investments. In both scenarios, mothballed CCGTs come back in the market, but in the EOM new investment comes too late and is insufficient to meet the reliability standard.
  - The CM allows for DSR to be used at its maximum technical potential and for sufficient and timely new thermal investments. In contrast in the EOM, DSR is less developed and new investments comes too late and is insufficient to meet the reliability standard.

Assessment of the CM in France

Impact on security of supply

Comparison of LOLE between the CM scenario and the EOM scenario



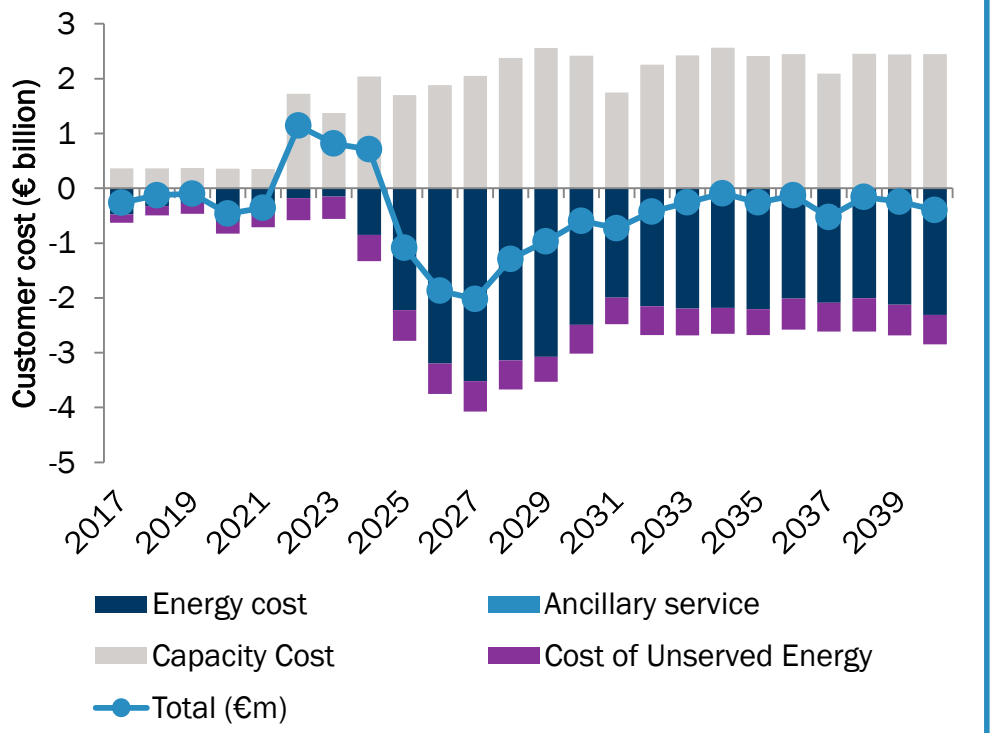
Contrary to the capacity mechanism, an energy-only market cannot achieve the security of supply standard set by the French public authorities.

- In the EOM scenario, the LOLE increases due to plant mothballs or shut down and underdeveloped DSR, exceeding the reliability standard of three hours per year.
- In the CM scenario, mothballed CCGTs are back in the market and timely and sufficient new DSR and thermal plant takes place, such that the security of supply standard is guaranteed.

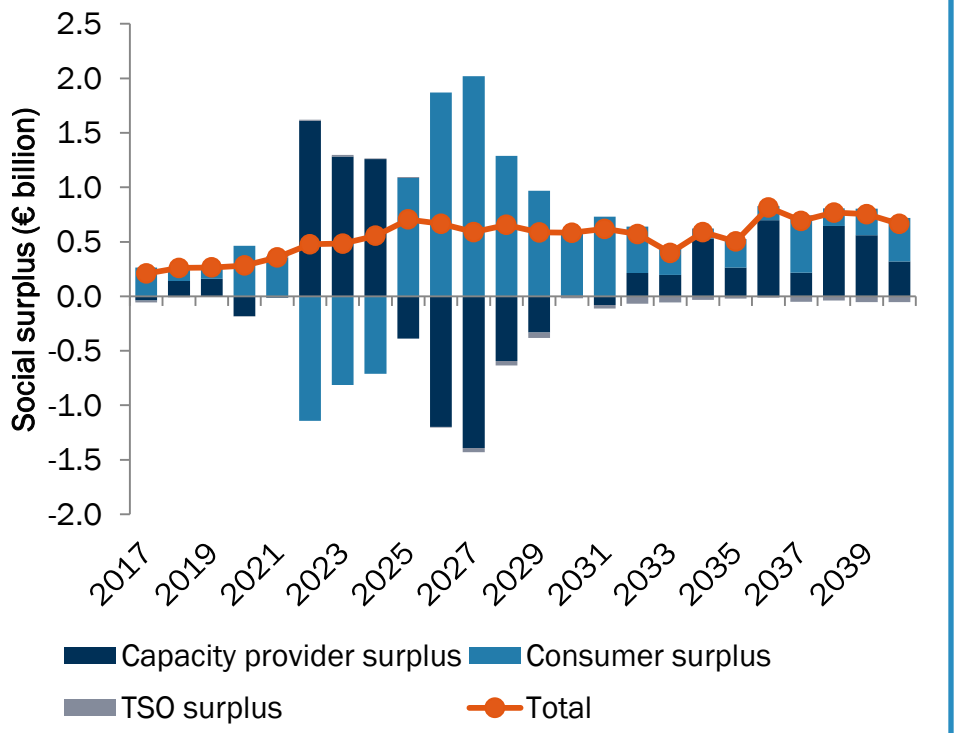
Assessment of the CM in France

Impact on consumer costs and social welfare

Impact of the CM on customer costs (CM-EOM)



