Focused capacity markets: A new market design for the transition to a new energy system

Short version of the study for the WWF Germany environmental foundation

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1 Background

1.1 The upcoming challenges

The German and European power supply systems face extensive changes. With the energy policy decisions made in 2010 and 2011 Germany has set itself the goal of comprehensively reducing the greenhouse gas emissions of electricity production by the middle of this century, of shifting its basis largely to renewable energies and of phasing out the use of nuclear energy by 2022. At the same time, one and a half decades after the market was opened, the transition phase from the monopolistically organised to the competition-based electricity market is coming to a close and existing surplus capacities among the conventional power plants are noticeably reduced.

The situation of the electricity supply system in Germany and most European countries – which is relatively comfortable in terms of existing power plant capacities – is going to change for a number of very different reasons over the next few years:

- existing power plants will be shut down – to a significant degree for political reasons (nuclear power plants especially in Germany and Belgium) or as a result of other legal requirements (EU emission standards for conventional air pollutants – in most of Germany's neighbouring countries);
- the current and foreseeable developments on the natural gas, hard coal and carbon markets, and the increasing pressure of competition will jeopardise existing power plant capacities and not allow investments in new flexible power plants;
- the enormous expansion of electricity production on the basis of renewable energies will reduce the capacity utilisation of conventional power plants and cap to a very large extent price peaks on the wholesale markets, which is going to reduce the profitability of conventional existing power plants and new plants even more.

This situation is primarily a result of the price-setting mechanisms in the liberalised electricity market, because the market was opened up to competition on the basis of a power plant fleet which was built during times of monopoly, is capital-intensive and largely depreciated, and has comparably low operational costs. This has led to relatively low price levels on the wholesale market for electricity and accordingly low contribution margins for conventional power plants. The large-scale expansion of

renewable energies and the current price crisis of the EU Emissions Trading Scheme further intensify the situation of (too) low contribution margins substantially.

Alongside the phase-out of over 20,000 megawatts of electricity capacity from nuclear power plants between 2011 and 2022, more than 10,000 megawatts of capacity from incumbent power plants are at more or less acute risk of decommissioning. In addition the building of approx. 5,000 megawatts of new power plant capacity up to 2020 and at least an additional 10,000 megawatts up to 2030 has to be ensured so that the (residual load) power plant fleet which guarantees security of supply is maintained and can flank the planned expansion of renewable energies.

1.2 The limit of current market design

Within the current setup of the electricity market as an energy-only market, the German electricity market forms a well functioning and efficient coordination mechanism for optimising the operation of power plants. It can and must retain this important role, but at the same time it is reaching its limits in terms of financing power plant capacities.

The current market model for the conventional segment of power generation developed in a concrete historical situation. The deregulation of the electricity market in Germany and the EU took place on the basis of a power plant fleet which was built during times of a monopoly and was largely refinanced. Moreover, in the Continental European market the fleet is largely marked by capital intensive investments with low operating costs (nuclear and coal-fired power stations) which to a significant degree were made in part on the basis of political parameters (coal subsidy policies, etc.). Only in this manner was it possible, in the specific context of power generation (balance of supply and demand in real time, extremely limited storability of electrical energy, long lifetime and large amount of capital stock tied to infrastructure), for an electricity market to develop for about a decade where prices (and income) are established on the sole basis of the short-term marginal costs (fuels and, from 2005, emission allowances).

The theoretical debate about the long-term viability of an energy-only market comes to different conclusions, especially due to considerable differences in the assessments of the reliability of the various economic-theory-based assumptions and starting points for the reality of the electricity supply system. Apart from (good) theoretical arguments, two more aspects strongly corroborate the necessity of complementing the current electricity market model by new elements through which income can be generated for the provision of power plant capacities.

Firstly, in the current energy industry environment it seems inconceivable that a situation might arise which could constitute an economic basis that is solid enough for maintaining existing or building new power plant capacities which would be necessary for providing great security of supply. Without massive and high scarcity premiums on wholesale prices for electricity which last for a long time and which are not rescinded by regulations, it is inconceivable that either the fixed operating costs for gas-fired power plants or for older coal-fired power stations are generated in the long term or that sufficient contribution margins will be generated to refinance new power plants. On the whole (basically, very high scarcity-induced prices over a significant period of the

year, availability for several years, no regulatory interference) it seems impossible that sufficient scarcity premiums in the electricity market will be granted to maintain existing plants and finance new plants.

