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Accelerating a technology-neutral flexibility strategy for the German power market

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Accelerating a technology-neutral flexibility strategy for the German power market

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EXECUTIVE SUMMARY

With the restructuring of our electricity system — i.e. the switch to an 80% share of green electricity by 2030 and "near" climate neutrality by 2035 — a flexibility gap is increasingly opening up in the German electricity market. To tackle this, there is need to go over and beyond the currently foreseen "power plant strategy". What is needed is a flexibility strategy that is open to all technologies. The measures proposed in the reformed European electricity market design should be utilised in full. Germany can also learn from other European countries, which have promoted policies to support flexible technologies. A swift, coordinated approach to closing the flexibility gap is necessary to ensure security of supply and avoid the costs of building up oversized capacities and excessive grid expansion.

Against this backdrop, EPICO has commissioned Aurora to systematically evaluate the current state of flexibility in the German electricity market as part of a joint policy report, and to identify levers to strengthen power market flexibility.

The study emphasises the double added value of an electricity system that is as flexible as possible:

- The more we leverage flexibility potential in Germany, the more cost-effective the energy transition can become. This applies both to the overall systems costs and to the costs for households and industry, which can purchase or consume electricity at particularly favourable times.

- More flexibility — on the demand side, for example — means that less secured capacity is required from fossil-fuelled back-up power plants. This will enable us to achieve our climate targets more quickly and efficiently.

The study presents the various technologies and approaches for more power market flexibility. These include, among others:

- Demand-side flexibility in the household sector, for example by shifting the times at which electric vehicles are charged

- Flexibility on the industrial side
- Storage solutions
- The addition of new power plants with various energy sources such as gas, hydrogen, biomass, etc.

The study then analyses various policy instruments to strengthen flexibility in the German electricity market. Some of these instruments are at very different stages of development. These include

- The aforementioned power plant strategy, but also the electricity storage strategy
- The introduction of “dynamic” tariffs, coupled with the smart meter rollout
- A revision of the grid fee structure, for example to incentivise grid-friendly behaviour on the industry side
- The establishment of a capacity market open to all technologies

The analysis shows the advantages and disadvantages of the respective policy instruments. However, an integrated approach to increasing flexibility is still lacking. Accordingly, the analysis by EPICO and Aurora shows how various measures to increase flexibility can be combined to form a coherent strategy.

As part of such an integrated approach, the paper recommends tackling a series of no-regret measures as quickly and in a structured manner as possible. This includes, for example, further lowering the regulatory hurdles for the expansion of batteries and adapting the legal framework for aggregators to European requirements. The approach should be open to all technologies.

The paper also contains a series of short case studies on good examples from other European countries that have already successfully launched initiatives to leverage flexibility potential and could in some cases serve as a blueprint for a German flexibility strategy.

TABLE SUMMARY

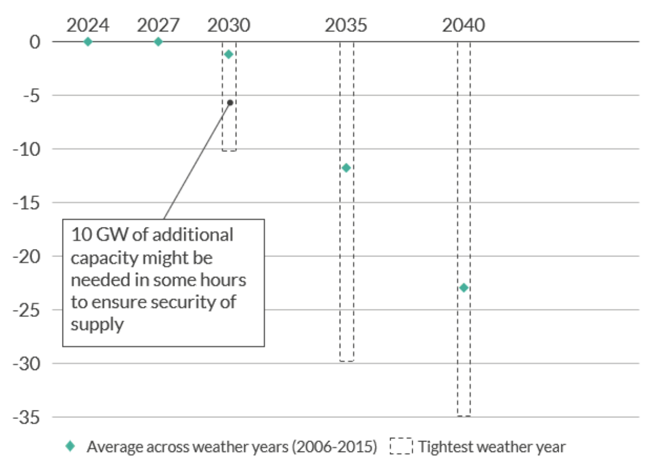
Evaluation criterion / Instrument	Cost-efficiency	Effectiveness	Sustainability (climate and political)
Dynamic tariffs	Low-cost opportunity to shift demand Minimal costs are required to roll out smart metering	Cannot alone close the flexibility gap Lengthy smart meter roll-out (until 2032)	Flexible consumers could benefit from dynamic tariffs Widespread adoption requires to enable households to optimize daily electricity usage in a convenient and automated way
Time variable grid fees	Low-cost alternative to other instruments Can reduce requirement for costly infrastructure upgrades by reducing grid congestion	Can shift demand to periods when grid can deliver renew-able energy Regulation hampers broad implementation	Can support integration of renewable energy sources Industry players, who currently qualify for low grid fees, may oppose instrument
Storage strategy (evaluation highly dependent on final version)	Removal of regulatory barriers presents a low-hanging fruit Minimal depth of intervention	Helps speed up market-based battery built-out Supports deployment of cheap power generation	Increased storage capacity incentivizes renewables build out Municipalities may financially benefit from storage ramp-up, increasing acceptance
Power plant strategy (July 2024)	No genuine competition between technologies, hence not technology neutral Capacity down from 24 GW to 10.5 GW reducing costs	Significantly reduces flexibility gap Extended discussions neces-sary around implementation	Increases the use of high-emission gas plants in the short run Timeline for switching fuels is open for some of the new plants
Capacity mechanism	Cost-efficient through competition between technologies Total required budget for auctions may be high	Can effectively reduce the flexibility gap Foreseen phase until imple-mentation potentially lengthy Can lower energy storage financing costs and boost build out	Awarded capacities must comply with emission standards Industry and households may support the capacity mechanism if they can participate in it via DSR aggregation