Impact of the CM on social welfare (CM-EOM)



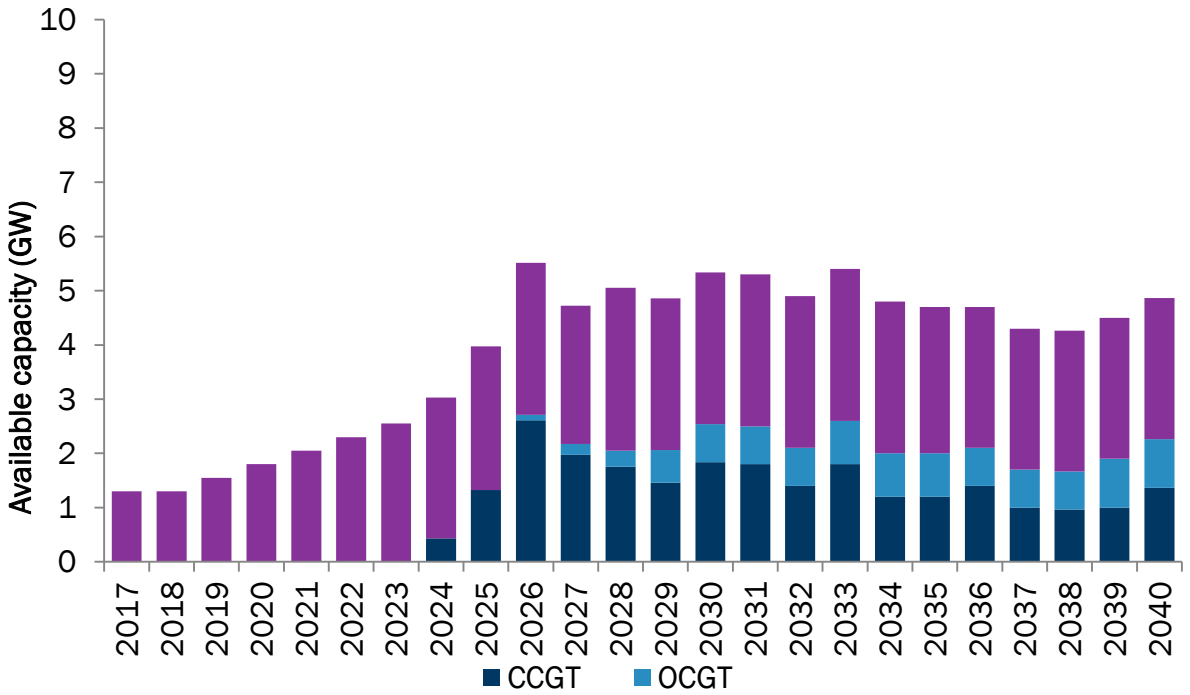
On average from 2017 to 2030, the CM reduces costs for French consumers by 400M€/year as the reductions in investment risk and energy and curtailment cost outweigh the additional capacity costs.

- In the long-term (after 2025), the CM significantly reduces costs for consumers through a decrease in energy prices and in the amount of curtailed energy, which largely compensates for the capacity cost.
- Overall, social welfare is increased by more than 500M€/year on average with the introduction of the CM.
- Capacity providers benefit of the CM to up to 100M€/year: when more expensive DSR capacity and mothballed CCGTs are necessary, capacity providers benefit from higher capacity prices, but this is partly compensated by lower energy revenues (fewer price spikes, as lower LOLE).

Assessment of the CM in France

Impact on available capacity

Change in the available capacity (Difference CM – EOM)



Key figures

- **Coal**: Same in CM and EOM scenarios: 2.9GW in the long term.
- **CCGT**: Same in CM and EOM until new build in 2024. 3 CCGT in mothball from 2017 to 2021. New build in 2017 and 2019 (Bouchain & Landivisiau).
- **Oil plants**: all are closed as of 2017 in EOM (no depollution investment without the perspective of CM).
- **DSR**: in the EOM scenario, the gradual loss of DSR through tariffs is not compensated by DSR valued directly in markets. In the CM scenario, 3GW of DSR in total is kept in 2017, and gradually increases from 2019.

In the short term, the CM does not impact bidding and dispatch strategies.

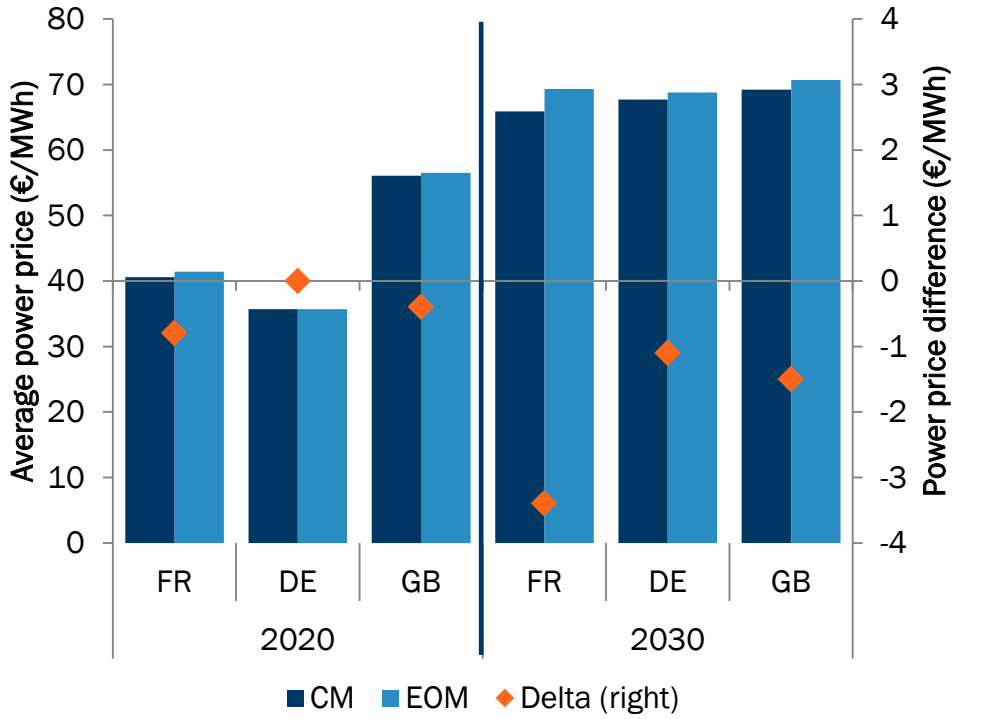
In the long term, it corrects the market failure where electricity prices are not reflecting the true cost of security of supply and helps to obtain more optimal available capacity given policy objectives