Secondly, an international comparison with electricity markets that are marked by growth, as well as a review of the investment activities in the period prior to the introduction of electricity market monopolies, investment and price regulation (in Germany: prior to 1935) clearly shows that electricity markets which are exclusively structured as energy-only markets must ultimately be regarded as typical consequences of a Brownfield deregulation (i.e. deregulation based on an existing power plant fleet). For phases with great investment activity in the competition-based electricity market ('Greenfield competition'), on the other hand, the energy-only market does by no means constitute the standard market model. Every market model achieves certain objectives and corresponds to a specific condition of the energy industry. When these objectives or general parameters change, it is legitimate and necessary to adjust the market design.

Thus a redesign of the electricity market is necessary. A redesigned market of this kind must – alongside electricity production – also generate a revenue for the provision of power plant capacities. Corresponding market models have been implemented and tested internationally in a variety of ways and are currently also advanced in many of Germany's neighbouring countries.

2 A possible solution: the focused capacity market

2.1 Objectives and starting points

The objectives of a new market mechanism have to take into account the target matrix of the energy transition. The instrument to be created must ensure the success of the energy transition in general. For this reason the following catalogue of energy and climate policy objectives is established as the basis for the instrument of the focused capacity market described here.

1. The capacity mechanism aims predominantly, but not exclusively, at providing security of supply. The energy transition can only be a success if market-based instruments that comply with the transition's target matrix are likewise provided. Taking into account the high level of expense involved in safeguarding consistency on the basis of a broad grouping of different and isolated approaches used to guarantee the various goals, an integrated target approach of this kind is both prudent and expedient.
2. A capacity mechanism should also take the climate policy targets into account. It should not lead to the accumulation of CO_2 and capital-intensive investment stocks ('lock-in') which fix a certain level of emissions for extended periods or the depletion of which would only be possible with very high CO_2 prices or other major interventions.

3. In order to guarantee acceptance of the instrument and of the energy transition in general in the long term too, the mechanism's design should, as far as possible, avoid deadweight effects and should keep the costs to consumers as low as possible.
4. A new instrument for the procurement of secured capacities should maintain the levels of competition in the energy-only market and in the balancing power market. After all, instruments that significantly reduce the level of competition at least indirectly result in an increase in costs in these markets.
5. The divergent cost structures of renewable energies and of conventional energy carriers make integrating renewables into the current design of the market difficult, if not impossible. While the renewable energies are characterised by very high fixed costs and almost negligible marginal costs, the conventional energy carriers have comparatively low fixed costs and high, variable production costs. A new market design should therefore be guided by a structure of revenue components which open up prospects for a joint energy market for conventional and renewable energies.

While a capacity market instrument thus primarily helps to provide security of supply, the other objectives mentioned should also be pursued. A contribution should be made towards transforming the power supply system for which the building of new, very flexible and low emission power plants is essential to complement the fluctuating electricity production from wind and solar energy for technical and economic reasons.

2.2 Fundamental design

Given this situation, the proposal for a focused capacity market rests on the following basic concept:

- Focusing the capacity market by segments: The focused capacity market should (initially) take into account the two segments of the power supply system which will face special challenges over the coming years: existing plants under threat of decommissioning and (necessary) new generating capacity. Thus, power plants that generate sufficient contribution margins to the fixed operating costs should not be recorded by the focused capacity market. At the same time, the segmentation of the capacity market is a good starting point for a product differentiation (see below) and facilitates the adjustments which are bound to become necessary based on practical experience as time goes by.
- Product differentiation: It makes sense to differentiate between the products of the capacity market, that is to say, capacity payments, based on their lifespans (in other words, structurally adjusting the term of the resulting contracts between the relevant authority and the plant operators to the decision-makers' general economic plans) in order to limit risk premiums (and

therefore the costs to the consumer, too). Furthermore, pre-qualification requirements should apply – especially for the new-build segment – which also bear the longer-term development of the power supply system in mind (flexibility, emission levels).

