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Necessity of and Design Options for a Capacity Mechanism for Germany

Interim report

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Translation from German

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Summary

This short report for the Federal Environment Agency provides an overview of the proposals for the design of capacity mechanisms that are currently being discussed and assesses the ones that are relevant for policymaking in terms of their effectiveness as well as their possible impacts on the market.

The German power market currently faces challenges related to the phase-out of nuclear power plants, the integration of renewable energies and the creation of the EU internal power market. Due to the current level of power prices, some stakeholders are concerned that the security of supply could be threatened in the foreseeable future. The low prices may provide insufficient incentives to retain existing power plants as well as to invest in new power plants.

Studies are built on different assumptions

A number of recent studies have highlighted the challenges that will need to be faced in the years to come from different perspectives. Fundamentally, there are two questions that need to be addressed: whether security of supply should be pursued at the national or European level; and whether the existing energy-only market will function in the future or if a market failure is to be expected. In energy-only markets power plant operators only get paid for their energy provided, and not for their capacity. Some studies focus on generation-side measures to deliver security of supply and assume that consumers are hardly able to respond to price signals of the wholesale market. Others argue that the price-setting of demand is already possible today and therefore classify the energy-only market as, in principle, well-functioning. As a consequence, in their assessments of security of supply, they take the consumers' willingness to pay as a possibility for temporary reduction of demand.

Capacity mechanisms under discussion: strategic reserves and security-of-supply contracts

Two different approaches to secure supply emerge from the studies that discuss the need for capacity mechanisms: strategic reserves (Consentec, 2012 and r2b, 2012) and comprehensive capacity markets based on security-of-supply contracts (EWI, 2012). The strategic-reserve concept serves as insurance for an energy-only market that is functioning well, at least over the medium term. Comprehensive capacity markets of the kind envisaged by the security-of-supply-contracts concept would be founded on one of two assumptions: either that the energy-only market is failing and power plants require additional revenues in order to operate economically; or that, although the energy-only market is functioning well, insufficient capacities are being installed in Germany to achieve security of supply at national level. If it is determined that a comprehensive capacity market is needed, strategic reserve could also be implemented as a transitional step to give an appropriate amount of time to develop a comprehensive capacity market.

Discussion of the actions needed

To provide a rationale for the recommended action, BET (2011), Consentec (2012) and EWI (2012) use quantitative model calculations. The contribution margins they calculate are not sufficient to finance investment in power plants or the operation of some existing power plants required to assure national security of supply. However, these calculations raise issues that need to be discussed from a methodological perspective. Capacity targets are set in the power market models. Subsequently, these capacities are assessed on the basis of short-term marginal cost prices without any other options (e.g. price mark-ups or demand response) being available in the models, which allow prices to be set above the variable costs of the last dispatched power plant. There are many discussions in the energy-economics literature on the fact that short-term marginal cost prices translate into a "missing money" problem. As a market solution, prices above short-term marginal costs are possible during scarcity events in the context of what is known as peak-load pricing (e.g. the setting of prices by means of demand response), which is not taken into consideration in the models specified. The results of these quantifications are therefore useful for determining the need for peak-load power plants or demand response, but less suitable for discussing the missing money problem or the need for capacity mechanisms.

One central issue is whether the existing energy-only market will function in future or if a market failure is to be expected. As far as the power market is concerned, security of supply means that supply and demand find an equilibrium and send a price signal. Empirically, there has been no evidence to date for a market failure in the medium term. Nor does economic theory suggest a failure of the energy-only market is to be expected. However, it cannot be completely ruled out ex ante from a long-term perspective.

Foreseeable developments will enhance the functioning of the energy-only market

The reasons for a potential market failure addressed in some studies, in particular the low elasticity of demand, will tend to weaken rather than strengthen in the near future. The flexibility on the demand side will increase – potentially in the near future – due to the increase of demand response measures such as the increased use of smart meters, smart grids and electric cars. According to calculations by Consentec (2012) and r2b (2011), which are based on the Federal Network Agency's *Monitoring Report*, more than 30 GW of consumption are real-time measured. Furthermore, major consumers are already active in the spot and balancing markets today. On the supply side, at least some of the previously out-of-market feed-in is now subject to price signals thanks to the increasing use of direct market participation for renewable energies. Furthermore, in situations of increasing scarcity the development of additional capacities becomes more attractive, so that other available options such as standby generators can also be activated in the market. As a result, there will be a reduction in demand for conventional generation capacity while market mechanisms in the energy-only market are strengthening. With regard to the construction of additional power plants, the investors' current reluctance is also to be interpreted as the efficient functioning of the market. The scaling-back of overcapacities in Germany at the beginning of liberalisation was indicative of inefficiencies in fields that had not previously been organised via markets. At the same time, it is expected that more than 12 GW of new power generating capacity will be commissioned in the next three years, while just 6.6 GW will be decommissioned.

