Report

"Effects of the German capacity reserve on neighbouring member states"

in accordance with
Article 21 No. 2 EU-Regulation 2019/943

for the

Federal Ministry for Economic Affairs and Energy

Cologne, 31st of March 2021

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Executive Summary

The planned transformation of the electricity system from mostly centralised and dispatchable power plants to emission-free, decentralised and variable generation is taking place at a high speed. Although the European internal market guarantees a secure power supply in principle, extreme situations in which additional capacities are needed cannot be ruled out.

The German capacity reserve additionally safeguards the comprehensive transformation process of the electricity system and serves as an additional reserve in extreme situations when all available market mechanisms have been exhausted. In this way, the capacity reserve contributes to the high reliability of the German and European electricity supply. It is activated when demand on the electricity markets cannot be met by supply. The Capacity Reserve Ordinance basically regulates the use of the capacity reserve as well as its procurement in accordance with the applicable European requirements of the EU Regulation on the internal electricity market (EU Regulation 2019/943), the ACER decision on technical guidelines for cross-border participation in capacity mechanisms and the EU notification on the approval of the capacity reserve under state aid law. Further design details are regulated by the German transmission system operators (TSOs).

The capacity reserve is held outside the electricity markets and is designed in such a way that investment incentives and the competition in the electricity markets are not distorted to the greatest possible extent. For example, power plants are prohibited from returning to the electricity and balancing energy markets once they have been bound in the capacity reserve. For a facility to be allowed to participate in the capacity reserve, it must fulfil certain requirements concerning its location and technical characteristics. Among other things, a facility must be connected to the German electricity grid and meet certain flexibility requirements. The capacities are procured in a transparent, competitive, and non-discriminatory manner. The reserve capacity to be procured (currently 2 GW) is put out to tender every two years and the TSOs award the admissible bids according to the bid

value in ascending order. The capacity reserve facilities are activated by the TSOs, if the demand on the electricity market is expected to possibly not be fully covered by the supply. The reserves are only used if the secure and reliable operation of the German transmission system is at risk and all grid-related measures (e. g. operational switching) and all market-related measures (e. g. use of balancing energy) have been exhausted. The BRPs being short of supply and responsible for the use of the capacity reserve will participate in the costs of the capacity reserve by paying an increased imbalance settlement price (currently at least approx. 20 T€/MW).

The qualitative analysis shows that the impact of the capacity reserve on the supply potential of power plants on the **futures and spot markets in Germany and Europe** is low. However, the participation of controllable loads in the capacity reserve can withdraw supply potential from the spot markets, which can increase the occurrence of shortage situations and higher price peaks and thus also make the use of the capacity reserve more likely. On the **balancing energy markets,** we also do not expect any significant repercussions from the participation of power plants in the capacity reserve. However, there is the possibility that the capacity reserve will bind demand side management potential that has not yet been tapped for the balancing energy markets and in this way reduce the supply potential on the balancing energy markets. The impact on a secure supply of electricity is three-fold: Firstly, the existence of the capacity reserve represents an additional safeguard for the electricity supply by preserving capacities outside the markets. Secondly, the capacity reserve indirectly increases **resource adequacy** in the German and European electricity markets, as the credible threat of high imbalance settlement prices in the event of a usage of the capacity reserve creates incentives for individual capacity provision. Thirdly, the capacity reserve can mitigate the consequences of unforeseen and extreme situations against whose risks the players on the electricity market do not hedge. In principle, we see very little impact on the competitive electricity markets and the **investment incentives** there, as the capacity reserve is held outside the markets.

Climate protection in the electricity system is not deteriorated by the introduction of the capacity reserve, as the capacity reserve does not provide financial incentives for fossil fuel market power plants to be operated on the electricity market for longer than necessary. The Emission Performance Standard (EPS), which limits the permissible CO_2 emissions in the capacity reserve, ensures that the plants in the capacity reserve, which is expected to be used only rarely, do not cause any substantial CO_2 emissions.

Table of Contents

1 Introduction

Germany has set itself the goal of making its energy supply more environmentally friendly while ensuring the high reliability of the electricity supply and cost efficiency. A central component of the energy transition is the progressive expansion of renewable energies, in particular onshore and offshore wind energy as well as photovoltaics (PV), the phase-out of nuclear energy by 2022 and the phase-out of coal by 2038 at the latest. The latter induces a substantial decommissioning of coal-fired power plants already in the short period by 2023. In addition to the development of a lower-emission electricity system, increasing cross-border electricity trade is another essential component of the energy transition. The efficiency gains from the further integration of the internal European electricity market and the Europe-wide expansion of renewable energies are leading to a reduction in conventional overcapacities in Germany and Europe. At the same time, new power plants are currently under construction, especially in the field of natural gas-based combined heat and power generation, and new innovative business models are being established to make the electricity system more flexible.

The planned transformation of the electricity system from mostly centralised and dispatchable power plants to emission-free, decentralised and volatile generation is taking place at a comparatively high speed. Studies, commissioned by the Federal Ministry for Economic Affairs and Energy, show that the European internal market can in principle ensure a secure supply of electricity.[1] However, it cannot be ruled out – especially for the period of the ongoing intensive restructuring of electricity infrastructure – that additional capacities or flexibility options will be needed in unpredictable or extreme situations. The German capacity reserve serves as an additional reserve when all available market mechanisms have been exhausted and thus contributes to resource adequacy in the German and

1 Cf. r2b, Consentec, Fraunhofer ISI and TEP (2019).

European electricity system. It is activated when demand on the electricity markets cannot be met by supply. The capacity reserve is held outside the electricity markets and is designed in such a way that investment incentives and the competition in the electricity sector are not distorted as far as possible.