- Extensive incorporation of the demand side: Demand-side measures (e.g. controllable load resources) should be incorporated extensively and equally into the focused capacity market as supply offers. By doing so, the demand side should be addressed via intelligent product differentiation within the respective market segments rather than by a separate market segment.
- No restrictions on participation in the energy-only market and the balancing power market: Firstly, this should limit the cost to the consumer and maintain the level of competition on the electricity market. Secondly, the interaction between the capacity, energy-only and balancing power markets should address a wider portfolio of options. Thirdly, this interaction paves the way for system designers, operators and investors to learn lessons which are needed for the dynamic further development of the system.
- In return for the capacity payments, the successful bidders should prove physical availability in the respective capacity auction and issue a call option to give the responsible body the right to paying the difference between the spot price available on the wholesale market and a fixed threshold (strike price). This would not prevent scarcity-induced prices on the electricity market, but it would simultaneously absorb potential scarcity-induced premiums and make them available to reduce the cost of the necessary capacity contributions on the consumer side.
- The cost of the capacity payments distributed via the auctions is refinanced by allocating them to the transmission charges.

This basic concept aims to establish a capacity market that is as simple and transparent as possible, but which is also capable of developing and therefore sustainable. There is no doubt that this generates a complicated dichotomy. However, the parametrisation issues which can ultimately be solved in a similar way for all capacity mechanisms provide a sufficiently robust way of dealing with this.

2.3 Implementation

The concept for the implementation of the focused capacity market consists of ten core elements:

1. the establishment of a capacity register to record the existing inventory,
2. the generation of a security of a supply report as part of comprehensive consultation procedures,

3. the development of differentiated capacity products (capacity payments over a specific period) for the two segments of existing plants including controllable loads and newly built plants,
4. the development of differentiated pre-qualification requirements for participating in the capacity auctions,
5. the determination of the capacities for the two segments to be auctioned by the relevant regulation government agency,
6. the auction following the descending-clock method,
7. granting a call option to call the capacities when capacity payments are granted,
8. the unlimited use of the capacities in the energy-only and the balancing power markets, with returns from peak price situations being absorbed by exercising the call option, if applicable,
9. the evidence of providing capacity by documenting bids in the energy-only or balancing power markets or calling controllable loads,
10. shifting the capacity payments (reduced by the returns from exercising call options, if applicable) to the system charges of the transmission network operators.

A crucial requirement for the focused capacity market – and ultimately also for all other capacity-based instruments – is an extensively validated, regularly updated output forecast. The processes used to draft the grid development plan could be used as a model for a 'monitoring and forecast report on security of supply' (security of supply report). The underlying assumptions, methods and results of this plan are all subject to an intensive consultation process along with variation calculations to increase the reliability of the results. The security of supply report could be drafted every two or three years in close connection with the annually produced grid development plan and the associated processes. This security of supply report could be drafted by the body responsible for implementing the focused capacity market or by the relevant government agency. It would have to be approved by the relevant government agency, initiated by the German government and submitted to the *Bundestag* (lower house of the German parliament) for the ministers' information.

A capacity register would have to be drawn up as well as the security of supply report. Although a register should ultimately be created for all generating capacity which feeds into the grid (like the one which already exists for power-generating units using renewable sources), it would make sense to initially set up a register in which existing and new plants (or new-build projects) must be included if they intend to take part in the focused capacity market auctions. The register should include at least the parameters necessary for participation (pre-qualification) in these auctions. Controllable load projects could also apply for inclusion in this register.

The various plant operators or resource providers would also have to state at a certain point that they were taking part in the existing capacity or new-build auction, either when they were voluntarily entered in the capacity register or at a later date. It would make sense to schedule this after the security of supply report has been

commissioned. By registering to participate, operators or resource providers would be obliged to take part in the next auction round for their segment (even if this meant submitting a bid of €0) and be bound by the capacity provision conditions if they were awarded the contract.

When registering for the auctions, the plant operators and project carriers must document that they meet the pre-qualification requirements entitling them to participate in the capacity auction:

1. For existing plants at risk of decommissioning, the required documentation is provided by the annual capacity utilisation in a basic period (which is updated over time). According to the current analyses, an annual capacity utilisation of less than 2,000 hours is a suitable threshold figure indicating that the fixed operating costs can no longer be generated and the threat of decommissioning exists. It does not appear to make sense or be necessary to establish any additional pre-qualification requirements.
2. The project carriers would have to provide the following documentation for new plants:
    a. a confirmed right to use the land on which the new power plant is to be built
    b. approval under public law – i.e. outline planning permission or (partial) approval as per the German Clean Air Act (BImSchG), stating that the project has been fundamentally approved by the planning and pollution control authorities
    c. supply contracts pertaining to key plant components or relevant confirmed options to purchase such parts
    d. proof of a minimum load range corresponding to a maximum of 20% of the nominal load (to prevent new ‘must run’ capacities in the partial load range, too)
    e. proof of cold start flexibility – that plants must be able to reach nominal output within one hour at most following a cold start
    f. proof of a maximum emission value of 600 g CO_2/kWh (on the one hand to avoid the build-up of high-emission new capital stock, and on the other to allow for the use of gas turbines with a bivalent firing system, i.e. gas turbines designed for natural gas and fuel oil).
3. Demand-side measures in the area of controllable load resources must demonstrate that the necessary number of load reductions can be achieved over the required periods in terms of technology and management.

The criteria for participation in the capacity auctions can and will be adjusted over time with respect to the changed basic parameters. This is not a problem in the area of existing plants at risk of decommissioning, nor is there a problem for new plants in view of the longer duration of capacity payments. It would make sense to analyse, consult and perform the adjustments of the pre-qualification requirements in the security of supply report.

Based on the information in the capacity register and an evaluation of the security of supply report, the relevant government agency would determine the size of the auction segments, possibly in conjunction with a forecast for the next two or three years. This would be done so as to ensure that the auction segments were smaller than the total capacity of the registered plants, projects or demand-side measures to a sufficient degree to enable a successful auction to be held. If the security of supply report concluded that there was no need to safeguard existing power plants or build new ones, an auction could be held exclusively for demand-side measures (see below).

If the security of supply report identified a need for the capacity auctions to have a particular regional focus (which could prove especially relevant in the shorter term), this would be taken into account when determining the auction segments. The following products are auctioned off:

- In the auctions for existing plants, existing plants under threat of decommissioning and demand-side controllable load projects can purchase capacity payments for one or four years.
- In the auctions for new plants, new plant projects can bid for capacity payments for a period of 15 years.

The auctions for the existing capacity and new-build segments would be conducted annually by the relevant body or a third party acting on its behalf. It would make sense for the auctions to use a multi-round auction based on the descending clock method so as to limit the cost to consumers:

- The auctioneer opens the first round by offering a starting price for the predefined demand, that is to say, the total capacity being sought. The pre-qualified bidders submit their (capacity) bids for the lot sizes prescribed for the auction (e.g. in multiples of 5 MW in line with the regulations for the balancing power markets).
- If supply exceeds demand in the first round, the auctioneer offers the total capacity volume at a reduced price. The bidders submit new bids.
- This process is repeated until the offers meet the total capacity being sought.

The bidders who are successful in the final round are awarded contracts for the respective capacity payments (see above) and may have to issue a call option to the relevant body.

The relevant body would also call on any controllable load resources which were successful in the auction. At this point, the evidence necessary for capacity provision would also have to be submitted. This could take the form of auditors' certificates, which are required by a number of other energy industry provisions (the German Renewable Energy Sources Act, the German Combined Heat and Power Act, etc.).

If the electricity prices in the energy-only market exceed the strike prices of the call option that were issued, the relevant body calls on the option, basically receives the difference between market and strike price and offsets this income against the total amount of the capacity payments.

The (net) cost of the capacity payments, preparing and conducting the auctions, and processing the documents confirming capacity provision would be shifted to use charges of the transmission networks.

The transmission network operators – specifically, the German Federal Network Agency in its function as regulation government agency – would be the best short-term solution. Last but not least, there is the option of creating new institutions – something which is suggested in the proposals for a comprehensive capacity market in Germany, for example.

As regards the institutional arrangements for the focused capacity market, it remains to be noted that all the tasks can be performed by existing institutions and that the various functions are also simple and robust enough to be adapted relatively easily in a changing institutional landscape.

2.4 The European dimension

European solutions in the area of the capacity mechanisms and capacity markets are often demanded in the debate surrounding the electricity market. Given the realities of the energy-only market, which is integrated across national borders, at least in some regions, this is the right approach in abstract terms, but the necessary institutional framework is not currently in place. For the time being, the responsibility for security of supply remains strictly with the Member States. The introduction of focused capacity markets by national legislators and lawmakers is permitted under European law – and, in view of similar problems, is actively pursued in many of Germany's neighbouring countries.

