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Electricity market in Germany – Does the current market design provide security of supply?

REPORT FOR THE FEDERAL MINISTRY FOR ECONOMIC AFFAIRS
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EXECUTIVE SUMMARY (ENGLISH VERSION)

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Background

Market participants in Germany as well as in other European countries discuss whether so-called capacity reliability mechanisms (CRMs) should be implemented to guarantee security of supply in the electricity sector.

The electricity market design in Germany and most of its neighbouring countries is so far based on the principle of an “energy-only market” (EOM). In an EOM, investments for electricity production are primarily financed through energy-based prices (in €/MWh), which incorporate an implicit payment for available capacity. In this context, various market stakeholders wonder whether a market design based on the EOM principle generates sufficient incentives to ensure mid- and long-term security of electricity supply. Some stakeholders have suggested the introduction of a CRM. Through a policial intervention, a CRM would induce explicit capacity payments (e.g. in €/MW per year) that would incentivise additional capacity and thus security of supply. Some of Germany’s neighbouring countries, for instance Belgium, France or Great Britain, are currently introducing CRMs.

Therefore the German Federal Government is exploring the following questions:

- ***This study (Frontier/Formaet): Ability of EOM to provide security of supply*** – Is the current electricty market design, based on the EOM principle, sufficiently reliable to guarantee mid- and long-term security of supply in the electricity sector – even in a market which is increasingly dependent on intermittent renewable energy? Which approaches exist within the EOM design to overcome possible obstacles to security of supply?
- ***Parallel study (Frontier/Consentec): Impact assessment of capacity reliability mechanisms*** – How do CRMs perform in terms of their impact on, for instance, security of supply, overall economic costs or wealth distribution?

To analyse these questions, the Federal Ministry of Economics and Energy (Bundesministerium für Wirtschaft und Energie - BMWi) has commissioned several studies. This summary provides results of a study by Frontier Economics Ltd. (“Frontier“) and Formaet Services GmbH (“Formaet“) on the ability of an EOM-based electricity market to ensure security of supply.

Approach and focus

Analytical approach

To answer whether an EOM is capable of guaranteeing security of supply, we apply qualitative as well as quantitative analyses (market simulations). The starting point of this analysis are potential market failures that might prevent that the welfare-maximising level of supply security is actually achieved. These potential market failures are analysed and assessed against the background of the real electricity market design in Germany and Europe and, as far as possible, empirically tested through electricity market simulations. In addition, we identify approaches for market design improvements to overcome potential failures.

Focus on generation adequacy, not on internal transmission constraints

Supply security can be at risk at several stages in the value chain. This study focuses on the production and consumption level. We analyse whether the market design is able to secure sufficient firm capacity of power plants, storage facilities or demand flexibility to guarantee secure supply without (significant) involuntary supply interruptions.

Possible supply limitations through congestion in the transport or distribution network within Germany are not in the scope of this study.

Not in focus: Lacking cost recovery of power plants per se

The discussion about EOM and possible CRMs is not at all new. However, it has gained momentum over recent years, as many conventional power plants can no longer or only merely cover their total costs, and new investments are not viable in the current market climate.

This is, however, not necessarily a supply security issue. In the first place, this is the consequence of significant overcapacities in the German electricity market, driven – amongst other things – by the entry of substantial subsidised renewable capacity investments. Following this, a period of market consolidation with (temporary and final) power plant closures and low plant investments, as already observed in some cases, is economically sensible and necessary.

Nevertheless, future security of supply could be at risk if closures and investment delays were to extend beyond necessary market adjustments. Such a situation could arise as a result of market imperfections or deficits in the market design. We analyse these issues in detail in this report. In exploring this, we identify market design imperfections that may endanger security of supply. However, we present approaches for amending the market design in such a way that an

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optimised EOM (“EOM 2.0”) will ensure supply security. We therefore come to the conclusion that a CRM is not required to sustain supply security in Germany’s electricity market.