Introduction

Germany faces the challenge of transforming its energy system amid rising power demand and an advancing coal exit. More precisely, the government aims to decarbonise the power system by 2035. At the same time, it can be assumed that the coal phase-out will de facto take place some time during the early 2030s, simply due to a changing market environment and rising CO2 prices. By that time (2030) power demand will grow by 45% compared to 2024, mostly to accommodate for the necessary electrification of heating and transport as well as additional demand by electrolysers (Aurora 2024a).

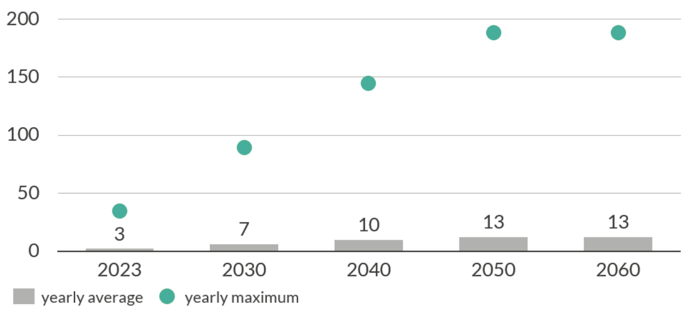
This presents numerous challenges to the system. One is about security of supply: Even when meeting the ambitious targets for renewables built-out, the retirement of coal power plants without replacement is anticipated to leave a capacity gap of 10GW in the system in 2030. Crucially, this capacity gap arises despite the substantial progress in demand side flexibility and energy storage assumed in this scenario. Without progress in these flexibility fields the capacity gap would be bigger.

Capacity gap without newbuilds in Aurora Net Zero Scenario incl. 2030 coal exit
GW



Various "patches" for this are conceivable. In a rapidly decarbonizing power system, any such "patch" needs to be as flexible as possible, because this addresses the heart of the matter. This means it should complement the growing share of intermittent wind and solar generation to maintain a balance between demand and supply. While the sun may be shining at one moment, a rain front may pass by the next, causing a sudden drop in generation. The average difference in generation from one hour to the next is expected to triple by 2040 and to reach a maximum of 140GW in extreme situations (Aurora 2024b). In such events, flexible capacity must be ready to be activated on the supply and demand side.

Hourly generation variation of wind and solar power, Aurora Net Zero Scenario
GW



Besides being indispensable in an electricity market fundamentally built on renewables, a flexible energy system offers numerous advantages. A key point is efficiency in terms of costs and carbon emission reduction. A flexible system can store cheap renewable electricity generated at times of low demand and feed it back into the grid at peak times. In other words, it can avoid electricity consumption when it is most expensive and typically carbon intense.

On a micro-level, households and industry can benefit from this effect. Aurora figures show that shifting demand away from the costliest 20% of hours of the year in 2030 could cut industry's power procurement expenses by 20%. This would bring down the level of wholesale prices within the long-discussed industrial power price of five to six cents per kWh (Aurora 2024a).

From a system perspective, flexible capacity saves costs by mitigating the risk of overbuilding capacity and unnecessarily expanding the grid. It can also avoid renewables curtailment and stabilize the price renewables can capture on the wholesale market, buffering the impact of the so-called cannibalization effect. This helps keep a market-based route for many renewables projects open, while reducing the need for subsidies.

Lastly, flexibility improves security of supply and energy security through reducing reliance on imported fuels like gas or electricity from other countries.