2 Description of the core elements of the capacity reserve and presentation of the relevant regulations

2.1 Description of the core elements of the capacity reserve

In order to provide a comprehensible overview of the functioning of the capacity reserve and its role in the electricity market, we first describe the core elements of the capacity reserve in this section step-by-step. This is followed by a tabular overview of the underlying legal and regulatory framework in Section 2.2.

The capacity reserve can be described by the following core elements or characteristics:

- Relationship to the electricity markets
- Participation requirements
- Procurement procedure
- Availability, test call of capacities and contractual penalties
- Activation
- Request
- Remuneration, reimbursement and settlement

Relationship with electricity markets

The capacity reserve is generally used **outside the markets** in order to minimise possible repercussions on the electricity markets. Thus, **power plants**[2] contracted in the capacity reserve may not sell any energy or capacity on the electricity and balancing energy markets. They only generate electricity on the instructions of

2 In principle, storage facilities are eligible for participation in the capacity reserve as well. In this case, the rules and guidelines for power plants would be applied. However, due to the design of the capacity reserve, we do not expect any storage facility to participate for economic reasons. Thus, storage facilities will not be specifically mentioned further in this report.

the TSOs if demand exceeds supply given technical bidding limits. Moreover, the TSOs may only request the capacity reserve once all grid-related measures (e. g. operational switching) and all market-related measures under the German Energy Industry Act have been exhausted. The latter include, among other things, the call of balancing energy, the disconnection of interruptible loads[3] or the binding of power plants via short-term OTC transactions. This is to ensure that all market options are used to react to any generation shortfall before the capacity reserve is used. The capacity reserve therefore does not intervene in the incentive structure of the electricity markets (futures, day-ahead and intraday). Rather, it serves as an additional safeguard outside the markets in order to prevent serious measures such as the involuntary shedding of loads (or rotating load shedding).

In order not to distort the competition in the long term, power plants are also **prohibited from returning to the electricity and balancing energy markets** once they have been committed to the capacity reserve. Otherwise, they would have a competitive advantage through the remuneration for keeping their capacity available in the capacity reserve. A detailed consideration of possible repercussions of the capacity reserve on the electricity and balancing energy markets is given in Section 3.

For **controllable loads,** partially different regulations apply. First of all, controllable loads must be active on the electricity market, as they have to cover their electricity demand on the futures markets in order to be able to make the capacity available, when the capacity reserve is requested by the TSOs. Strictly speaking controllable loads are not outside the market. Controllable loads are also not prohibited from returning to the electricity markets after having been contracted in the capacity reserve. Otherwise, the load (e. g. a factory or refinery) would have

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[3] Interruptible loads are electricity consumers (loads) that are contracted by the transmission system operator (TSO) and are controllable, i. e. can also be disconnected. If necessary, a TSO can instruct the interruptible loads to consume less electricity in order to remedy a generation deficit or a grid bottleneck.

to be shut down, which would be prohibitive for participation in the capacity reserve. Thus, supply potential is effectively withdrawn from the electricity market for the period a controllable load participates in the capacity reserve. As a result, the technical bidding limits on the electricity markets are, ceteris paribus (c. p.), reached faster or more often because the controllable load contracted in the capacity reserve is unable to switch off on a market-driven basis when it reaches its willingness to pay, as it must meet its obligations from the capacity reserve. For this reason, the controllable loads in the capacity reserve have a significantly greater influence on the electricity market than power plants (cf. also Section 3).

This applies analogously to the balancing energy market, which is also deprived of supply potential. Therefore, it is regulated that controllable loads may return to the balancing energy markets after a single participation in the capacity reserve for two years. In the case of a longer participation, a temporary ban on returning to the market of one year applies. This aspect is also examined in more detail in Section 3 regarding potential effects on the electricity and balancing energy markets.

Participation requirements

Capacities must fulfil certain technical **participation requirements** in order to be eligible for the capacity reserve. These are regulated in the Capacity Reserve Ordinance and are specified by the TSOs in two sets of rules. Furthermore, there are specific requirements for power plants and controllable loads. The operators of the participating facilities must declare with their bid that they fulfil the required prerequisites. The requirements are:

- A connection to an electricity grid in the federal territory that is connected to the extra-high voltage level via no more than two substations,[4]
- a start-up time of maximum 12 hours (for generation units from cold state),
- the ability to adjust the active power feed-in or consumption by at least 30 per cent of the reserve power each within 15 minutes (for generation units from operation in minimum partial load),
- the fulfilment of the "Minimum requirements for the information technology of the reserve provider for the provision of balancing energy", defined and published by the TSOs,
- for power plants, a minimum partial load of a maximum of 50 per cent of the bid quantity and
- for controllable loads, a constant and uninterrupted power consumption at least equal to the bid quantity.
- For controllable loads, participation is also restricted to those installations that have not received any remuneration on the balancing energy market or for their flexibility by a contract for interruptible loads by the TSOs in the preceding 3 years.