The question of whether capacity mechanisms are needed will only be answered differently with regard to national, regional or European markets if it is possible to fundamentally rule out the functional deficits of the energy-only market with regard to security of supply. In this case, the European or regional market would secure the necessary investments, but not necessarily within the relevant national borders. However, if the functional deficits are taken seriously, they will materialise throughout the market area. The fundamental question of whether capacity mechanisms are needed would then no longer be raised. Instead, the issue would at most be when to initiate the inescapable creation of these instruments.

Firstly, it must be considered whether the appraisals of the capacity needed to safeguard security of supply in Germany would reach a different conclusion if the possibility of cross-border electricity sharing was incorporated into the analyses.

The analyses of the shortage situations that have occurred so far show clearly that for Germany, the integration of the electricity market has caused more problems than it has alleviated, at least as regards regional security of supply. It is by no means possible to determine whether cross-border electricity sharing makes a positive or negative overall contribution to security of supply. It cannot necessarily be assumed that it helps Germany to safeguard security of supply.

Two conclusions can be drawn from this finding as regards the design and/or parametrisation of the focused capacity market:

- Firstly, there is no doubt that a much stronger focus must be placed on the cross-border component of the shortage analysis. However, access to the relevant instruments and liaison procedures is as yet incomplete, not least in terms of cross-border dialogue.
- Secondly, however, the shortage situations seen to date and capacity trends in neighbouring countries could be said to justify the conclusion that Germany needs to ensure it has sufficient national capacity to meet national load peaks – at least as a starting point – and that there may be demand for export capacity on top of this.

Both aspects therefore need to be considered in depth as part of the security of supply report, which must identify the key volume-related requirements for the focused capacity market instrument.

In addition to the volume aspect of the focused capacity market (i.e. the definition of the existing capacity and new-build segments for the auctions), the question must be considered as to whether foreign power-generating capacity can be permitted to bid in the respective auctions:

- In the new-build segment at least, bids from foreign providers could be permitted for power stations which are operated in a single price zone (this currently affects Germany, Austria and Luxembourg), provided that this does not go against the pre-qualification requirements, e.g. regarding localised power plants in certain network areas.
- To be sure, it would generally be possible to grant this kind of approval for power stations operated outside the single price zone. However, for the time being this is probably out of the question due to the limited transmission capacity and in view of the necessarily firm reservation of these transmission capacities and the consequences resulting from this for electricity trading.

The introduction of a capacity mechanism such as the focused capacity market is legally permissible for Germany and could be effected comparatively robustly and quickly using the procedures outlined above. However, it is very important that capacity mechanisms be harmonised across national borders for several reasons (efficiency, distribution effects, system consistency, etc.).

Attempts to bring about harmonisation of this kind face a whole host of challenges, however. Firstly, capacity mechanisms must take effect – especially as regards real investments – within a limited space of time. If there is a further delay in implementing capacity mechanisms lasting several years, Continental Europe's electricity market at the very least will face considerable challenges in terms of safeguarding capacity, and political ad hoc solutions will be more likely to be implemented to a considerable extent. Secondly, political measures (especially in France) are already so well advanced that attempts to harmonise the capacity market models would mean that far-reaching

changes may have to be made to an already existing system. This would pose considerable political barriers to harmonisation.

Four conclusions can be drawn from this situation concerning the options for harmonisation (which is worth striving for):

- Harmonisation efforts will only succeed if they are initiated relatively quickly.
- Harmonisation efforts should concentrate primarily on regional markets which already have a high degree of integration and not on an EU-wide approach.
- Harmonisation efforts could initially focus on a few key elements of the chosen capacity mechanisms, e.g. the volume targets set for the relevant systems (taking reliable assumptions for the role of cross-border electricity deliveries into account).
- Although capacity mechanisms may initially be introduced separately in individual countries in the face of rising pressure to act, they should be flexible enough to be able to be incorporated into integrated models at a later date. In other words, neither highly complex capacity mechanisms which are difficult to adapt (such as comprehensive capacity markets) nor very restrictive solutions (such as those proposed under the strategic reserve) should be introduced, which would ultimately require capacity to be excluded from the energy-only market.

As the instrumental and procedural framework for EU-wide activities will probably make it difficult to take action in this way, an approach at regional market level might make sense. The Pentalateral Energy Forum established in 2005 for North-Western Europe's regional market (Germany, France, The Netherlands, Belgium, Luxembourg and, since 2011, Austria) has proved successful in the past when it comes to gradually linking and integrating markets.