- The available capacity will be obtained based on the most competitive technologies.
- Based on our cost assumptions, DSR covers most of the incremental capacity need until 2023, and at least 50 percent beyond 2023 up to 2040.
- Capacity needs could be filled in by other technologies, such as mothballed CCGTs or closed peaking units depending on cost assumptions.

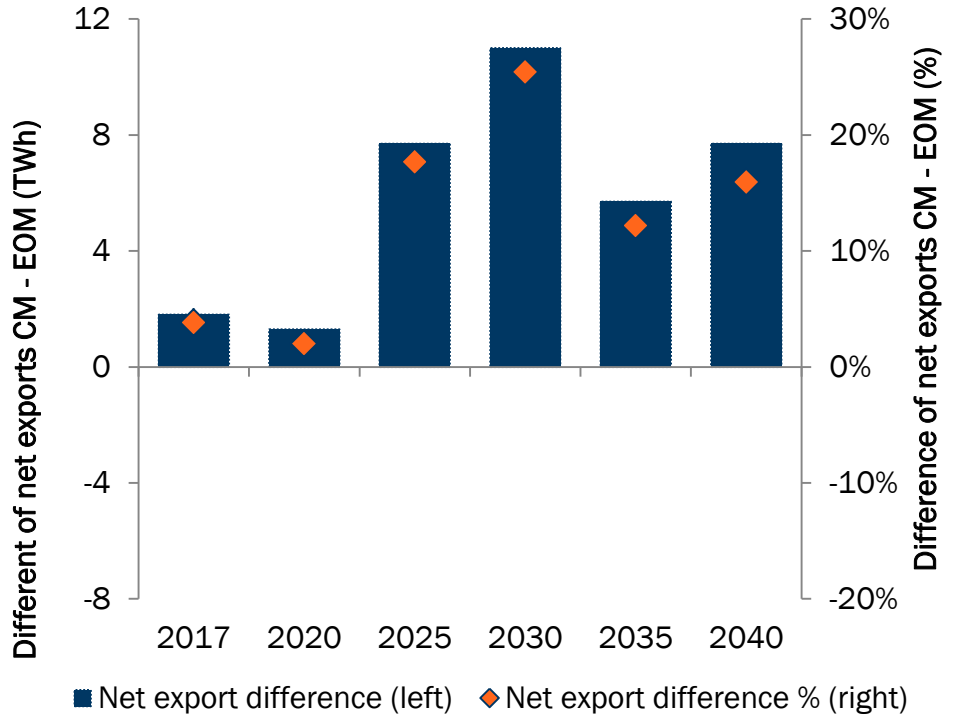
Assessment of the CM in France

Impact on power prices and cross-border flows

Impact of the CM on power prices



Impact of the CM on net export balance



The CM does not modify the behaviour and strategies of market players in the energy market and the short-term merit order

- In a longer horizon, the wholesale electricity price reduces because of additional capacity to ensure adequacy and, as a result, a lower occurrence of price spikes.
- As more efficient generation and DSR assets are built, the CM increases exports at mid-load periods and reduces imports at peak times.

4 – Comparison with other policy interventions

Comparison with other policy interventions

Rationale for comparison

As part of their national energy policy objectives and responsibilities, Member States put in place policies which can lead to changes in the volume of available capacity and the generation mix

- These policy interventions are legitimate in order to achieve the national policy objectives (either for security of supply or support to specific technologies)
- CMs are one of these many public policy interventions taken by the Member States in the energy sector

The EC wants to avoid that public policy interventions introduce distortions which could affect the Internal Electricity Market but there is often a lack of robust quantitative analysis

- The qualification of these policies' impact as a 'distortion' is questionable
- The quantification of these policies' impact on the energy market is usually not based on a robust modelling
- In the case of capacity mechanism, it has been frequently heard, without quantitative demonstration, that such mechanisms would have a major impact on prices in France and in neighbouring countries

The objective of this study is to contribute to the European policy debate and address this need for quantification of the impacts of public policies in electricity markets

- We compare the impact of the French CM on the electricity market with the impact of policy interventions aimed at guaranteeing security of supply and/or supporting specific technologies
- The objective is not to evaluate these policies, but to provide some elements of comparison with the effect of the French CM as regards their impact on energy prices

Comparison with other policy interventions

We assess the impact of four policy interventions

The German strategic and climate reserve

- The German Strategic Reserve is a capacity mechanism, which targets adequacy and security of supply.
- In addition, the Climate reserve requires up to 2.7 GW of lignite power to be placed in the strategic reserve; the rest of the strategic reserve (the “capacity reserve”) will be filled through an auction mechanism.
- In the counterfactual case, we assume that lignite plants are not retired before reaching the average age of 45 years.