Results

Ideal EOM allows total cost coverage

The German electricity market is currently based on the principle of an EOM. In a competitive EOM, electricity producers offer their available production with reference to their variable production costs, and consumers (usually via retail suppliers) signal their willingness to pay for electricity supply.

As a result, the wholesale price corresponds to variable costs of the last unit that is needed to balance supply and demand. The marginal unit may be a power plant or a consumer who is able to flexibly shift or reduce his consumption (DSM = Demand-Side-Management). In the latter case, consumers mainly face ‘opportunity costs’ of not consuming electricity (in that period) – which could for instance mean a reduction in production output in the case of an industrial user.

Therefore, an EOM allows wholesale prices that exceed the own variable costs of all generating units that are required to provide security of supply:

- **Rents for inframarginal units** – As the uniform electricity wholesale price exceeds the variable costs of most operating plants, inframarginal generators (i.e. generators with variable costs below the marginal unit’s variable costs), receive rents at any time.
- **Rents for marginal units** – With prices corresponding to the variable costs, the price-setting marginal unit does not, in a static perspective, receive inframarginal rents. However, with the following mechanisms, an electricity market based on the EOM principle can still allow rents to cover capital costs and fixed operating costs of these plants:
 - **Scarcity rents through demand flexibility** – In shortage situations, the market can be cleared via demand side response, implying that consumers shift or reduce their load. If there are enough consumers who can contribute without requiring significant investments (which would have to be covered in the EOM), this leads to market clearing at high prices. This mechanism allows for inframarginal (‘scarcity’) rents even for the most expensive generating production unit.

- **Scarcity rents through “Peak Load Pricing”** – In situations of increasing shortage and insufficiently flexible load, some generators may become pivotal, i.e. system load cannot be covered without their capacity. Pivotal suppliers are then – within the confines of applicable competition law – able to request prices above their variable costs to allow that their own total cost are covered, as – from a static point of view – they cannot be replaced by cheaper suppliers (see also our explanations on market power below).
- **Dynamics in the power plant park** – Today, older plants may be relatively inefficient compared to newer plants and thus only rarely earn inframarginal rents. They may, however, have had an efficiency advantage in the past (when they were more efficient than what were the older price setting plants at the time), where they may have earned inframarginal rents regularly. This means that from the observation that some existing plants merely cover their own variable cost, today, we cannot automatically derive that necessary plants cannot recover their capital costs over the course of their entire lifetime.

In summary, an ideal, competitive EOM is technically able to allow cost coverage (i.e. including investment and operating costs) for all plants that are needed for secure electricity supply. Thereby, market forces could determine a welfare-maximising level of supply security and a cost-minimising production mix. However, these initial considerations are valid within an ideal, competitive EOM.

Real EOMs do assure security of supply – if designed appropriately

In practice, we can think of constellations in energy-only electricity markets in which the above mechanisms of an EOM may not work appropriately. Potential real-world market (design) imperfections are explained below. We conclude, however, that these challenges are manageable with the measures of an EOM, or that they are less relevant in the actual German context.

In the literature, several market imperfections or regulatory interventions into the electricity market are listed as causes for possible market failures:

- **External effects** due to public good nature of security of supply;
- Inefficient allocation of **market risks or prohibitive risks** of capital-intensive investments;
- **Market power abuse** in scarcity periods;

- Lacking cost coverage through regulatory interventions in wholesale pricing (“**missing money**”);
- **International ‘spill-over’ effects** by the introduction of CRMs in neighbouring countries.

In the following, we explain how we assess these aspects’ relevance against the background of today’s market design in Germany and Europe.