An initiative could be rolled out at relatively short notice under the aegis of the Pentalateral Energy Forum with the following prime objectives:

- Agreeing on a procedure for delimiting cross-border electricity deliveries in the context of assessing the individual countries' security of supply in an appropriate, sufficiently robust fashion.
- Creating a consistent set of data and jointly assessing security of supply.
- Signing agreements about harmonising central functions of the chosen capacity mechanisms.
- Establishing processes for mutual inclusion in the capacity mechanisms created in this way.

Given that time is at a premium (as regards both the security of supply discussion and developments in neighbouring countries), initiatives of this kind should be pursued at the same time as making the necessary preparations to establish a focused capacity market.

2.5 A possible timescale

The time frame for the introduction of a focused capacity market depends on both the material need to act (i.e. the necessity to support existing plants and new investments) and the number of implementation measures and processes involved. In light of this, an illustrative timescale could be conceivable:

- Autumn 2012/early 2013: Examining the question of whether a capacity mechanism is fundamentally necessary and considering the elementary issue of whether it is prudent and/or necessary to exclude plants which receive capacity payments from the energy-only market (as proposed in the strategic reserve model).
- Throughout 2013: Extensive discussion about the instrument's fundamental design and key parameters, consultations as part of the Pentalateral Energy Forum if applicable.
- November 2013: Incorporating a pledge to introduce a focused capacity market into the coalition agreement.
- Mid-2014: Establishing the legal framework via an amendment to the German Energy Industry Act.
- Autumn 2014 to summer 2015: Drafting the 2015 security of supply report in conjunction with the 2015 grid development plan, establishing the delegated legislation, setting up the capacity register.
- Autumn 2015: Approving the security of supply report, giving notice of auction participation to the capacity register.
- Late 2015/mid-2016: First auction for the existing capacity and new-build segments (stronger regional focus possible for the latter).
- Early 2016/2017: First capacity payments to existing plants and/or controllable load resources, final investment decisions by successful bidders in the new-build segment.
- Mid-/late 2017, 2018, etc.: Further auctions for the two segments of the focused capacity market.
- Throughout 2019/2020: Going live with the first new plants to generate income from capacity payments.

Even this relatively ambitious timetable shows that the time-frame for introducing a capacity mechanism is already very tight (ultimately in all its forms) if a solution is to be found within this decade to support the power plants under threat of decommissioning and if new investments are to create capacity which can go into production at the beginning of the next decade. However, it also becomes clear that it may be necessary

to find alternative solutions for the period up to 2016/2017, especially to safeguard existing plants.

2.6 Placing the focused capacity market in context

Based on the current state of the informed debate in Germany, the fundamental necessity of incorporating capacity instruments into the current energy-only market and the scheduling of such mechanisms is (still) a contentious issue. Even so, concrete models for instruments are now being discussed that take capacity management into account and which are competitive in nature.

Among these, two mechanisms play an important role (with a number of possible secondary alternatives in each case) which represent two radically different starting points and can therefore be used for a comparison with the focused capacity market:

- Comprehensive capacity markets are mainly based on a uniform tendering process for the total capacity being sought. As a result, all power plants that are successful in the auction and are active in the energy-only market without any further limitations receive a capacity payment which is calculated from the uniform market clearing price of the capacity auction.
- The strategic reserve model basically rests on a tendering process for a capacity payment for backup power plants from the stock of existing or new plants, if necessary, which may not now or in the future ('no way back') participate in the energy-only market and may only produce in emergency situations when the security of supply is threatened.

The comparison of these two capacity instruments yields the placement – shown below – of the focused capacity market along the (selected) criteria of cost of implementation and scope of implementation, regulatory risks, adaptability and reversibility, distribution effects and cost to the consumer, macroeconomic efficiency as well as capacity to learn and sustainability.

At first glance, it would appear that the steps for specifying the market segments relevant to each model are essentially the same in each case:

- For a focused capacity market, a benchmark must be defined for the total capacity needed in order to guarantee security of supply (including cross-border electricity flows), preferably in agreement with the neighbouring states or the countries in the same regional market. This step is also necessary for all other capacity instruments and should be implemented with the same transparent procedures.
- Both for the focused capacity market and the strategic reserve model, the target segments for the capacity instrument in question have to be specified. The expenses incurred for this would likely be the same in both cases.