Policy support to renewable generation in Germany

- The Renewable Energy Act (EEG) came in force in 2010 to support a stronger growth of renewable energy sources (RES).
- In the counterfactual case, a lower RES development scenario is considered based on the expected development of RES prior to the EEG.

Nuclear phase-out in Germany

- All 17 German nuclear power plants are to be shut down by 2022.
- In the counterfactual case, an energy mix without nuclear phase-out is modelled.

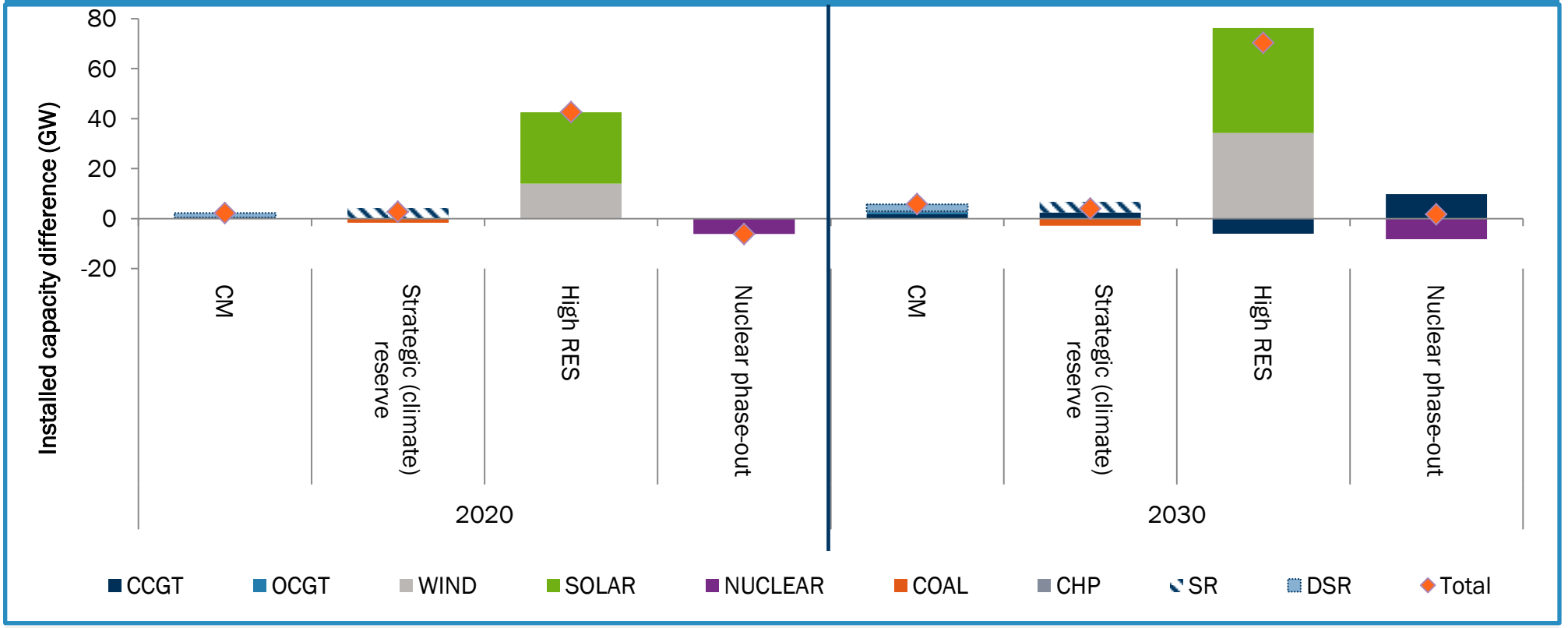
Carbon price floor in the UK

- The UK Carbon Price Support introduced in 2014 increased the carbon tax and capped it at 18£/tonne between 2016 and 2020.
- In the counterfactual case, the EU-ETS price is charged to power plant operators.

Comparison with other policy interventions

Impact on available capacity

Impact on available capacity of the CM and other policy interventions vs. counterfactual



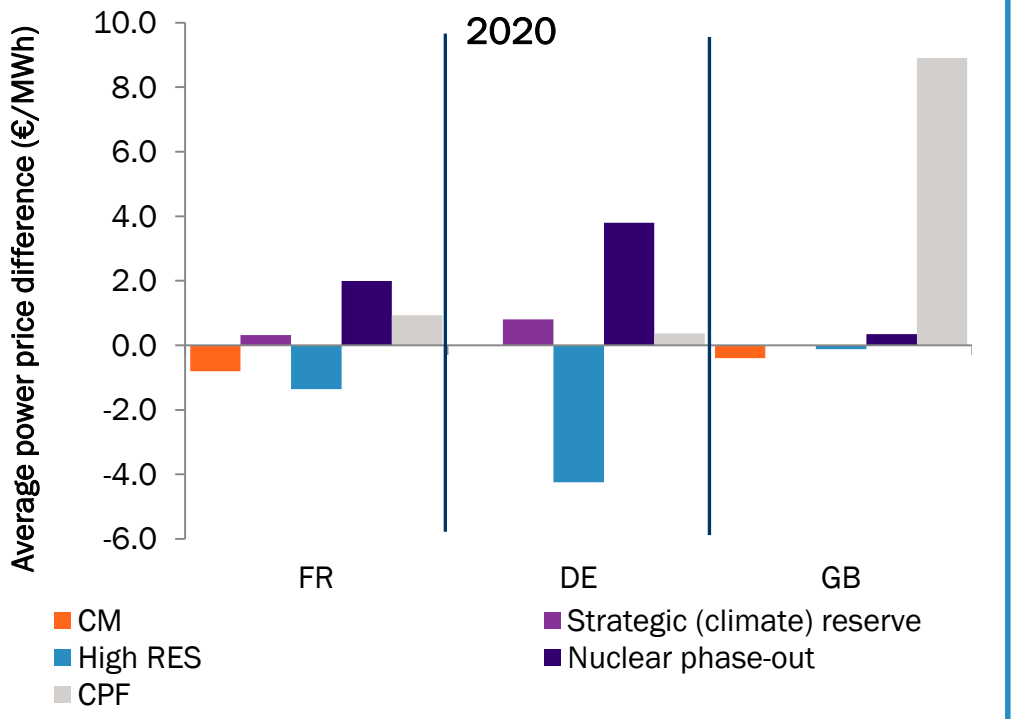
The impact of the different policy interventions is difficult to compare as they aim at different objectives.