Adjustments of market rules minimise external effects

Security of supply implies that supply and demand coincide at (almost) any moment in time. Real-world electricity markets may, however, be characterised by:

- **Relatively low (short-term) price elasticity of demand** – Many electricity consumers (mainly households) currently do not have the technical infrastructure to allow them to adjust their consumption (manually or automatically) in response to (real-time) market prices, and thus to system scarcity. Therefore, a situation in which market clearing is not feasible cannot be ruled out when all available production capacity is already generating electricity.
- **External effects through non-exclusion** – Again due to limited technical infrastructure, it is not possible to limit actual consumption of consumers individually to prevent them from consuming more electricity than they have actually purchased. In addition, market stakeholders are linked via the grid. As a consequence, single consumers are not able to avoid an interruption of their supply by signalling their willingness to pay high prices. In case the market does not clear at all, involuntary – if only partial - supply interruptions will affect consumers irrespective of their willingness to pay for supply security.¹ This could, in turn, dampen incentives for consumers to pay for security of supply measures such as reserve (option) contracts. Analogously, generators may be involuntarily excluded from generating high revenues, if their connecting grid is being cut off in a situation with no market clearing.

¹ With the exception of a decentralised physical cover via, for instance, emergency generators or battery storages.

- **External effects through price caps** (see also “missing money” further below) – If the market does not clear, there is no or only an administratively set market price. This price may, however, not reflect the (marginal) value of electricity to all consumers in this extreme situation. The real value of electricity would correspond to the marginal price of the additionally required load reduction to clear the market. If this value is not reflected in the administratively set price (e.g. in the form of balancing prices), investors will not factor the true value of electricity into their investment decisions and these will be distorted leading to insufficient security of supply.

In practice, supply interruptions would affect only parts of the grid, and therefore only a relatively small number of customers would face potential external effects. Furthermore, it is difficult for market participants to predict which customers would face interruptions in a brown-out case. Therefore, in industry practice market participants normally don't take external effects into account when developing business cases for investments in generation capacity or contracting back-up capacity for supply contracts. However, we cannot rule out completely that external effects occur in the electricity market. These external effects can be significantly reduced or avoided by the following market design adjustments:

- **Removing barriers for demand flexibility and unconventional generation flexibility:** Based on our empirical analyses, we do not expect any generation inadequacy until 2022 (for the interconnected region that includes Germany) and therefore no external effects through a failure of the market to clear. In addition, we believe that the (economically) accessible potential for demand flexibility, especially in the industry sector, is sufficiently large to avoid involuntary supply interruptions even in the long term. Analogously, there are further production flexibilities (e.g. emergency generators), that are financed outside the electricity market and that are currently not part of the market, but could be activated at low cost. There are, on the other hand, still substantial barriers for these flexibilities to be activated, for example by a non-favourable grid charge system. These barriers need to be removed.
- **Aligning power exchange price limits to a VoLL level in case of scarcity:** In order to achieve a welfare-maximising level of security of supply, wholesale prices should be able to reflect consumers's willingness to pay. An indicator for this willingness to pay is the average cost of an individual supply interruption ('Value-of-Lost-Load', VoLL). This average VoLL should also be reflected in the maximum price of the spot market of power exchanges. At EPEX Spot, current (technical) price limits have been

set at 3,000/MWh (Day-Ahead) and 10,000€/MWh (Intraday), respectively, but may be considered to be increased to an appropriate VoLL estimate of, for example, 15,000€/MWh. Estimating the average VoLL is, however, not trivial (but still easier than many alternative measures such as capacity reliability mechanisms, see Frontier/Consentec (2014)).