There is ultimately no difference between the models in terms of the awarding procedure, with the vast majority of the known proposals for capacity instruments being based on descending-clock auctions. Naturally, market liquidity is highest in the case of comprehensive capacity markets (assuming there is no further segmentation) and lowest in relation to the strategic reserve model, while the focused capacity market falls somewhere between the two, with the explicit integration of demand-side measures being able to considerably contribute towards increasing liquidity.

Qualitatively speaking, complying with the obligations is very similar in each case, but entails a larger basic total of plants in the case of the focused capacity market and the comprehensive capacity markets, and is therefore (somewhat) more expensive by definition.

In terms of lead time, a realistic consideration of all the implementation steps suggests that there will ultimately not be any significant differences between the different models (comprehensive or focused capacity market, or strategic reserve).

There are regulatory risks involved in all of the proposed capacity instruments. While these first and foremost arise as a result of system parametrisation in the case of the comprehensive and the focused capacity market and can be handled in the form of procedures which are as robust as possible, the regulatory risks pertaining to strategic reserve above all relate to the operational stage (approval of capacities above and beyond shortage situations that can no longer be remedied via the markets, watering down of the 'no way back' principle). Based on all the experience gained in comparable situations, these specific risks of the strategic reserve are therefore characterised by a very situational component and are far more difficult to contain.

Ultimately there is adaptability in all of the models. The comprehensive capacity markets that already exist (such as in the USA) have been modernised time and again, and the segmented capacity instruments that have been implemented so far have likewise in effect been adapted again and again as and when needed. In comprehensive capacity markets, such adaptations are more costly due to the full recording of plant capacities. The cost of adaptations is also not marginal in the case of segmented sales such as in a focused capacity market or with strategic reserve, but the adaptations to be made to the system tend to be less complex, and to some extent the necessary adaptations can also be integrated into the system on the basis of rules.

The question of reversibility has to be evaluated in context. In the case of comprehensive capacity markets that continuously generate income for capacity for the entire power plant fleet, the abolition of this pricing mechanism constitutes an economic shock, the consequences of which are difficult to estimate – not even their direction can be forecast. However, if the introduction of a capacity market is founded on the presumably reliable assumption that energy-only markets are not a sustainable basis for the development of the power supply system, reversibility is not a crucial analysis dimension.

In contrast, the various strategic reserve models are explicitly defined as transitional models until the long-term efficiency of energy-only markets in terms of security of supply, etc. has been determined. Regardless of when the uncertainties regarding the overall portfolio's relevant determinants (CO_2 and fuel prices, the development of the

plant market, the characteristics of the expansion of renewable energies, the development of the European environment, etc.) allow for a sufficiently robust evaluation, more in-depth consideration has to be given to the parameters for the abolition of the strategic reserve instrument. If the strategic reserve remains very small (which is not all that likely based on the current developments), only existing plants are recorded and the 'no way back' approach can be maintained even after the instrument's abolition ('never go back'), the consequences of an abolition would be minimal if constellations came about in the energy-only market that guaranteed sufficient contribution margins for the maintenance of security of supply. If, however, one or more of these prerequisites are not necessarily the case, an abolition would cause a system shock here too, e.g. if a sizeable proportion of the capacities of new plants could, for legal or political reasons, move from the specified strategic reserve to the energy-only market in the event of this instrument being abolished.

In terms of reversibility, the focused capacity markets model is probably the most robust option. Existing plants under threat of decommissioning are handled separately. If the threat of decommissioning were to dissipate, this would result in a price close to zero in the auction, thereby giving an empirically proven signal of the no longer existing necessity of capacity payments. In other words, even if the capacity instrument is abolished, these payments are continued and there will therefore be no change in the situation if the capacity payments over multiple years are secured for new plants. If, then, the energy-only market proves to be sufficiently efficient in the long term in contrast to the fundamental assessment presented in this study, the abolition of the focused capacity market would not trigger a system shock that would seriously stand in the way of such a reversal of the capacity instrument.

Just like the energy-only market, all of the capacity instruments have distribution effects. We need to distinguish between the mechanisms in the case of the especially important distribution effects between the producers and consumers:

- the direct cost of capacity payments, and the
- the indirect (differential) cost effects in the energy-only markets.