In addition, further provisions on load characteristics apply to controllable loads, which must be proven to the TSOs on a minute-by-minute basis. For example, a controllable load must consume power of at least the reserve capacity without interruption in at least three quarters of all schedule intervals of a year. The

4 Foreign capacities with direct connection to the German extra-high voltage grid via no more than two substations are basically allowed to participate in the capacity reserve (e. g. pump storages Kopswerke in Austria or Vianden in Luxembourg). In the context of the approval under state aid law, it was stated that there is no obligation to allow foreign capacities to participate in the capacity reserve. The reason for this is that in the planned case of use, the necessary import capacities would be fully utilised due to the priority of market solutions, and thus a foreign plant would not be able to provide an equivalent technical output. It is acknowledged that foreign power plants may indeed be able to provide for an equivalent technical output in times of simultaneous scarcity. However, such situations are so far not expected to occur until 2025 – the end of the notification period – according to the latest national resource adequacy assessments.

constancy and uninterrupted nature of power consumption by the load are determined on the basis of its mean minute values.

Furthermore, the power plants in the capacity reserve are bound to the emission performance standard (EPS) laid down in the EU Regulation 2019/943 on the internal electricity market (EU Regulation 2019/943). The following requirements apply with regard to the emission performance standard:

- Power plants commissioned on or after 4 July 2019 may emit a maximum of 550 g of CO_2 from fossil fuels per kWh of electricity.
- From 1 July 2025, installations commissioned before 4 July 2019 may emit a maximum of 550 g CO2 from fossil fuels per kWh of electricity or a maximum of 350 kg CO_2 p.a. from fossil fuels on an annual average per installed kilowatt of electrical capacity.

Procurement procedure

The **procurement procedure** is intended to ensure a transparent, competitive, and non-discriminatory determination of the resources for the capacity reserve. The reserve capacity to be procured (currently 2 GW[5]) is put out to tender every two years. For this purpose, the TSOs publish the relevant information on the offer at least three months in advance. This includes the date of the auction, the total contract capacity, the technical and formal requirements for participation, the delivery deadlines and the upper limit for the bid values. The auction generally takes place at least 18 months before the start of the delivery period. Interested market players must submit their offer (offered reserve capacity and bid value per megawatt) in accordance with the formal requirements of the TSOs and declare that they fulfil the requirements for participation in the capacity reserve (cf. above

5 The size of the capacity reserve will be regularly evaluated based on updated calculations. However, the volume can't be increased beyond 2 GW until 2025 as this volume is fixed as upper limit in the current state aid approval.

explanations on participation requirements). The TSOs award the admissible bids according to the bid value in ascending order until the tendered volume is reached. The contracted capacities are bound in the capacity reserve for two years from the start of the provision period and may participate again in tenders for subsequent provision periods. The approval of the capacity reserve under state aid law in its current form is limited until 1 October 2025. Until then, it is planned to carry out two further procurement rounds in 2021 and 2023.

Availability, test call of capacities and penalties

Before the start of the provision period, the connecting TSO shall carry out a **functional test** for each capacity reserve facility (power plant or controllable load). The function test serves to check whether the capacity actually fulfils the participation requirements. For this purpose, the TSO to whose network the facility is connected (connecting TSO) activates the reserve facility on a date agreed with the capacity's operator and uses the fully committed reserve capacity for a period of up to twelve hours.

As a rule, the capacity reserve facility must be available for the entire provision period and with full reserve capacity for activations and requests by the TSOs. However, planned and unplanned unavailabilities are permitted as long as they have been notified to the connecting TSO in good time and their total duration does not exceed three months in a contract year. "Planned unavailabilities" may arise due to technically necessary maintenance measures. They shall be deemed "planned" if they are notified to the connecting TSO before 31st of July of the previous year. Unplanned unavailabilities are unavailabilities whose necessity was not yet apparent before expiry of the deadline. The capacity operator must report unplanned unavailabilities to the responsible TSO without delay.

In order to check the functionality of the capacity reserve resources within the performance period, the connecting TSO must carry out a **test call** of the capacities at least once and at most twice per contract year. For this purpose, the TSO activates the facility and requests it for a period of up to twelve hours. If a reserve capacity is regularly called and provides its full reserve capacity, the number of necessary and maximum permissible test calls is reduced by one test call each. During the function tests and test calls, market power plants are accordingly down-regulated by the TSO (redispatch) in the amount of the capacity requested from the reserve, so that market distortions caused by the additional electricity fed in during function tests and test calls are excluded.

If **capacity reserve facilities do not fulfil their contractually agreed obligations or do so only inadequately, the Capacity Reserve Ordinance provides for various contractual penalties.** For example, if a facility does not complete a successful function test by the start of the provision period, the capacity's operator is obliged to make a payment amounting to 20 percent of the remuneration agreed for the entire provision period. In the event of breaches of duty due to services not being provided (in full) or not being provided on time, a contractual penalty of 15 per cent of the remuneration agreed in the contractual year is provided for. The capacity's operator pays the contractual penalties to the corresponding connecting TSO.

Activation

The TSOs are obliged to activate the capacity reserve in good time to ensure that the facilities are able to feed in their full reserve capacity at the possible time of use. Activation in the sense of the capacity reserve means that power plants are started and run at minimum partial load and controllable loads are prepared for a possible request. **Activation takes place in market situations that indicate a need for additional capacity.** These market situations are defined by law. Thus, the TSOs must activate the facilities in the capacity reserve when:

- market clearing fails to occur in the last auction of day-ahead trading on the power exchange (day ahead market), [6]
- market clearing fails to occur in the opening auction of intraday trading on the power exchange (intraday opening auction), or
- in intraday continuous trading on the power exchange (intraday market), open bids at the level of the technical bidding limit are set for a schedule period (quarter hour), which are not completely fulfilled within one hour.