- **Defining a proper ‘brownout price’:** In case the market would not be able to clear (and thus balance supply and demand), some consumers may need to be curtailed involuntarily (‘brownout’). In this situation, however, the majority of consumers are still supplied, and (almost all) producers are still generating. Therefore, the market design should contain a rule to determine what the market price should be in such a ‘brownout’ situation. Ideally, this should be based on a VoLL estimate. The definition of such an – ideally only hypothetically relevant – fictional price would create the conditions to compensate market stakeholders for external effects and to account for financial imbalances. The definition of such a price would also have the advantage of signalling to market participants which wholesale prices policy makers and the public administration would consider as justifiable – e.g. prices in the range from 10,000 to 15,000 €/MWh (see above).
- **Marginal rather than average balancing prices:** Balancing energy prices should be calculated according to the market logic based on marginal costs of reserve purchases. In scarcity situations, they should reflect the costs of supply interruptions (VoLL). By this, balancing responsible parties would receive adequate incentives to balance their portfolios. For instance, retailers would be incentivised to purchase as much electricity as they expect their customers will consume, and to sign additional (option) contracts to cover any unpredictable circumstances. Analogously, capacity holders could generate additional income by selling option rights to draw on their capacity. Germany’s current balancing energy price system should be reviewed thoroughly and adjusted to reflect actual scarcity values at any time.
- **Improved incentives for balancing for regulated stakeholders:** Due to lacking infrastructure, actual consumption of many consumers as well as actual production of some renewable energy production units is not metered and settled in real-time. Instead, their consumption or generation is estimated using simple algorithms (e.g. standard load profiles for household consumption). Deviations of these estimates from actual load or production, respectively, are managed by distribution system operators (DSOs). As DSOs are natural monopolies and regulated by the German regulator Bundesnetzagentur, it is important that the regulation framework sets the

right incentives for them to manage these deviations appropriately. This is, however, not always given today.

To summarise, potential external effects, and therefore the likelihood of supply interruptions, can be reduced or even avoided by measures that ensure that possible scarcity situations are economically felt by all relevant market participants. There should be adverse financial consequences for participants that cause shortages, and additional revenues for participants that contribute to supply security – for instance parties that hold reliable generating or load reduction capacity. Also, the described rules have a self-assuring effect: By implementing them, the probability of actually needing them is minimised.

The described market adjustments can significantly reduce external effects in the electricity market, even if not necessarily fully eliminating them. In summary, we believe that market participants in practical investment decision will – at least after the market design has been amended as suggested above – abstract from theoretically remaining external effects in case of supply interruptions.²

Risks manageable within EOM

Risks arising from uncertainties about future market and political developments play an important role in the electricity market with its long-term and capital-intensive investments. However, the electricity market is able to manage these risks effectively and efficiently:

- In the short- and mid-term, there are several instruments and products to hedge uncertain future costs and revenues. For example, volatile spot prices can be transformed into stable prices by contracting corresponding forward products such as futures or options. These are liquidly tradeable up to three or four years in advance.
- Long-term risks are carried by investors, who are compensated with respectively higher revenues to accept these risks.

As long as there is no other market failure in the capital market, we expect efficient investment decisions in consideration of all opportunities and risks that are linked to this investment. Thereby, consumer preferences are adequately reflected in investment decisions.

² Exceptions are customers with prohibitively high interruption costs (e.g. computer centres, airports, hospitals, etc.) which are already hedged against network failures by, for example, emergency generators.

Moreover, we expect that capacity provision will become less capital-intensive in a market which is more and more characterised by renewable energy. For example, we expect the extended use of existing plants (including retrofit), construction of gas turbines or activation of demand flexibility, all with low capital and high variable cost.

One possibility through which policy makers could deal with the above-mentioned risks (if they so desired) would be to oblige a socialisation of risks, for example by mandating a CRM with long-term capacity contracts. This can lead to reduced overall economic risk and financing costs. This approach contains, however, the risk of misinvestments, as investment decisions are no longer taken by investors who actually bear the opportunity and risks of future revenues. Instead decisions would – at least indirectly – be taken by government or administration. This could, for instance, result in more capital-intensive investments than economically sensible. Furthermore, the introduction of CRMs goes along with new (mainly political) risk for investors, which then need to be compensated with higher revenues.

A pragmatic approach to minimise economic costs caused by political risks is to determine clear – and if possible socially agreed – political guidelines to create a stable long-term investment environment. For instance, if explicit promotion of renewable energy is declared as a policy objective, then policy makers should determine long-term, legally binding renewable energy expansion paths. Another example would be clear, long-term objectives and rules for the European CO₂ trading system.