There are various forms of flexibility, as outlined in the next section. Crucially, these different forms are, to a certain extent, inter-dependent (see also next section). Progress in one field, say, demand-side flexibility, may lower the need for flexibility in other fields, such as in the context of security of supply.

In the past, flexibility has often been confined to a niche – conceptually interesting, but of practical relevance only for a limited number of business cases, such as easing grid congestion. For some time now, there has been rising awareness for the topic which is not lost on regulators and policy makers: The European electricity market design reform, released in March 2023 following the recent energy crisis, highlights a "general lack of low carbon flexible supply, demand response and energy storage" to react to price peaks in power systems (European Commission 2023a). It requires member states to assess how much flexibility is needed in the short and long term. For example, the Federal Network Agency (Bundesnetzagentur) will need to submit Germany's needs by 2025 at the latest, including an assessment of the potential contribution of storage and demand side response (DSR). The reform also enables member states to tailor support schemes for non-fossil fuel flexibility and evolve capacity mechanisms to enhance flexibility.

Given this broader context, there is urgent need to discuss which levers to pull in what sequence in order to foster flexibility in the German power sector.

The following sections zoom in on Germany and evaluate various proposals discussed by policymakers and/or the Platform for a Climate-Neutral Electricity System (PKNS), a group bringing together stakeholders from politics, business, science, and civil society. Each instrument considered has its up- and downsides regarding cost-efficiency, effectiveness, and sustainability. While the proposed measures can be effective, it becomes evident that there is no integrated flexibility strategy, and that Germany is not yet fully leveraging most measures suggested by the EU reform. Other European countries demonstrate how policy frameworks can foster attractive environments for flexible technologies. Ultimately, policies will need to be synchronised to work well together and unfold their full flexibility potential that is needed to prevent power supply disruptions, overreliance on fossil fuel backups, and avoid costs for overbuilding capacity and unnecessary grid expansion.

A plethora of options to close the flexibility gap?

A range of technologies exist to provide energy precisely when needed within the system. Broadly, they can be categorised by their duration of power supply, meaning how long they can bridge a low generation gap (see table below).

Short-duration flexibility technologies are, among others, peaker plants, that generally only run at times of high electricity prices (natural gas or hydrogen open-cycle gas turbines (OCGTs) and reciprocating engines). This category also contains different storage technologies including batteries. These will play an increasingly important role in Germany's energy mix. For instance, while batteries make up around 10GW of capacity today this is projected to increase to over 80GW in 2045 according to Aurora's Net Zero Scenario (Aurora 2024a). At the same time, the extent to which they can fill the flexibility gap is limited by the batteries' relatively short duration.

Technologies with mid- to long-duration flexibility can run continuously to meet the regular, ongoing demand. These are necessary to cover extended hours with little sun and wind ("Dunkelflaute"). Among them are biogas and combinations of natural gas closed-cycle gas turbines (CCGTs) or biomass with carbon capture and storage (CCS), among others. Their potential to fill the flexibility gap is partly limited by physical or political constraints that restrict their capacity expansion. Biomass, for example, is in limited supply in Germany. On top of that, the technology is highly debated politically with concerns over land-use conflicts and negative environmental impacts, such as deforestation. Similar obstacles hamper CCS technologies from playing a more prominent role in the (future) energy mix. Suitable CCS sites are of limited availability in Germany. Even though the government has recently announced that gas and biomass plants are eligible to use CCS it is yet to be discussed whether CCS combined technologies can participate in the planned capacity mechanism, where suppliers of flexibility are compensated for their ability to serve the grid if necessary. Participation in the capacity mechanism[1] is a crucial step to create a viable business for CCS in the first place.

Some flexibility sources can fill low generation gaps in various durations of power supply, such as interconnectors and demand side response (DSR). The latter will be crucial in reducing the need for new generation capacity to close the flexibility gap. This is because the distinction between flexible and inflexible demand will become more important in the future. Essential services, like hospitals and specific industrial processes, will always require energy, whereas demand from electric vehicles (EVs) may be shifted to off-peak hours. Combining the capacity of flexible sources can easily add up to hundreds of gigawatts. For example, Aurora estimates under its Net Zero Scenario, that EVs alone could offer a charging or discharging power of approximately 300GW