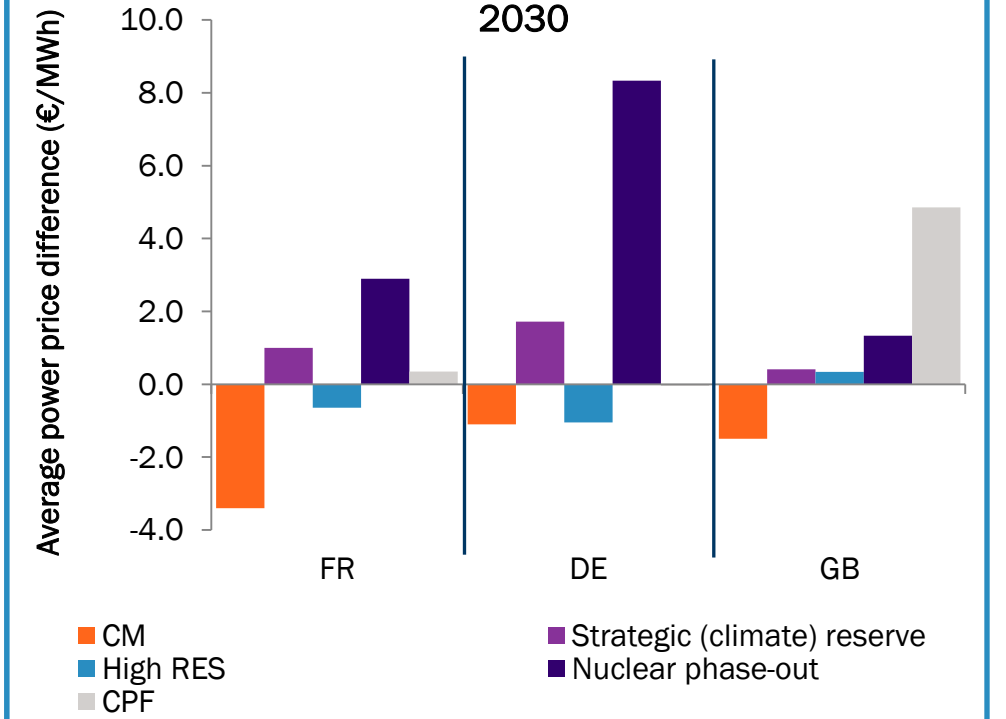
However, this shows that the modifications of the available capacity induced by some of the other policy interventions modelled such as the German nuclear phase out or renewables support are much more significant than the changes driven by the French CM.

Comparison with other policy interventions

Impact on power prices

Power price impact of the CM and other policy interventions vs. counterfactual





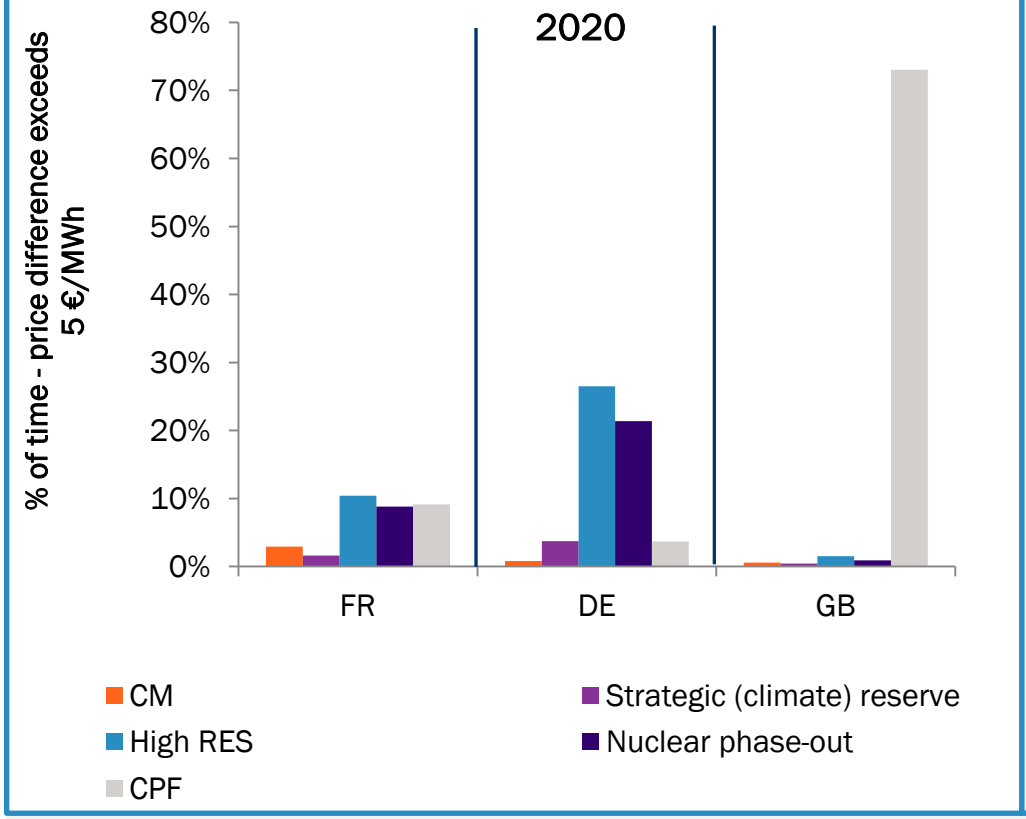
Public interventions may drive electricity prices upwards or downwards, but the impact of the CM in absolute terms on power prices is comparable to the other policies modelled:

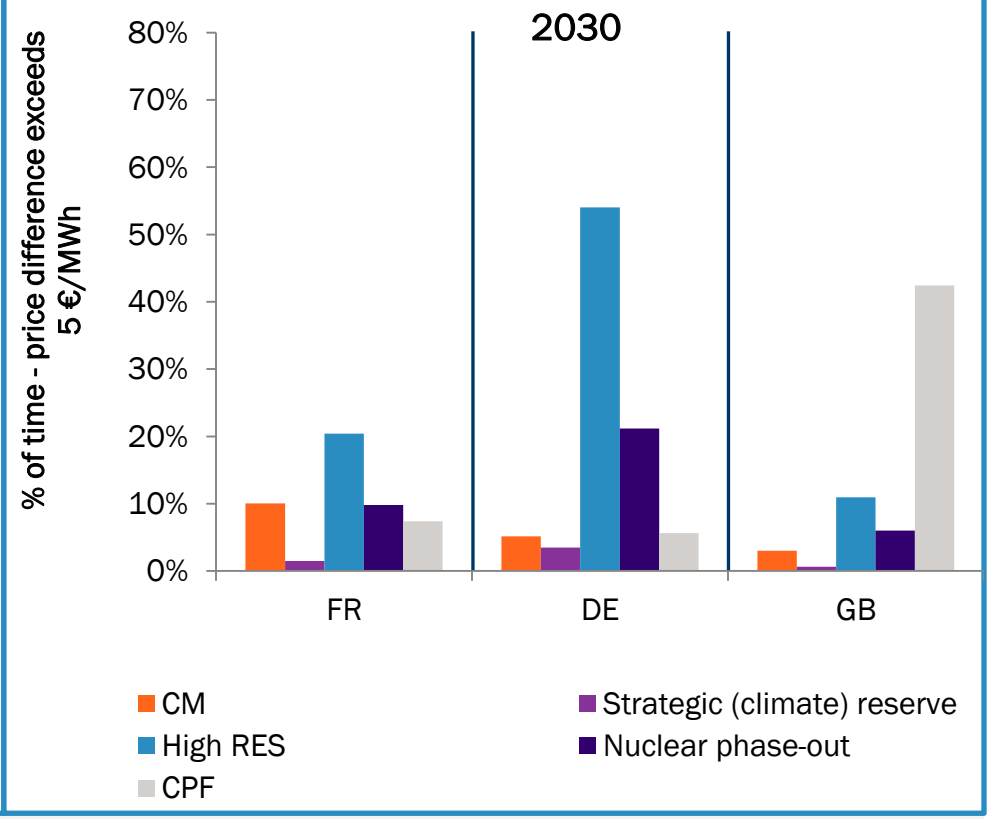
- The price effect of the strategic (climate) reserve is similar to the CM.
- The nuclear phase-out in Germany or the CPF in the UK have a much more significant impact on average prices than the French CM.

Comparison with other policy interventions

Impact on power prices

Percentage of time when the price difference exceeds 5€/MWh compared to the counterfactual





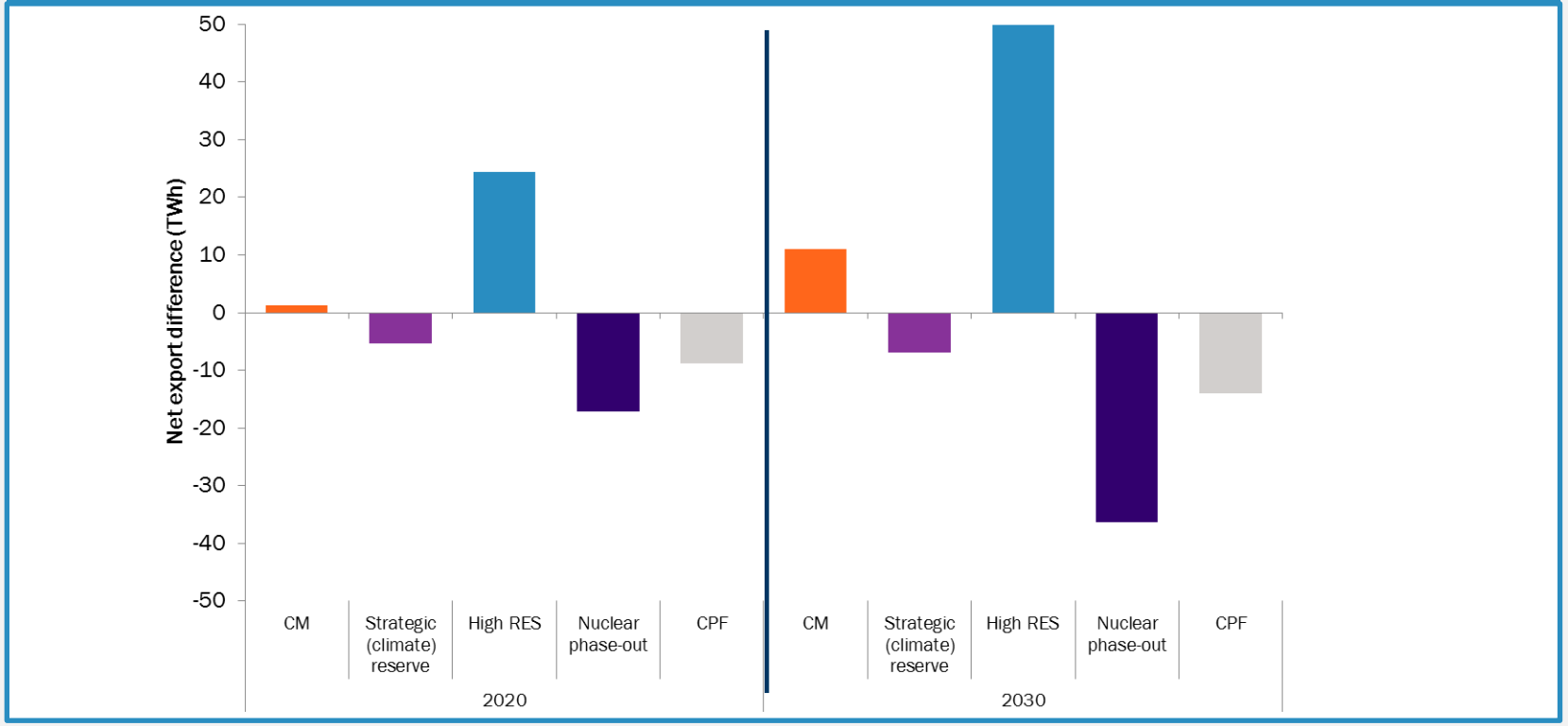
The extent of price difference between scenarios with and without the CM is relatively small.