Strategic reserve would allow safeguarding against extreme situations

A strategic reserve would allow safeguarding against short-term market imbalances caused by rare and extreme situations, and ensure the goal of national security of supply, which may be desired for political reasons. The strategic reserve could be deployed quickly, either by new gas turbines or by contracting existing gas and coal power plants which would otherwise be decommissioned due to economic reasons. The power plants within the strategic reserve would not participate in the power market, but only be utilized in the case of a capacity deficit. Financing these power plants could be organised via a recovery in the grid charges. The power market remains unaffected. Market-driven responses to existing and future challenges would be made possible efficiently by strategic-reserve approaches. Due to its conceptual similarity to the existing balancing markets, a strategic reserve could, where necessary, be integrated into the existing market design and the current regulatory policy framework with comparatively low regulatory risks. The example calculations, which suggest the need for a 4-GW reserve, arrive at annual costs of between €140m (Consentec, 2012) and €242m (r2b, 2012). The costs for the end consumer would be moderate and would amount to less than 0.1 cents per kilowatt hour if they were recovered in the form of grid charges.

Partial capacity markets are inefficient and do not guarantee security of supply

Partial or selective capacity markets that only incentivise individual elements of the power market would lead to neither an increase in security of supply nor an efficient solution. Since they would promote individual elements of the power market, they could distort market results. As a consequence, for example, existing power plants might be forced out of the market.

Implementation of security-of-supply contracts would raise efficiency and distribution issues

The security-of-supply-contracts approach put forward by EWI (2012) could be an effective option to guarantee security of supply, e.g. where a failure of the energy-only market was to be expected. In this approach, besides the existing energy market, there is a new market for capacity, which increases the revenues for the construction and operation of power plants. In this capacity market power plant operators receive additional revenues for the provision of secured capacity. The costs of this capacity market would be passed on to the consumers. A comprehensive capacity market has large regulatory risks. A preparation time of about seven to ten years is needed for its implementation (this includes the tender process of five to seven years and an additional two to three years for implementation of the market design). This approach would be less suitable for short-term or regional challenges. In its implementation, attention should be paid to ensure that its design permits as many options as possible (demand response measures, in particular). To a great extent, its efficiency depends on the details of its implementation, since for example, the proposed minimum and maximum prices in the markets in question could create considerable inefficiencies and distribution risks. The scale on which the demand side was incorporated into the call for bids would also have a major influence on the efficiency. The secure long-term planning environment necessary for new power plants and the short-term planning for potential demand response measures would pose challenges when the auction was issued. If this approach were implemented, there would be a danger of greater attention being paid to distribution aspects than to effectiveness and efficiency. The

potential market volume is considerable: Under the approach taken by EWI, the expected value of the auction would be €4.5bn to €5.8bn a year, since it would include the whole capacity of Germany's fleet of conventional power plants.

Comparison of a strategic reserve and security-of-supply contracts

Compared to a theoretically efficient solution of a functioning energy-only market, it is found that a strategic reserve would suffer systematically low efficiency losses due to its additional power plant capacity, as well as low efficiency risks. Security-of-supply contracts would involve considerable efficiency risks because of the various interaction effects during the process when the security-of-supply contracts were formulated in practice.

If there was a functioning energy-only market – from both the European and national perspectives on security of supply – there would be no expectation that the overall economic cost of the security-of-supply contracts solution would be lower than that of a strategic reserve, because a system with more generating capacities has higher costs. Also for the end customers, the security-of-supply-contracts approach would not necessarily be more cost-effective than a strategic reserve, since the capacity payments would be passed on to consumers on top of the wholesale prices.

In the interests of environmental compatibility, the mechanism should support long-term energy and climate-policy targets. This would be ensured if it were compatible with the instruments relevant for the achievement of those targets and facilitated the integration of renewable energies. Against this background, elasticity of demand is as important as flexibilities in the fleet of power plants for balancing variable renewable energies. The security-of-supply-contracts approach would raise the expectation that the energy-only market would be considerably influenced, in particular with regard to the flexibility of demand. There would therefore be a danger of a failure to put in place the flexibility incentives required to effectively and efficiently integrate large market shares of renewable energies into the system.