Short-duration flexibility (hours to days)	Mid- to long-duration flexibility (weeks)	Alternative flexibility sources
▪ Battery storage (lithium-ion) ▪ Long duration energy storage – Redox-flow – Compressed air storage ▪ Natural gas OCGT & reciprocating engines ▪ Hydrogen OCGT & reciprocating engines	▪ Natural gas CCGT + CCS ▪ Biomass & CCS ▪ Biogas ▪ E-methane ▪ Natural gas CCGT ▪ Hydrogen CCGT	▪ Interconnection ▪ Demand side response – Smart charging electric vehicles – (Hybrid) heat pumps – Electric boilers – Industrial demand side response – Electrolysers

[1] See section on strategies to overcome flexibility gap (Power Plant Strategy)

in 2045 — about three times higher than peak inflexible demand (105 GW) by that time. Industry's potential contribution is projected to be at 21GW, constituting roughly 4% of the total flexible demand (Aurora 2023).

While DSR certainly has potential to shift peak demand and reduce the flexibility gap, it cannot by itself cover high energy demand for extended periods of low renewables generation, e.g. in the winter months. Furthermore, there are several constraints for DSR to develop its full potential in Germany, which need to be tackled.

On the side of industry, large power offtakers currently risk losing out on financial benefits if they were to switch from a steady to a variable electricity consumption during hours with more renewables generation. This is because they qualify for a substantial reduction in grid fees if they use the grid for at least 7000 hours of the year, meaning they must take off power around 80% of the time (§ 19 (2) 2 StromNEV). Many smaller offtakers are exposed to gradual grid fees with a high capacity-based component depending on maximum use. This also means they have no incentive to increase their electricity demand in hours of high renewables generation (§ 17 (6) StromNEV).

Turning to the household-side, the lack of metering and information infrastructure, and the lengthy process of introducing these technologies on the part of grid operators put a constraint on DSR's potential. On top of that, there is still room in German regulation to support small capacities, e.g. EVs or heat pumps, to be combined via aggregators to offer a sufficiently large capacity at various markets, including the wholesale market. The existing framework requires aggregators to get permission from suppliers to aggregate and sell customers' flexibility in turn for a compensation. This means that the former must pay the latter, in essence a levy to be able to offer their services (§41d EnWG). Additionally, since capacities smaller than 400KW keep receiving a market premium in negative price hours, they may be disincentivized to participate in DSR aggregation, which also collects larger capacities and would thus curtail in these very hours (§51 EEG).

Evaluation criteria for regulatory instruments: Cost-efficiency, effectiveness, and sustainability

A variety of regulatory instruments exist for closing the flexibility gap. To assess the degree to which each policy instrument fosters an increase in flexibility, the instruments will be evaluated along three key criteria:

- 1. Cost-efficiency

This criterion primarily targets the question of whether the instrument achieves a reduction of the flexibility gap at minimal cost (in comparison to other instruments). It thereby evaluates the depth of intervention.

- 2. Effectiveness

The effectiveness criterion assesses the degree to which the instrument reduces the flexibility gap, including the time required to fully implement an instrument. From a consumer's perspective, this criterion considers whether an instrument increases consumer welfare by lowering prices and system costs.

- 3. Sustainability

This criterion differentiates climate and political sustainability. It evaluates whether the instrument supports or hampers the achievement of emission targets (climate sustainability). Furthermore, it assesses whether resistance to or support for its implementation can be expected from industry or households (political sustainability) and if the instrument aligns with EU legislation.

Exploring strategies to bridge the gap and foster flexibility

Stakeholders like the German Federal Ministry for Economic Affairs and Climate Action (BMWK) and the PKNS are exploring a variety of measures to incentivise flexibility and close the forecasted capacity gap. While some of these proposals, like dynamic power tariffs, are already quite concrete, other proposals, such as large parts of the storage strategy, are still vague.

A summary of our evaluation of those measures can be found in the table at the start of this paper. For a more detailed assessment of each instrument, please the following.

Dynamic tariffs

Dynamic tariffs are endorsed by the PKNS as one approach for a new electricity market design. The group outlined a roadmap for their rollout and recognised their importance in enabling small-scale flexibility, particularly from EVs, heat pumps, batteries, and electrolysers (PKNS 2024).