The TSOs must consider the start-up time of the power plants in the capacity reserve when activating them. The electricity produced by the power plants in minimum partial load initially creates an oversupply as a result of activation. The TSOs must compensate for this oversupply by adjusting the feed-in of operating power plants through the application of redispatch. These power plants are selected according to technical suitability and economic criteria and their operators are compensated accordingly for the adjustment of their feed-in.

Request

In the event that the secure and reliable operation of the German transmission system is at risk[7] and all grid-related measures[8] and all market-related measures (e. g. use of balancing energy) have been exhausted, the TSOs may request the capacity reserve. This "subordination" of the capacity reserve also means that a

[6] Market clearing on the power exchange fails when demand exceeds supply at the given technical bidding limits.

[7] In principle, there are two kinds of situations where the system is at risk, and thus the capacity reserve is activated and requested: First, situations, where the markets do not clear. Second, situations without fundamental market scarcity, but with other, grid-related issues. Also, in the latter case the TSOs have the option to activate and request the capacity reserve if no other options exist anymore to avoid a loss of load.

[8] Such grid related measures could for example be busbar shifting's in grid nodes or the use of phase shifters to enable resources to feed-in their maximum available capacity. The Capacity Reserve Ordinance states that, such grid-related measures are to be used before any market related measures and both of these measures are to be used before the capacity reserve is requested.

large part of the balancing energy[9] is used before the capacity reserve. This ensures that the price signals in the balancing energy market (balancing energy prices) are also influenced as little as possible. A capacity reserve request can last up to twelve hours. At least six hours must elapse between two requests, but the capacity operator can waive this period. Those power plants which were redispatched during the activation period of the capacity reserve are ramped up again when the capacity reserve is used. This means that the physical provision of the capacity reserve is carried out partly by capacity reserve facilities and partly by market power plants. Both of which have been operated at partial load since the activation of the capacity reserve (cf. also the explanations in section "Activation").

Remuneration, reimbursement and settlement

The annual remuneration for the operators of the resources in the capacity reserve results from the individual bid size multiplied by the value of the highest winning bid in the procurement period (pay-as-cleared). This remuneration covers the expenses for the function test, the permissible test calls and up to 16 uses (activations and / or requests) of the capacity reserve. The operator of a capacity reserve facility can also claim further costs from the TSOs, such as costs:

- for requests in the capacity reserve that exceed the compensated number of requests (e. g. for fuels, CO_2 certificates and other operating materials or, in the case of controllable loads, for opportunity costs),
- incurred for establishing or maintaining the black start capability of an installation at the request of the TSOs,
- incurred for establishing or maintaining the capability to feed in reactive power without feeding in active power at the request of the TSOs, and

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9 According to the justification of the Capacity Reserve Ordinance, a large part of the balancing energy is regularly assumed to be used if 100 % of the positive manual Frequency Restoration Reserve available to the TSOs and 60 % of the positive automatic Frequency Restoration Reserve are requested.

- for the balancing energy that is necessary during feed-in or reduction of consumption at the request of the TSOs as part of the management of the balancing group.

In general, the costs of provision of the capacity reserve are financed via network tariffs by all electricity consumers. Analogous to the energy balancing market the balancing responsible parties (BRPs) do not finance the provision of capacities. This is justified as long as BRPs can balance their balance groups and the capacity reserve is never requested.

However, in the event of a usage of the capacity reserve, the BRPs causing the imbalance in the system will share the costs. BRPs with a short balancing position must pay an increased imbalance settlement price for the quarter hours with a request of the capacity reserve, which is at least twice as high as the technical bidding limit on the Intraday Market (currently at least approx. 20 T€/MW). The revenues arising from these payments will be deducted from the overall costs, and thus lead to a lower financing need via network tariffs. Given the high imbalance settlement price, it can be assumed that not only the costs for requesting the capacity reserve will be fully covered, but also at least parts of the costs for activation and provision of the reserve.

2.2 Legal and regulatory framework

The table below shows and briefly explains the legal basis for each core element of the capacity reserve. The relevant regulations on the capacity reserve are:

- the Regulation on the internal market in electricity (EU Regulation 2019/943),

- the ACER decision on technical guidelines for cross-border participation in capacity mechanisms,[10]
- the EU notification for approval of the capacity reserve under state aid law, [11]
- the Capacity Reserve Ordinance,
- the standard terms and conditions of the TSOs and [12]
- the participation requirements for the capacity reserve.[13]