Current functioning of the energy-only market does not justify a profound regulatory intervention

Since at present there is insufficient indication that the energy-only market cannot overcome the challenges it currently faces, a profound regulatory intervention in the form of a comprehensive capacity market with security-of-supply contracts involves significant and unnecessary regulatory risks. Furthermore, the introduction of comprehensive capacity markets would be practically irreversible because they would be intended firstly to encourage investment decisions that are tied to very long-term contracts and secondly to make future new investments unacceptable without capacity payments for market participants. There would be a danger that the design of the whole power market, including the pricing-setting on the wholesale market, would have to be fundamentally modified as a consequence of the introduction of a system of this kind. It is probable that inefficient design would result in high consequential costs.

From the present point of view, the potential for innovation and efficiency of the energy-only market should be preserved or strengthened over the short, medium and long term. If it is perceived that there is a danger of a market failure of the fundamentally efficient energy-only market over the long term, the primary aim should be to remedy the causes, e.g. by expanding elasticity of demand,

instead of treating the symptoms, e.g. by replacing missing contribution margins for the construction of new power plants with capacity payments.

A strategic reserve: an easily established, cost-effective insurance

In this context, a strategic reserve could take on the role of a form of insurance for the functioning of the energy-only market. Such a strategic reserve would be relatively easy to implement, cost-effective and reversible. If in the future conditions change, the strategic reserve could be removed. In order to take advantage of the integrated internal market, this system could just as easily be further developed into a European mechanism. Apart from this, if there was an expectation that the energy-only markets were going to fail, it would be possible to develop it further into a comprehensive capacity market, as envisaged by the security-of-supply-contracts approach.

Prospects

The studies under discussion have made valuable contributions to the identification of challenges that will be encountered by Germany's energy system in its transformation. They indicate the range of regulatory options that is available. If the energy-only market were to fail, the discussion in the studies would offer important indications for initial moves to further develop the system towards a comprehensive capacity market, such as the security-of-supply-contracts approach put forward by EWI (2012). However, the introduction of a deep regulatory system in the near future does not appear to be necessary at the moment. For instance, in the press release on their study, EWI themselves state that there is no immediate need for action to introduce a mechanism of this kind.

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Contents

1 Introduction and motivation

This short report for the Federal Environment Agency gives an overview of the proposals for the design of capacity mechanisms that are currently being discussed and assesses their effectiveness in achieving the goals that are being pursued, as well as their possible impacts on the market.

The German power market currently faces challenges related to the phase-out of nuclear power plants, the integration of renewable energies and the creation of the EU internal power market. Because of the current level of power prices, some stakeholders are concerned that the security of supply could be threatened in the foreseeable future. The low prices may provide insufficient incentives to retain existing power plants as well as to invest in new power plants.

This report analyses a series of studies on the need for governmental intervention in the current German market and regulatory design, in the form of introducing capacity mechanisms. Two concrete design proposals are subsequently assessed, by applying economic criteria. A major driver in the discussion of capacity mechanisms is the uncertainty about the proper functioning of an energy-only market. For this reason, this report also discusses the extent to which there are signs of a possible market failure,[1] i.e. the structural incentives for investment might not be sufficient to ensure equilibrium of supply and demand in the power market at all times.

Empirically, there has not yet been any evidence of a market failure in the medium term, and economic theory does not foresee any imperative reasons why a market failure should be expected. From the long-term perspective, however, the possibility of a failure also cannot be completely ruled out ex ante. The scaling-back of overcapacities in Germany at the beginning of liberalisation was indicative of inefficiencies in fields that had not previously been organised via markets. The current reluctance to invest can also be understood as evidence that the market is functioning, since no additional capacities should be built up at times of overcapacity (Haucap, 2012).

The main rationale for the discussion of capacity mechanisms is the effective and efficient availability of security of supply within the current regulatory policy framework. However, security of supply is defined in various ways. While some studies assume generation-side security of supply, other studies take consumers' willingness to pay (e.g. demand response) into account. Another discussion is about the perspective on security of supply: Is it being pursued nationally or is the European interconnection considered? These issues are major drivers behind the recommended actions and could influence the results considerably. Therefore they should also be discussed at the policy level.

[1] In the context of this analysis, the proper functioning of markets is limited to the question of an efficient level of security of supply, i.e. a sufficiently high probability that supply and demand will be in balance (see also section 4).