Widespread adoption could commence with broader availability of digital infrastructure and a consistent regulatory framework. Changes to the Energy Industry Act (§41a EnWG) have laid the foundation for this.[2] Starting from January 1st, 2025, all electricity suppliers must offer dynamic tariffs to consumers with smart meters, with every household given the option to request a smart meter. At the same time, larger consumers (6,000 to 100,000kWh/year) and system operators, such as households with PV installations (7 to 100kW capacity), will be mandated to upgrade. The objective is to replace analog devices nationwide by 2032. The process is particularly lengthy as households must request their smart meter from their metering point operator, of which there are 770 in Germany, each handling the ordering and installation process differently. In turn, suppliers must create regional offers, leading to an administrative burden. The current legal

[2] See also: Gesetz zum Neustart der Digitalisierung der Energiewende

framework does not foresee any sanctions for non-action by network operators, leaving only legal recourse. This increases the uncertainty over the business case among market players further.

Evaluation: Dynamic tariffs present a low-cost opportunity to shift demand and reduce the flexibility gap. Compared to other instruments minimal costs are required to roll out smart metering, however, their roll-out will not be completed before 2032, making the instrument less effective in the short run. Further, dynamic tariffs cannot alone close the flexibility gap, particularly during long periods with little sun and wind across Central Europe. They thus need to be combined with other instruments, e.g., a capacity mechanism (see below). Regarding the instrument's political sustainability, flexible consumers, such as households, could benefit from dynamic tariffs. A recent study on the possible effects of dynamic tariffs for German household consumers and for different appliances yielded substantial yearly net savings. For example, households could save between 64 Euro to almost 400 Euro per year when opting for a dynamic tariff to run a standard heat pump, and between 158 Euro to 316 Euro when doing so for the charging of an EV (Eicke et al. 2024).[3] Saving money alone will, however, not lead to widespread adoption of flexible consumption. Daily electricity usage must be optimized for households in a convenient and automated way. Further, dynamic tariffs will be more popular if they include a protection against peak prices, which may limit their potential to increase overall flexibility in the system in turn.

Time variable grid fees

Time variable grid fees are another opportunity to incentivise flexibility in energy consumption and generation patterns, which has been discussed by the PKNS (PKNS 2024). This involves adjusting grid fees based on different time periods. Static variable fees change at predetermined intervals, such as monthly or annually. Dynamic fees fluctuate in near real-time based on the level of grid congestion, influenced by factors like demand and renewable energy generation. In November 2023, the Bundesnetzagentur introduced regulation allowing "controllable consumer devices" like heat pumps to access time-variable grid fees by 2025 (§14a EnWG). But only a limited number of consumers will qualify for this. Households can participate only if their grid operator is able to temporarily restrict their electricity consumption to prevent grid overload. In exchange, the operator must lower their grid fees, either through a percentage discount or a flat-rate reduction, which then grants access to time-variable grid fees. Broad implementation of dynamic time variable grid fees will be possible by 2029 at the earliest, when distribution grid operators (DSOs), of which there are 866 in Germany, will be mandated to monitor grid congestion and collect real-time data.

Evaluation: Regarding cost-efficiency, time variable grid fees present a low-cost alternative to other instruments. In reducing grid congestion, they can reduce the requirement for costly infrastructure upgrades. Considering the effectiveness criterion, time variable grid fees offer significant potential to shift demand to periods when the grid has the capacity to deliver renewable energy. The current regulation, however, is a provisional measure and will not be sufficient to quickly reach consumers en masse or close the flexibility gap in its entirety. DSOs must undertake substantial infrastructure upgrades and digitisation efforts, delaying the widespread implementation of this measure until at least 2029. From a climate sustainability perspective, time

[3] The range is a function of the type of dynamic tariff in use.

variable grid fees can support the integration of renewable energy sources by moving demand to periods when the grid is able to transport high renewables generation. On the political sustainability criterion, resistance to the instrument can be expected from industry players who currently qualify for low grid fees and may face increased fees, for example the paper, chemical and aluminum industries.

Storage strategy (as of December 2023)

The unveiling of the storage strategy by the German Federal Ministry for Economic Affairs and Climate Action (BMWK) in December 2023 was long-awaited. It confirmed that German policymakers have officially incorporated storage solutions into their toolkit for the energy transition. Despite the absence of concrete expansion targets or legislative timelines, the document acknowledges the significance of electricity storage facilities, including batteries and pumped hydro, and outlines barriers to scaling them up in Germany (BMWK 2023). The ministry pledges to address various challenges for battery ramp-up, such as removing regulatory obstacles related to grid connections and licensing laws and improving the business case for large-scale batteries. This includes improving transparency around grid construction costs and possibly extending the exemption from grid fees for large scale storage beyond 2029. While some proposals have already been taken up in the government's discussions on the solar package, such as the distinction between green and grey electricity or prioritized grid connections for batteries, the ministry continues its consultations with sector representatives until summer 2024.