Market abuse no inherent EOM problem, as market is contestable

Germany's electricity wholesale market has always been characterised by a certain market concentration on the supply side. Market concentration in electricity production has, however, decreased in recent years. This is due to substantial constructions of renewable energy plants, desinvestment programmes of large producers and new conventional power plants of non-incumbent investors.

Nevertheless, it is an inherent part of a competitive EOM that single plants become pivotal in scarcity situations. The possibility to enforce scarcity prices in peak-load periods is required to remunerate capital costs and fixed operational costs for marginal units. This is what literature calls "Peak Load Pricing", and is not *per se* an abuse of market power. Scarcity prices would only be a matter of concern if some producers had very big portfolios and were therefore already pivotal even in situations where capacity shortage was not an issue. Due to the changed market structure (see above) we deem this risk much less relevant these days.

The market benefits from disciplining competitive pressure from a dynamic perspective, as (actual or expected) excessive prices would lead to market entry. This may be through new players investing in power plants or in activation of demand flexibility. Thus, the market is contestable, and incumbents need to fear market entry if they systematically drove up the price in scarcity situations.

To enable contestability, market entry barriers need to be as low as possible. While entry barriers for conventional power plants have been widely reduced during liberalisation, market entry conditions for demand flexibility and unconventional power plants such as emergency generators need to be improved. As an example, the network tariff regime needs to be reformed such that consumers are not penalised when they flexibilise their demand. In addition, further efforts for an improved integration of electricity markets in Europe (“internal market“) would increase contestability.

“Missing Money” through price regulation is avoidable

Regulatory interventions can undermine an EOM’s capability to guarantee security of supply. If electricity price are restrained in order to impede the abuse of market power, investors may not be able to generate scarcity prices that are required to cover total costs (“Missing Money”).

In some countries, for instance in the US, regulatory interventions such as price caps were the underlying motivation to introduce CRMs. In Germany, however, the situation is different:

- **No regulatory price caps** – Price limits at the EPEX Spot day-ahead and intraday market are only technical bid limits. If they became binding, they could easily be increased by the exchange(s). Furthermore, market participants are free to trade at higher prices when trading outside the exchange (i.e. OTC). In addition, balancing energy prices are unlimited, in principle.
- **“Mark-up prohibition” does not prevent scarcity prices** – Electricity wholesale pricing is subject to competition control. Among others, the Federal Cartel Authority has expressed its interpretation of a valid European and German competitive law in its sector review in 2011. The authority concluded that companies with a dominant position are, in principle, not allowed to offer power at prices exceeding their direct marginal costs. This “mark-up prohibition” does, however, not necessarily interfere with prices necessary for total cost remuneration. This is because the restriction does not extend to non-dominant firms,

and even dominant firms are allowed to request prices above marginal costs if they can prove that these are needed to cover total costs.

Even though explicit, politically determined price caps do not prevail today, there is a risk of implicit caps which could as well be relevant for potential investors. The following measures would help to avoid these efficiently:

- **Increase of technical price limits at exchanges:** Technical upper price boundaries at electricity exchanges could be increased, ideally up to a VoLL-estimate, ie from currently 3,000€/MWh in the day-ahead market to approximately 10,000 – 15,000€/MWh. To support the credibility and acceptance of this price limit, a political backup of this limit would be advantageous. One example would be to define an official ‘brownout price’ at the same price level for the case of partial supply interruptions (as described above). By this, potential investors would receive a strong signal that high scarcity prices are politically accepted.
- **Practice of cartel authority:** Although the “mark-up prohibition” does not generally prevent scarcity prices, electricity companies still face a considerable risk that the Cartel Authority does intervene when high prices arise. In practice, companies find it difficult to prove that prices exceeding variable costs are needed to cover total costs. A practical approach could therefore be to reverse the burden of proof when it comes to high prices. This way, even companies so far regarded to be “dominant” could request prices exceeding their variable costs – unless it could be proven that they are not necessary to cover total costs and would therefore be abusive.