Core element capacity reserve	Relevant regulations	Explanations
Relationship to the electricity markets	• Art 22 para 2 d) and e) EU Regulation 2019/943 • EU notification • Section 3 para. 2, 4 Capacity Reserve Ordinance	Art 22 para 2 d) and e) EU Regulation 2019/943 regulates the relationship of strategic reserves to electricity markets. Section 3 para 2 Capacity Reserve Ordinance implements the EU requirements and regulates the prohibition of return. Para. 4 contains the exception to the prohibition of return for controllable loads.
Participation requirements	• Art 22 para 4 and 26 para 1 EU Regulation 2019/943 • Section 9 Capacity Reserve Ordinance • Participation requirements of the TSOs • Art 3 para 1 ACER Decision 36-2020	Art 22 para 4 of EU Regulation 2019/943 regulates the emission performance standards that installations in the capacity reserve must comply with. Section 9 Capacity Reserve Ordinance regulates basic participation requirements for capacities and loads. It also allows the TSOs to define additional participation requirements for each procurement period. Art 26 para 1 EU Regulation 2019/943 generally requires the participation of foreign capacities in capacity mechanisms and also in strategic -

10 Cf. ACER (2020).

11 Cf. EU Commission (2018).

12 Cf. TSOs (2019a).

13 Cf. TSOs (2019b).

	• (RN 125) EU Commission Decision on State Aid Scheme SA.45852	reserves, as far as technically possible. Art 3 para 1 of ACER Decision 36-2020 specifies that foreign capacities must provide a technically equivalent service. In the context of the approval under state aid law, it was stated that there is no obligation to allow foreign facilities to participate in the capacity reserve. The reason for this is that in the planned case of use, the necessary import capacities would be fully utilised due to the priority of market solutions, and thus a foreign facility would not be able to provide an equivalent technical output.
Procurement procedure	• Art 22 para 1 EU Regulation 2019/943 • Sections 11 to 18 Capacity Reserve Ordinance	Art 22 para 1 EU Regulation 2019/943 defines design principles for capacity mechanisms. Taking these EU requirements into account, the regulations on the entire procurement procedure are laid down in sections 11 to 18 Capacity Reserve Ordinance. This concerns, among other things, the announcement of the procurement, bidding modalities, deadlines to be met and the awarding of the contract.
Availability, test calls of capacities and penalties	• Sections 27 to 30 and 34 to 36 Capacity Reserve Ordinance • Chapters 4, 5.7, 5.8 and 10 of the TSOs' standard terms and conditions.	Art 22 para 2 a) EU Regulation 2019/943 specifies when strategic reserves can be used. Para 2 c) regulates principles for accounting. The articles of the Capacity Reserve Ordinance form the legal basis for these core elements in compliance with these design principles. More detailed specific regulations, especially with regard to technical aspects, are regulated in the standard terms and conditions of the TSOs. *On availability, test calls and penalties*: Section 27 Capacity Reserve Ordinance regulates the availability requirements, Section 28 Capacity Reserve Ordinance the functional tests before the procurement period, Section 29 Capacity Reserve Ordinance Test calls and test drives during the procurement period
Activation	• Art 22 para 2 a) and c) EU Regulation 2019/943 • Section 25 Capacity Reserve Ordinance • Chapter 5.4 of the TSOs' standard terms and conditions	
Request	• Art 22 para 2 a) EU Regulation 2019/943 • Section 26 Capacity Reserve Ordinance	

	• Chapter 5.4 of the TSOs' standard terms and conditions	and Section 30 Capacity Reserve Ordinance the obligations to rectify. Sections 34 to 36 Capacity Reserve Ordinance also regulate the contractual penalties to be paid in the event of non-availability or other breaches of duty.
Remuneration, reimbursement and settlement	• Art 22 para 2 c) EU Regulation 2019/943 • Section 19 Capacity Reserve Ordinance • Chapters 6 and 7 of the TSOs' standard terms and conditions.	*On remuneration, reimbursement and settlement*: Section 19 Capacity Reserve Ordinance regulates the modalities for remuneration and reimbursement of costs. Sections 31 to 33 Capacity Reserve Ordinance regulate the settlement modalities between TSO and capacity reserve operator as well as TSO and BRP.

3 Qualitative analysis of the impacts on the core elements of the electricity system

In the following section, the effects of the capacity reserve are analysed qualitatively. For better clarity, the analysis is carried out step by step along the following core elements of the electricity system:

1) Futures markets for electricity,
2) Spot markets for electricity,
3) Balancing energy markets,
4) Balancing responsibility and imbalance settlement,
5) Resource adequacy,
6) Investment incentives on the European electricity markets,
7) Climate protection in the electricity system.

For each element, we first examine the effects of the capacity reserve in the German electricity system. We then assess whether and to what extent the identified effects are transferred to neighbouring European systems.

1) Futures markets for electricity

The participation of a facility in the capacity reserve is equivalent to its withdrawal from the electricity markets. This withdrawal is permanent for (conventional) power plants, while controllable loads are allowed to return to the electricity markets after being used in the capacity reserve. For a closer look at the effects, we accordingly differentiate between power plants and controllable loads due to the different framework conditions.

Power plants are permanently excluded from the **futures markets** by the prohibition of return anchored in the Capacity Reserve Ordinance, which may reduce the supply potential there. Assuming power plants bound in a capacity reserve were still viable, the introduction of this capacity reserve would reduce the actual supply on the futures markets. This can lead, ceteris paribus (c. p.), to higher futures market prices. However, it is questionable whether the power plants in the German capacity reserve would actually be competitive on the futures markets. Rather, due to the strict prohibition of return, it can be assumed that participation in the capacity reserve is only opportune for those power plants that cannot be marketed economically on the futures markets. These are power plants that would either be permanently shut down or marketed at short notice on the spot markets and in the balancing energy market. Without the capacity reserve, these power plants would probably be removed from the futures markets anyway.