Evaluation: The German storage strategy states the intention to improve the merchant business case for batteries via clarifying the legal framework and increasing market transparency. On the effectiveness criterion, removing regulatory barriers will de-risk projects and further speed up market-based built-out, which has happened already without consistent regulation aimed at batteries. The strategy thus targets a low hanging fruit at minimal depth of intervention with a clear benefit for the system: Increased storage capacity can shift demand and make use of cheap renewables power generation. How much capacity is ultimately installed, however, will depend on the profitability of projects. So far, shorter durations have been more profitable than longer durations. In the medium to long-run, however, subsidies may be necessary to support (long duration) storage in a more saturated market environment. Regarding climate sustainability, an increase in storage capacity will create an incentive to build out renewables supporting emission targets. From a political sustainability angle, municipalities will benefit from large scale storage ramp-up if they, as proposed by BMWK, will receive a share of the trade tax revenue generated by the projects they host. Additionally, the BMWK announced to explore opportunities for municipalities to financially benefit from electricity storage projects, similar to the provisions for wind and solar installations under the Renewable Energy Sources Act.

Power plant strategy (July 2024)

Germany's power plant strategy has recently been updated (BMWK 2024b). It stands as the cornerstone in addressing the emerging capacity gap in the system. According to the government, key points have been provisionally agreed with the European Commission. It will now be consulted with stakeholders over the summer of 2024. In discussion since 2023, as of the time of writing this report, only the general policy outline of the Power Plant Strategy exists, but no legal text and the documents for consultation have yet been published.

The revamped Power Plant Strategy, which formally will be implemented via a "Power Plant Security Law", rests on two pillars. Under the first pillar for decarbonisation measures, 5 GW of dispatchable capacity through new hydrogen-ready gas plants and another 2 GW of hydrogen-ready modernisation measures for existing installations will be auctioned off. As of the 8th year of (either) their modernisation or their start of operation, those plants will have to convert to hydrogen.

In addition, there will be 500 MW for so-called "sprinter" hydrogen plants (i.e. running on hydrogen from the start) and, notably, 500 MW of long duration energy storage.

Under the second pillar for security of supply, another 5 GW of new gas-powered Power Plants will be auctioned off, mostly to cover extended hours with little sun and wind ("Dunkelflaute"). For those, no fuel switch requirements have yet been announced.

As highlighted in the introduction, this additional capacity of 10.5 GW of new build plants is roughly in line with Aurora's Net Zero scenario. Crucially, in this scenario, we see substantial progress in demand side flexibility and storage. Put differently: While the Power Plant Strategy itself directly contributes to bridging the flexibility gap, it is built on the premise of progress in other areas that are relevant for flexibility. This underscores the need for coordination among the different regulatory instruments analyzed in this section.

These power plants will be offered financial backing through auctions for capital expenditure (CAPEX) subsidies to cover investment costs as well as a subsidy to cover the fuel price difference between natural gas and hydrogen. This will (likely) be mostly relevant for the decarbonisation pillar that needs to convert within 8 years. The first of four auction rounds, subject to formal state aid approval, is scheduled for late 2024 or early 2025.

Evaluation: Regarding cost-efficiency, in contrast to previous iterations, the power plant strategy now includes, mostly via the element of long duration energy storage, at least a token reference to technology neutrality. It still does not allow for genuine competition between flexibility options, as the auctions for the different technologies are (seemingly) "segmented". To keep costs at bay, the revised strategy now only contains 10.5 GW of new built (plus 2 GW conversion) capacity instead of the initially proposed 24 GW of capacity.

The instrument effectively incentivises the rapid construction of much-needed dispatchable capacity, significantly reducing the flexibility gap. It appears that extended discussions with the EU Commission around the previous version's lack of technology neutrality were at least partially conducive to design improvement. Regarding the sustainability criterion, the strategy might still increase the use of high-emission gas plants. Additionally, the timeline for switching fuels for the power plants in the pillar for security of supply remains unclear. Furthermore, at this point, it is still unclear how the location of the new built plants will be determined, since it is only announced that they should be predominantly built in the South.

Capacity mechanism

With the final publication of the power plant strategy, the government also unveiled plans to develop concepts for a market-based, technology-neutral capacity mechanism to be launched in 2028. Its introduction will influence investment decisions in conventional and renewable energy generation, as well as storage and hydrogen-ready solutions, depending on derating factors. The government plans to reach consensus on the capacity mechanism's design parameters this summer. The central, decentralised, hybrid, or peak price hedging approaches, as proposed by the PKNS, could create divergent incentives. For example, decentralised flexibilities might integrate more seamlessly into decentralised capacity mechanisms, which operate on a smaller, localised scale with procurement distributed across various entities. Centralised capacity mechanisms on the other hand might offer advantages in terms of security of supply due to their centralised procurement on a larger scale (PKNS 2024).