To summarise, implicit and explicit price interventions should be prevented by corresponding political and administrative signals and (self) commitments. A market environment with a latent threat of political interventions does not provide a suitable framework for long-term investments.

CRMs abroad do not automatically threaten security of supply at home

Some countries surrounding Germany such as France, Belgium or the UK, are currently implementing CRMs. There are complex reasons for these political choices, and the move is to be interpreted in the light of individual circumstances and policy objectives of the countries.

However, the introduction of CRMs in neighbouring countries alone does not require a CRM in Germany to guarantee security of supply:

- **Additional capacity also of use for Germany** – In many situations, additional capacity induced by a CRM abroad can contribute to security of supply in Germany – as long as transport capacities are available. This requires, however, that the assessment of security of supply in Germany is made in consideration of the contribution of available imports in shortage situations (see below).
- **Market mechanism continue to work** – In extreme situations available foreign capacity is limited due to simultaneous residual load peaks or limited transport capacities. In such cases, however, electricity prices in Germany increase accordingly, sending signals to investors for capacity in Germany. The market mechanism is therefore not fundamentally changed by CRMs abroad. Nevertheless, price and quantity risks rise due to rare but higher price peaks (in countries without a CRM)). These risks can, however, be refinanced via higher prices and revenues in the market (see above).

Even though different market designs in neighbouring countries have – with a sensible definition of security of supply – no detrimental effect on security of supply, distributional effects arise between producers and consumers in different countries. Therefore, international coordination and, if possible, harmonisation of market designs are preferable.

Security of supply to be considered in an international context

When assessing the security of supply contribution of available import possibilities in scarcity situations need to be considered. If policy makers demand a national, self-sufficient supply, then an EOM can only fulfil this requirement arbitrarily, irrespective of whether other countries have a CRM in place or not. The reason is that investment decisions in the EOM are based on international interactions of supply and demand, which naturally take import and export opportunities into account (and not based on the balance of national supply and demand alone).

Conclusion

Germany's electricity market design, which is based on the EOM principle, is capable of ensuring secure electricity supply at lowest possible cost. This is even valid on the background of increasing shares of intermittent renewable energies and CRMs in neighbouring countries. Currently, there is no imminent risk of a generation-based threat to security of supply given existing overcapacities.

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To guarantee future supply security, some market design adjustments are required. These include:

- **Removal of market entry barriers** for demand flexibility and unconventional production plants (such as emergency generators);
- **Introduction of commercial rules for involuntary load interruptions** – To minimise or prevent (then only hypothetical) external effects, market participants should have knowledge of what would happen in a case where individual consumers need to be curtailed due to insufficient available capacity;
- **Improvement of incentives for balancing generation and consumption** – This could be achieved, for instance by introducing marginal pricing for balancing energy and by improving the regulatory framework for balancing groups that are responsible for not real-time metered load and RES generation;
- **Development of a stable, long-term political framework** – This could be achieved, for instance by entering into clear and credible commitments with regards to the politically guided expansion of renewable energy, combined heat and power (CHP) or climate policy (e.g. EU ETS);
- **Preventing (implicit and explicit) price caps** – To enable total cost remuneration, scarcity prices need to be allowed during near-shortage situations (“Peak Load Pricing”). Policy makers or the administration should reliably signal their acceptance of scarcity prices, for instance by trying to align exchange price limits to value of lost load estimates;
- **Coordinate definition of supply security internationally** – When assessing security of supply, governments need to take cross-border contributions into account. In addition, cross-border processes are required to handle cases of actual shortages.

With these measures in place, an EOM-based electricity market does guarantee security of supply in the form of sufficient available capacity (‘generation adequacy’). However, the actually achieved level of supply security depends on how far these measures are ultimately put into practice.

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