The exclusion from the **futures markets** does not apply to **controllable loads.** Participants in the capacity reserve must demonstrate long-term coverage of their electricity demand in order to fulfil the participation requirements. Rather, participation in the futures markets is mandatory for this. This can tend to increase the activity of controllable loads on the futures markets in order to fulfil the participation requirements of the capacity reserve. However, we estimate the effect to be very low, as it can be assumed that loads procure a large part of their electricity demand on the futures market anyway in order to hedge against price risks.

For these reasons, we do not expect the capacity reserve to have a significant effect on the futures markets in Germany and Europe. At most, it is conceivable that power plants will leave the futures markets somewhat earlier due to the opportunity in the capacity reserve.

2) Spot markets for electricity

The same regulations regarding participation and return in the event of obligations in the capacity reserve apply to both the spot markets and the futures markets. As in the previous section, the effects on the spot markets are differentiated between power plants and controllable loads.

Power plants that are active on the **spot markets** sell their produced electricity there in the short term. If a power plant participates in the capacity reserve, it must withdraw from it, so that the **supply potential** tends to decrease. However, the actual impact on the market result is determined by the economic characteristics of the power plants in the capacity reserve. Thus, it is to be expected that operators which are considering to participate in the capacity reserve would have relatively high marginal costs and would accordingly be placed rather at the end of the merit order on the spot market. For this reason, they would not meet a corresponding demand in most hours of a year and would therefore have no effect on the electricity price. However, should a situation arise in which the electricity price level is above the marginal costs of these power plants, their absence on the spot market would have a price-driving effect, as more expensive plants would set the price instead. Under such circumstances, the capacity reserve could therefore make the occurrence of higher price peaks more likely. In addition, situations in which demand exceeds supply on the spot market could occur more quickly and more frequently if the capacity reserve actually withdrew supply from the spot market. However, this is contrasted by the assumption that power plants participating in the capacity reserve would have shut down near term anyway because of economic reasons. Therefore, we estimate that the **impact of the capacity reserve on the supply potential of generation plants on the spot markets in Germany and Europe is low**. At most, it is conceivable that operators of power plants will withdraw from the spot markets somewhat earlier than planned in order to be able to participate in the capacity reserve.

Controllable loads have contracted their electricity supply in the past on the futures markets and can now offer its flexibility as supply on the **spot markets**. Like power plants, controllable loads in the capacity reserve are not allowed to participate in the spot markets. Their flexibility is therefore not available anymore in the spot market. In contrast to power plants, it can be assumed that the primary interest of the operators of controllable loads is the continuation of their business activity. Selling flexibility on the electricity market is only an additional income.

Therefore, it cannot be expected that controllable loads would be shut down without involvement in the capacity reserve but would continue to be market participants.[14] If controllable loads are committed to the capacity reserve, they cannot react to the situation on the electricity markets. **The participation of controllable loads in the capacity reserve therefore withdraws supply potential from the spot markets, which can increase the occurrence of shortage situations and higher price peaks and thus also makes the use of the capacity reserve more likely.** In a situation where electricity demand exceeds supply, controllable loads in the capacity reserve cannot be activated via market signals to balance the excess demand. The balancing of supply and demand then only occurs with the activation of the capacity reserve. This means that under certain circumstances a capacity reserve contracting controllable loads outside the market is contributing to a failing market clearing and thus to its own requests. Due to the progressive integration of the European electricity markets, it is expected that the described effects may also partially affect the electricity markets in neighbouring countries.

3) Balancing energy markets

Power plants as well as controllable loads can sell positive and negative balancing energy of different qualities to the TSOs. Power plants can either offer balancing energy from ongoing operation by increasing or decreasing their generation output or provide positive balancing energy by starting-up on request (cold start). Controllable loads can provide positive or negative balancing energy by increasing or decreasing their electricity consumption accordingly. The power plants participating in the capacity reserve are prohibited from participating in balancing energy markets. In addition, those plants are prohibited from returning to the

[14] This is the reason for the exception of the return ban for controllable loads.

balancing markets, while controllable loads are generally allowed to return to the balancing markets after the end of the provision period.

First of all, the legally prescribed subordinate request of the capacity reserve (cf. core element "request" in Section 2.1) is a central aspect. According to this, the TSOs must first use a large part of the balancing capacity before the capacity reserve is used. This ensures that the price signals in the balancing energy markets are also influenced as little as possible. In particular, high price peaks in the balancing energy market are not suppressed by an (earlier) use of the capacity reserve.

Analogous to the spot and futures markets, however, the capacity reserve can also reduce the supply potential on the balancing energy markets and thus, ceteris paribus, have a driving effect on the prices for balancing energy. This could happen if suppliers withdraw from the balancing energy markets in order to participate in the capacity reserve. The supply potential for balancing energy by generators is thereby permanently withdrawn, as they fall under the prohibition of return. Controllable loads, on the other hand, can return to the balancing energy markets after their involvement in the capacity reserve.[15] Nevertheless, their supply potential would also decrease over a period that extends beyond the procurement period, as controllable loads may not have generated any "revenues from flexibility" (i. e. balancing capacity and contracted interruptible loads) in the 36 months prior to the announcement of the tender. This regulation ensures that the capacity reserve does not withdraw any existing potential from the balancing energy market and from the contracted interruptible loads by the TSOs.