An assessment of the distribution effects between the producers and consumers must take the net effect of both mechanisms into account, as a selective approach does not deliver meaningful results:

- Based on equal capacity requirements for safeguarding the security of supply, comprehensive capacity markets generate the highest level of capacity payments, firstly because they apply prices to the entire power plant fleet (volume effect) and secondly, because a standardised auction results in a relatively high price based for a longer term on the capacity payments necessary for new plants (price effect). On the other hand, price peaks caused by shortages are avoided in the energy-only market.
- Strategic reserve probably generates the lowest capacity payment costs, because the segments of the power plant fleet that enjoy capacity payments will likely be limited – even though the total figure very much depends on the actual design of this capacity instrument (old plants versus new plants or a

hybrid model). However, strategic reserve causes price peaks in the energy-only market – this being the purpose of the model – that are necessary for economic viability of new power plants but also apply to the entire market volume and which therefore have a considerable leverage effect and result in significant knock-on effects among the already profitable existing power plants. In total, the price effects thus generated (and ultimately aimed for) in the energy-only market will be considerably greater than those of the capacity payments.

- In all probability, the focused capacity market comprises a larger capacity volume than strategic reserve, but will more than likely remain well below that of the comprehensive capacity market. By differentiating between existing plant and new plant segments, the above-mentioned price effect of the focused capacity market is much reduced. With comparable security of supply levels, the price effects in the energy-only market are identical to those of the comprehensive capacity market model.

The net cost effect of the focused capacity market would therefore almost certainly be below those of the two other models, as there would undoubtedly be inefficiencies that arise from the regulation-based splitting of the market for existing plants under threat of decommissioning and the necessary new plants in comparison to a uniform market, but they are hardly likely to reach a level that could offset the differences in relation to the other cost components.

This also fundamentally applies to the evaluation of (macroeconomic) efficiency, which initially overlooks distribution effects and focuses on optimising the system costs. The static efficiency (at a given point in time) is comparatively easy to model and evaluate. As far as dynamic efficiency is concerned, in other words the optimum system costs over time, the evaluation is heavily dependent on the assumptions and expectations regarding the economic and political parameters and on the specification and parametrisation of the capacity instruments. However, theoretical deliberations suggest that operation and investment decisions that take into account the shortage signals of the energy-only and the capacity market and that above all directly address the demand side lead to results that are more beneficial in the light of dynamic efficiency. In view of this, there can therefore certainly be efficiency advantages not only for the comprehensive capacity market, but very likely also for the focused capacity market. Finally, however, it should be noted that, for various reasons, it is difficult if not impossible to identify reliable evidence of real efficiency advantages.

The learning aptitude of the various capacity instruments goes hand in hand with their potential contributions to restructuring the power supply system in favour of renewable energies. Among other things in the light of the underlying approach of ‘one goal – one instrument’, the strategic reserve and comprehensive capacity market models are designed exclusively with security of supply in mind. The challenges in relation to safeguarding flexibility in power supply systems with a high proportion of variable renewables and regarding the accumulation or maintenance of a carbon-intensive capital stock, are therefore delegated to the spheres of action of other instruments.

In contrast, the focused capacity markets model explicitly incorporates the challenges relating to the flexibility requirements of new power plants and the climate policy restrictions of new-build plants, and addresses these issues with comparatively straightforward regulations. This capacity instrument therefore constitutes a solution which is compatible with the concept of capability markets which mostly aims at extensively incorporating the demand side as well as being specifically directed at flexible supply offers.

Seen as a whole, the focused capacity markets instrument has a large number of design effects and therefore has more in common with the model of comprehensive capacity markets, while also endeavouring to incorporate various regulatory advantages of the strategic reserve model. Considering the various dimensions of analysis discussed from a qualitative perspective here, the focused capacity markets model generally occupies a very positive position on the spectrum of models.

As a result, the focused capacity market constitutes a pragmatic and, compared to the models of a comprehensive capacity market and a strategic reserve discussed up to now, a very advantageous instrument for tackling the current and foreseeable challenges with regard to security of supply. At the same time, however, a focused capacity market can also make a substantial contribution to flanking the transformation of the energy system to one based on renewable energies and maintaining a high intensity of competition in the electricity market while substantially limiting the costs for electricity consumers.

Download of the entire study

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