- The proportion of hours with significant price differences is much higher in the cases of RES promotion, nuclear phase-out, and CPF policy.

Comparison with other policy interventions

Impact on cross-border flows

Impact on domestic cross-border flows of the different policy interventions



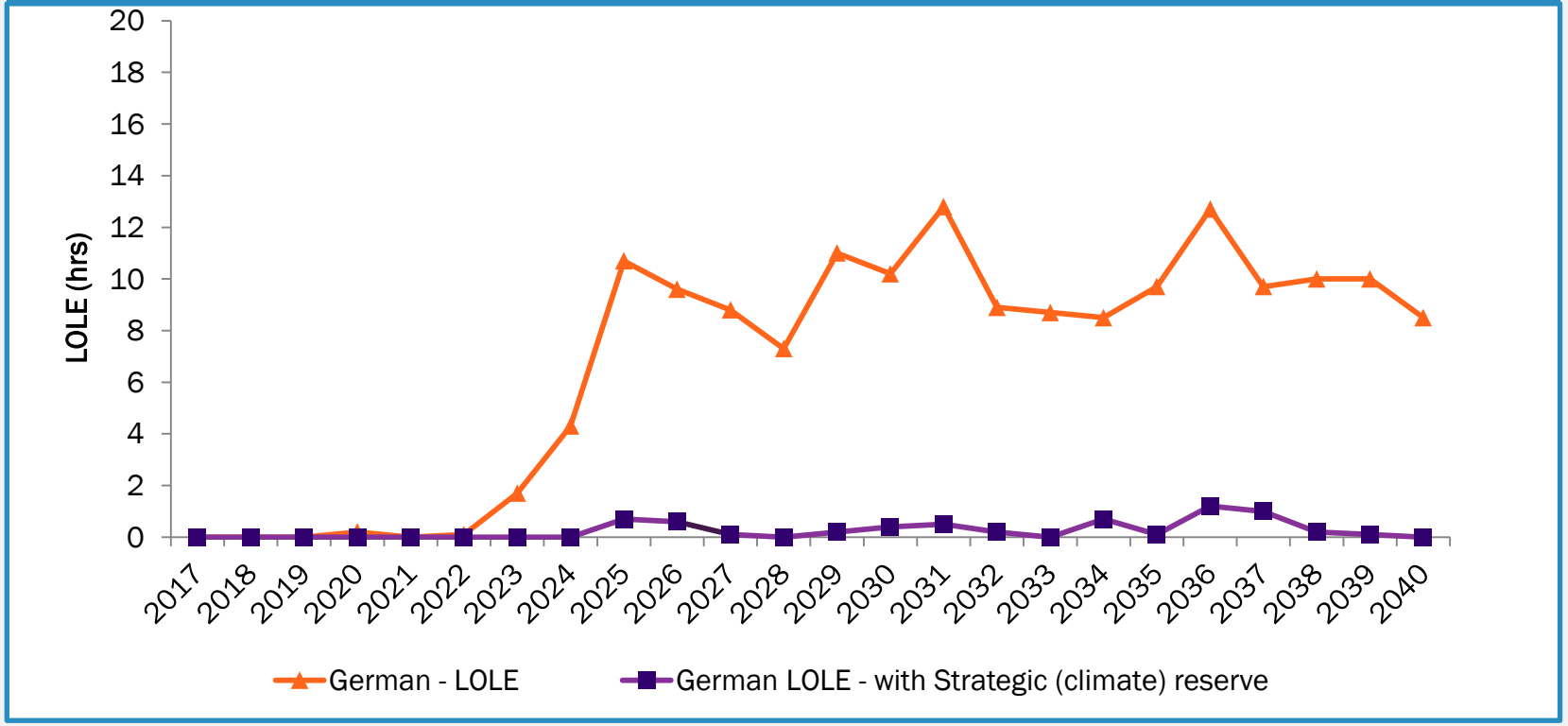
Because the available capacity is modified to maintain security of supply, the CM has an impact on cross-border flows, but it is more limited than the impact of some of the other policy interventions:

- Other mechanisms such as RES support schemes, nuclear phase-out or the CPF have a much greater impact on cross-border flows.
- Especially, the massive deployment of RES increases exports by 24 to 50 TWh per year.