The extent of the effect described depends on the revenue opportunities of the capacity reserve compared to the balancing energy markets. In the market for

[15] In the case of one-off provision of reserve capacity for the capacity reserve, controllable loads may return to the balancing energy markets immediately after the end of the commitment in the capacity reserve, whereas a longer provision entails a twelve-month prohibition on return.

primary balancing energy (Frequency Containment Reserve - FCR), only power plants that are connected to the grid and have the ability to automatically increase/reduce feed-in depending on the frequency, as well as (large battery) storage facilities, usually participate due to the technical requirements. Power plants must feed in continuously in order to be able to provide FCR in both directions. It can be assumed that for such power plants an involvement in the capacity reserve, and thus a withdrawal from the spot and balancing energy markets, is hardly economically opportune. **Therefore, we do not expect any repercussions for the FCR through the capacity reserve and thus also no effects for the rest of Europe.**

However, effects on the supply potential cannot be completely ruled out for the other balancing energy products. The markets for automatic Frequency Restoration Reserve (aFRR) and for the manual Frequency Restoration Reserve (mFRR) can also be attractive for **power plants** that do not regularly feed into the grid, as these can be provided at least partially from a cold start. Whether power plants decide to participate in the balancing energy markets or the capacity reserve depends on the competitive situation. In our view competitive power plants will tend to remain in the balancing energy markets. In the case of aFRR and mFRR, however, it cannot be ruled out that power plants c. p. leave the balancing energy market earlier in order to realise revenues from the capacity reserve before the end of the power plant's lifetime. In this case, supply potential of power plants would be withdrawn from the balancing energy market, at least temporarily, analogous to the possible effects on the spot and futures markets. However, since this option is only possible for power plants whose economic or technical lifetime has at least almost been reached, we do **not** expect **any significant repercussions on the balancing energy markets from the participation of power plants in the capacity reserve.**

Likewise, **controllable loads** can participate in the aFRR and mFRR markets and would reduce the supply potential there if contracted in the capacity reserve.

However, the condition that controllable loads must not have generated any revenues from flexibility in the 36 months prior to the announcement of the tender significantly reduces the attractiveness of a switch from the balancing energy market to the capacity reserve. The intention of this regulation is not to withdraw any (already developed, active) supply potential of controllable loads from the balancing energy markets.[16] Nevertheless, it cannot be ruled out that the operators of controllable loads will withdraw if they expect higher revenues from participation in the capacity reserve. Moreover, controllable loads that have not been active in balancing energy markets so far are not confronted with opportunity costs to this extent. It is therefore conceivable that they will consider participating in the capacity reserve without prior involvement in the balancing energy markets. **It is therefore possible that the capacity reserve binds controllable loads potential that has not yet been tapped and, in this way, reduces the supply potential on the balancing energy markets.**

We currently assume that the effects described above will not affect other European countries. FCR is the only balancing energy product that is currently procured on a cross-border basis at European level. In this regard, no effects are to be expected from the capacity reserve. The procurement of mFRR and aFRR in Germany is currently still carried out at control zone level and is coordinated nationally between the TSOs. A possible reduction of the supply potential due to the participation of controllable loads in the capacity reserve therefore has at best a purely national effect. In the future, the procurement of these products will take place at European level within the framework of the ENTSO-E projects MARI and PICASSO. Then, possible effects may also become relevant for neighbouring European countries, even though we estimate only low impact since we don't expect large shares of controllable loads participating in the capacity reserve.

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16 The corresponding loads would have to forego revenues for their flexibility on the balancing energy markets for almost five years for a one-time provision (including the two-year provision period) of reserve power for the capacity reserve.

4) Balancing responsibility and imbalance settlement

The balancing responsibility and imbalance settlement system are the core components of the electricity system and of market-based European electricity trading. It sets the necessary incentives for BRPs to contribute to a balanced electricity system at all times. Deviating behaviour is penalised. More precisely, each BRP pays for each quarter of an hour in which it has contributed to a system imbalance its pro rata costs for the use of balancing energy in the corresponding quarter of an hour. BRPs that have reduced the system imbalance (due to a deviation from their own balance in the opposite direction to the system imbalance) receive a payment per MW in the same amount. This is why one also speaks of a symmetrical imbalance pricing system.

With the introduction of the capacity reserve, this system is (at least potentially) asymmetric, as now in situations where the capacity reserve is requested, the payment for shortfall BRPs deviates from the actual calculation methodology of the imbalance settlement price. In the event of an actual use of the capacity reserve, shortfall BRPs must pay at least twice the technical bidding limit on the intraday market (currently approx. 20 T€ /MW), regardless of the quantity and costs of the balancing energy used. Surplus BRP representatives, on the other hand, receive the actual balancing energy price, which is usually significantly lower.

This asymmetry of the imbalance pricing mechanism represents a credible threat of high balancing energy costs in the event of a shortfall in situations with probable use of the capacity reserve for BRPs. Compared to the original imbalance pricing mechanism, this creates additional incentives for BRPs to prevent a potential shortfall in the BRP by encouraging increased efforts for "individual capacity provision" (generation or load flexibility). The **very existence of the capacity reserve thus indirectly increases the resource adequacy due to the incentives created for individual capacity provision for BRPs in the partly asymmetric imbalance pricing mechanism.** Even though flexibilization takes time, these additional flexibility incentives also have an effect on neighbouring countries. As additional flexibility can be marketed in the internal electricity market it also increases the supply potential abroad.