Evaluation: Considering cost-efficiency, the proposed capacity mechanism is expected to allow for all technologies to participate and thus selects the cheapest set of technologies. Still, setting up a capacity mechanism is a significant intervention. Further, auctions can come at considerable costs to the taxpayer depending on the exact renumeration design and the awarded capacities. From an effectiveness perspective, experiences from other countries show that a carefully designed capacity mechanism can effectively reduce the flexibility gap. Securing long-term capacity mechanism payments is also expected to bring down financing costs for energy storage and boost its build-out. However, its implementation could take several years, even though recent examples, such as the Belgium capacity mechanism (see below), demonstrate that blueprints can be approved by the EU in a quick manner. Regarding climate sustainability, the capacity mechanism is unlikely to hamper the achievement of emission targets since awarded capacities are required to comply with emission standards set by the EU. Political support for the instrument can be expected from industry and households if participation in the capacity mechanism via demand aggregation is possible.

What can Germany learn from other European countries?

Looking at policy frameworks in selected European countries can inform the debate on the development of German policy instruments to close the flexibility gap.

Italy: Attractive policy environment for batteries

Across Europe, an increasing number of countries implement support systems for batteries. The existing strategies and targets, however, vary strongly. Few countries stand out with storage strategies routed in policies, via auctions or National Energy Climate Plans. Among them, Italy presents a particularly attractive policy environment for the deployment of grid-scale batteries. In contrast to the German government, which to date has no definitive targets on battery build-out, the Italian government aims to achieve 9GW of storage capacity in 2030, which is the most ambitious target of all European countries. The transmission system operator (TSO) plans to procure this capacity from batteries and pumped hydro plants via a new renumeration mechanism, the Mechanism for the Acquisition of Storage Capacity (MACSE). This pay-as-bid auction support mechanism targets 8h storage durations but shorter durations can still participate. The bids can cover total project CAPEX and operational expenditures (OPEX), which significantly reduces merchant risk. On top of that, auction winners are still eligible to retain up to 5% of their revenues from participation in the ancillary services market (MSD), creating an even stronger business case for batteries.

Evaluation: Regarding cost-efficiency, Italy's storage strategy is very costly since both, CAPEX and OPEX, are covered by the bids. The European Commission approved a 17.7bn € state aid scheme to support the strategy (European Commission 2023b). By providing 9GW of storage capacity, which could supply up to 71GWh of energy storage, the instrument, however, should be effective in promoting carbon-free flexibility in Italy.

Belgium: Speedy capacity mechanism implementation

European countries differ widely in their design and implementation status of capacity mechanisms. The Belgium capacity mechanism aims at filling the flexibility gap that is partly driven by the country's nuclear phase-out, very much in parallel with Germany's coal exit. The Capacity Renumeration Mechanism (CRM) is operated by Belgium's TSO Elia and functions as a pay-as-bid support mechanism on top of a regular market operation. The CRM is open to all technologies, however, in alignment with EU legislation all capacities must comply with emission standards and all newly built thermal capacities are required to decarbonize by 2050. On top of that, the renumeration of capacity is based on derating factors, which represent each technology's contribution to security of supply and thus differ by technology. For instance, nuclear capacity had a derating factor of 80% in the 2024 Y-4 auction[4] compared to solar PV capacity with a derating factor of 1% (Ministry of Energy (Belgium) 2024). To avoid windfall profits, a reimbursement applies whenever the day-ahead price exceeds a predefined strike price. Capacity holders must reimburse profits earned above this price. Given the significant depth of intervention, the implementation of the CRM proved very time-efficient taking only several years from its first proposal in 2017 to the first auction in 2021. At this first auction contracts were awarded to two newly built gas CCGTs among other existing capacity such as DSR. In the second auction, no additional

[4] Denotes the auction with 4 years' time between capacity being contracted and its delivery.

capacity was selected as the operation of two nuclear reactors was extended. The third auction awarded contracts to 338MW of newly built derated battery capacity. All other capacities awarded in this auction constituted of existing assets, mostly OCGTs and CCGTs. A Y-2 auction, where the time between capacity contract and delivery is particularly tailored towards batteries and their shorter development times, is expected for 2025.