Comparison with other policy interventions

Impact on security of supply

LOLE in Germany in the EOM scenario and with the German strategic reserve



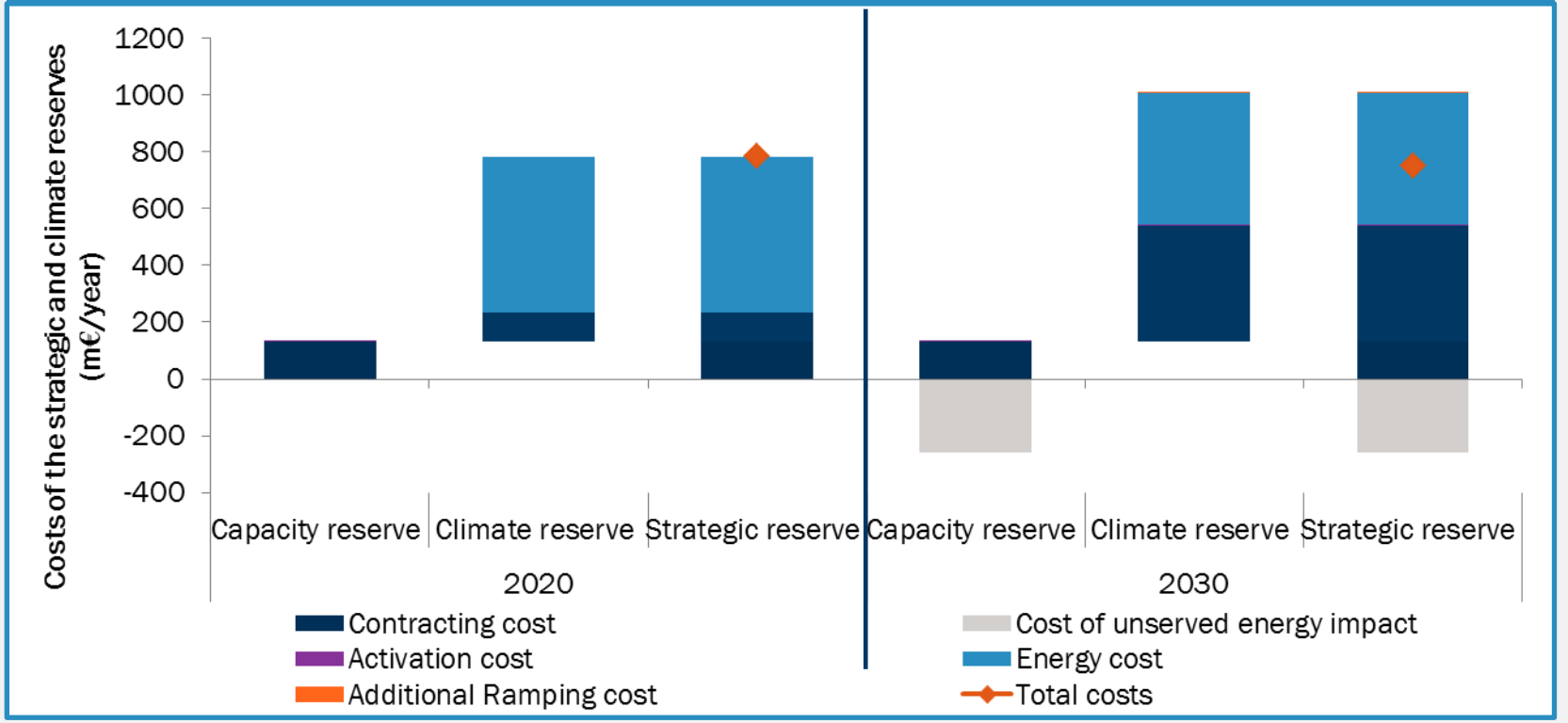
The German strategic reserve leads to a higher level of security of supply than usual reliability standards in Europe.

- The LOLE increases significantly in the EOM in Germany post 2023.
- The implementation of the strategic reserve covers for this risk as the LOLE falls down to zero to one hour per year.

Comparison with other policy interventions

Impact on economic efficiency

Breakdown of the impact of the German strategic reserve on customer costs



In our modelling and based on public information, the strategic (climate) reserve could induce between 400M€ and 750 M€ per year of additional costs for consumers

- Most of the net cost for consumers is due to the 'climate aspect' of the strategic reserve.
- A perfect strategic reserve would still have induced a net cost in the first years of implementation. But, over the period 2018 to 2030, it would have been a zero-sum gain for end consumers.

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5 – Conclusions

Conclusions

- **The French CM is designed to maintain security of supply at the reliability standard** determined by policy makers, which is comparable to the one defined in other countries.

- **The French CM achieves this goal in a cost efficient manner** as it increases social welfare and reduces end consumers' net costs. A strategic reserve approach does not appear to be a more economical alternative to secure supply. However, the 2 approaches are different and may be addressing different adequacy situations. The strategic reserve might be more adapted to address transitional market failures.

- **The French CM achieves the security of supply objective while limiting impact on the energy market**. The CM does not modify the behaviour and strategies of market players in the energy market and the short-term merit order, contrary to other mechanisms. It has an impact on prices and cross-border flows in the long term, but this impact is comparable to or lower than most of the other regulatory or policy interventions considered.

- **The French CM impact on the available capacity in the medium to long-term in pursuance of supply security is also comparable or lower than other policy interventions modelled in the study.** In addition, the French CM encourages a strong development of DSR alongside generation assets.

- The French CM does not increase CO_2 emissions at the European level nor affect cross border flows significantly more than the other policy interventions modelled.

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Critical Thinking at the Critical Time ™

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