5) Resource adequacy

The above explanations on the balancing responsibility and imbalance settlement mechanism show that the resource adequacy on the electricity market tends to increase indirectly, as the incentives for individual capacity provision / flexibility tend to increase due to the asymmetry of the imbalance pricing mechanism. In addition, the capacity reserve creates a safeguard for very rare and unforeseeable extreme events, against which the market does not hedge, due to its direct provision of capacity outside the electricity market. For example, the capacity reserve can presumably mitigate the consequences of an event such as the massive winter storm that recently occurred in Texas[17], resulting in prolonged power cuts in millions of households, in which the power held outside the markets would have been used by the TSOs.

An opposite effect, which tends to reduce resource adequacy on the electricity market c. p., can arise if the capacity reserve withdraws supply potential from the electricity market by contracting controllable loads or power plants that would otherwise offer their flexibility on the electricity market. This effect should be less relevant for power plants, as explained in the previous section on spot and forward markets. Power plants that have an economic perspective on the electricity markets are not expected to participate in the capacity reserve. For controllable loads, on the other hand, this effect is more relevant, as their flexibility potential would otherwise be available to the electricity markets.

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[17] Winter storm in Texas from 13 to 17.02.2021. Cf. e.g. https://www.fcc.gov/uri.

A direct and explicit increase in resource adequacy on the electricity markets abroad via an activation of the German capacity reserve is not possible. When demand exceeds supply in a neighbouring member state, it must be assumed that electricity prices abroad have reached technical bidding limits and therefore all free capacity on the electricity market is already exported from Germany to the corresponding Member State. If prices do not converge the interconnectors are utilised to their full extent so that additional capacity could not be transmitted. Thus, a ramp up of the capacity reserve would not contribute to compensating for the imbalance in the corresponding neighbour state. In contrast, a direct additional safeguard outside the electricity market is also available for neighbouring Member States, as the capacity reserve can also be used as ultima ratio in emergency situations in which there is no fundamental market scarcity.

In summary, over the described three effects of the capacity reserve on the reliability of supply, those that increase the resource adequacy predominate at least as long as no substantial capacities are provided by controllable loads. This also applies to the electricity systems in neighbouring countries.

6) Investment incentives of the European electricity markets

The introduction of the capacity reserve triggers incentives for investments in individual capacity provision (generation or load flexibility). The main reason is the credible threat of high balancing energy costs for shortfall BRPs when the capacity reserve is used.[18] The natural prerequisite is that market players assume a sufficiently high probability of the capacity reserve being used.

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[18] Even without the use of the capacity reserve, high balancing energy prices can arise in shortage situations. With the capacity reserve regulation, it was ensured that this is at least twice the amount of the technical bidding limit on the upstream and downstream electricity markets. According to EU Regulation 2019/943, these technical bidding limits must be raised to at least the Value of Lost Load (VoLL) when reached.

In addition, there may be incentives for investments in the flexibility of hitherto not-controllable loads (within the meaning of the Capacity Reserve Ordinance) in order to enable participation in the capacity reserve. In this case, financing can be provided - at least in part - through the additional revenues from the capacity reserve remuneration. This can be, for example, investments in (intermediate) product storage that enable more flexible operation of electricity-intensive processes (loads) in the manufacturing sector. Since controllable loads can return to the electricity markets, these newly developed flexibilities would then also be available to the European electricity markets as additional supply potential.

In **principle, we see only very minor repercussions for the strategic reserve on the competitive electricity markets, as the capacity reserve is held outside the markets.** Thus, the capacity reserve only marginally influences the investment incentives of the European electricity markets. The EU Regulation 2019/943 also prescribes the choice of a strategic reserve outside the electricity markets as preferred option. For example, it is expected that the important powers of the energy-only market to drive innovation and flexibility are largely preserved when a strategic reserve is introduced. This is reached by avoiding structural overcapacities in the electricity market and by not inhibiting price peaks in the electricity markets. Thus, the capacity reserve at least does not inhibit innovative business models (e. g. based on price peaks) for making the electricity system more flexible. Business models based on price peaks are becoming increasingly important for balancing the fluctuating energy supply with demand.

7) Climate protection in the electricity system

In addition to phasing out the use of nuclear energy, the German government is driving forward the energy transition in the electricity system with a substantial expansion of renewable energies and the complete phase-out of the use of lignite and hard coal in the electricity supply by 2038 or, if possible, already by 2035. The relatively high speed and, in view of the approval period for the capacity reserve, the high synchronicity of the three aforementioned measures for the transformation of the electricity system confront the German electricity supply system with an extraordinary test of endurance. For this reason - in addition to safeguarding against extreme and unforeseeable events - Germany has decided to introduce a strategic reserve in the form of the capacity reserve. It is intended to ensure that the high reliability of the German electricity system is always guaranteed, even in the phase of the comprehensive transformation of the electricity supply.

On the one hand, the capacity reserve does not constitute an incentive for fossil market power plants to be operated on the electricity market for longer than necessary. This means that climate protection in the electricity system at least does not deteriorate as a result of the introduction of the capacity reserve. On the other hand, the so-called Emission Performance Standard (EPS) with the limits for permissible CO_2 emissions in the capacity reserve ensures that the plants in the capacity reserve, which are expected to be called only rarely, do not cause any substantial CO_2 emissions.

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