Evaluation: From a cost-efficiency perspective, the CRM has awarded contracts to various different technologies, demonstrating its technology openness. Costs of the instrument are also kept at bay by means of the reimbursement for day-ahead price exceedance. On the effectiveness criterion, the CRM stands out for its speed of implementation. Further, the CRM has contracted newly built capacities of both, gas plants and batteries, significantly reducing Belgium's capacity gap. Regarding sustainability, all capacities comply with emission standards and decarbonisation requirements and thereby comply with EU legislation.

UK: Empowering DSR aggregators

The EU recognises the pivotal role of consumers in addressing the flexibility gap, as outlined in the Clean Energy Package of 2019. It advocates for the development of demand side flexibility through measures such as ensuring non-discriminatory access to all electricity markets and granting full recognition to independent aggregators as market participants (EU Electricity Directive 2019/944). While EU member states are at varying stages of establishing their regulatory frameworks in alignment with EU directives, the UK has made significant progress in granting aggregators unrestricted access to multiple markets. In October 2023, regulations were introduced allowing for so called Virtual Lead Parties (VLPs) to sell aggregate DSR and flexibility in the wholesale market starting in November 2024. Unlike in Germany, where the aggregator pays a compensation to the electricity supplier, compensation costs in the UK will be paid by all suppliers collectively. The energy regulator Ofgem justified this decision by pointing to expected lower wholesale prices for electricity which will benefit all market participants and increase welfare across the board (Ofgem 2023). Prior to this policy announcement, VLPs could already offer flexibility in the balancing and capacity market. The next phase of policy evolution aims to empower households to access the wholesale market themselves without an intermediary.

Evaluation: From a cost-efficiency angle, enabling DSR aggregators to participate in various markets, presents a low hanging fruit that does not require an additional grid connection. No roll out of smart metering is required if aggregators themselves provide their customers with dedicated measurement devices. The policy can help shift peak demand and reduce the flexibility gap, but it cannot by itself cover extended periods of low renewables generation, e.g. in the winter months. Considering the instrument's political sustainability dimension, there should be no barriers for Germany to transpose the EU Clean Energy Package into national jurisdiction and grant unrestricted access of aggregators to the wholesale market. For example, it could be considered whether a change in the compensation calculation could create more incentives for DSR aggregation. Further, consumers will likely support aggregators' participation in the German wholesale market since they can benefit from lower prices and consumption management provided by aggregators.

Summary and recommendations: Blend for a sequenced technology-neutral flexibility strategy

In summary, the German flexibility gap can be closed by implementing a comprehensive policy environment that supports both, the build-out of additional capacity and the coordination of existing capacity to shift peak demand. Most instruments currently under discussion are, however, still in the design phase. They are unlikely to be fully operational until around 2030, as they require extensive system digitisation or are only scheduled for completion by that time (e.g. the capacity mechanism). It is thus essential to use the interim period to swiftly eliminate regulatory barriers to low hanging fruits such as DSR aggregation, dynamic tariffs, time variable grid fees, and battery build out. In the case of DSR aggregation, the compensation scheme should be altered to incentivize participation following the UK example.

Political prioritization would be required to push for more flexibility in the short term. This could involve legislative measures, such as incorporating broader Clean Energy Package provisions to ease aggregator access to wholesale markets or, say, sanctioning network operators if smart meters are not installed in time. Accompanying this, a technology-neutral flexibility strategy should be set up developing a sequenced approach with coherent short- and long-term flexibility measures. As the analysis of the Power Plant Strategy highlighted, some measures that aim to bridge the flexibility gap are built on assumptions about parallel progress with regard to flexibility in other areas. This underscores the important of a sequenced, well-coordinated approach.

When designing and introducing measures and regulation, all instruments must complement each other to achieve the most effective, cost-efficient system outcome and live up to the full potential of flexibility. This also applies to the market-based, technology-neutral capacity mechanism, which should be implemented quickly following the Belgium example once a decision has been made on its specific design (e.g. centralized vs. decentralized mechanism).

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ABOUT US

EPICO is an independent climate and energy policy think tank based in Berlin and Brussels. Founded in 2021 by Dr Bernd Weber, EPICO has a social market-oriented approach to promote a socially cohesive and environmentally sustainable transition to climate neutrality. Supported by its broad-based Advisory Council, EPICO provides a platform and network for diverse stakeholders from politics, academia, industry, and civil society to exchange and find majorities for ambitious climate policies.

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