Two proposals emerge from the large number of concepts:

- A strategic reserve, proposed for situations in which the energy-only market is functioning in principle, but needs an insurance to cover possible short-term market imbalances. This would be needed during the transition to an EU internal market with rising shares for renewable energies or to ensure security of supply on a national level. If comprehensive capacity markets were needed, the strategic reserve could also serve as a transitional solution to give an appropriate amount of time to develop a comprehensive capacity market. The strategic reserve could be deployed quickly, either by new gas turbines or by contracting existing gas and coal power plants which would otherwise be decommissioned due to economic reasons. The power plants within the strategic reserve would not participate in the power market, but only be utilized in the case of a capacity deficit. Financing these power plants could be organised via a recovery in the grid charges. The power market remains unaffected.
- Comprehensive capacity markets, e.g. realised by security-of-supply contracts, are founded on one of two assumptions: either that the energy-only market is failing and power plants require additional revenues in order to operate economically; or that, although the energy-only market is functioning, insufficient capacities are being installed in Germany to achieve security of supply at the national level. In this approach, besides the existing energy market, there is a new market for capacity, which increases the revenues for the construction and operation of power plants. In this capacity, market power plant operators receive additional revenues for the provision of secured capacity. The costs of this capacity market would be passed on to the consumers. A comprehensive capacity market has large regulatory risks. A preparation time of about seven to ten years is needed for its implementation.[2]

In this context this short report is structured as follows: An introduction in this section is followed by a comparison of several recent studies, identifying two concepts for capacity mechanisms that are currently being discussed. In the third section, the effectiveness of these two approaches is evaluated in the light of current circumstances. The fourth section considers the possibility of a failure of the energy-only market. The fifth section sets out recommendations for action.

[2] EWI (2012) suggests an auctioning timeframe of five to seven years. In order to start the first auction, a legislative foundation is required accompanied by an exact market design. Between two and three years are assumed for this.

2 Recent developments in the discussion

Various recent studies have investigated the necessity for and possible designs for capacity mechanisms in Germany. The following studies are taken into consideration in this short study:

- Cramton and Ockenfels (05/2011), commissioned by: RWE AG
- Frontier Economics (07/2011), commissioned by: RWE AG
- BET (09/2011), commissioned by: Federal Association of New Energy Suppliers (BNE)
- r2b (10/2011 and 03/2012), commissioned by: Federal Environment Agency (UBA)
- LBD-Beratungsgesellschaft mbH (11/2011), commissioned by: Ministry of the Environment, Climate Protection and the Energy Sector Baden-Württemberg
- Düsseldorf Institute for Competition Economics (DICE) (2011), commissioned by: RWE AG
- Consentec (02/2012), commissioned by: EnBW AG
- Institute of Energy Economics at the University of Cologne (EWI) (03/2012), commissioned by: German Federal Ministry of Economics and Technology (BMWi)

Brief descriptions of the studies can be found in the Annex. This section compares the methodologies and main results. The concrete designs proposed for capacity markets that are currently of relevance to the policy discussion are explained in greater detail in subsection 2.2 in order to lay a foundation for the discussion of the proposals that follow.

2.1 Discussion of the assumptions and results of various studies

To a certain extent, the studies are based on different parameters and assumptions, and adopt different priorities in their analyses. As a consequence, they also arrive at contrasting results. The opinions expressed concerning the parameters of the discussion diverge with regard to the following points, among others:

- Functioning energy-only market or proven market failure
- National or EU-wide security of supply
- Urgency of the need for action

These parameters cannot be assessed conclusively in the context of this short study. Some of the fundamental parameters and the results of various studies are juxtaposed and discussed below.

Functioning energy-only market or proven market failure

Central issues for the studies under examination are security of supply and the possibility of a market failure of the energy-only market. As far as the definition of security of supply is concerned, apart from its geographical delimitation, (sometimes implicit) assumptions are also made about the market actors responsible. For the power market, security of supply means that supply and demand always have to match up. For instance, r2b (2011) state that security of supply requires a market price at all times. This market price incentivises appropriate investments. When identifying missing market incentives on the generation side, BET (2011), Consentec (2012) and EWI (2012) base their calculations on the marginal costs of the last unit dispatched. They draw on this approach to explain the necessity of a capacity mechanism intended to guarantee national security of supply.

The academic literature shows that a 'missing-money' problem inevitably arises when prices are set exclusively on the basis of short-term marginal costs, i.e. without consideration of price-setting by the demand side (see e.g. Stoft, 2002). As a solution when scarcity events occur, prices above short-term marginal costs are possible in the context of what is known as peak-load pricing (e.g. price mark-ups or prices set by demand response), which is not taken into consideration in the models mentioned. The results of these quantifications are therefore useful for determining the need for peak-load power plants or demand response, but less suitable for answering questions about the missing money problem or the need for capacity mechanisms. Consentec (2012) and EWI (2012) take up this discussion in qualitative terms and point out that it is certainly possible for situations to arise on the energy-only market in which the marginal utility of demand has a price-setting effect. r2b (2011/2012), DICE (2011) and Cramton/Ockenfels (2011) follow the same argument.

In reality, there is only limited price elasticity at present, but r2b (2011) point to a large number of supply and demand-side options that could be activated if there were corresponding price signals, and that have merely not yet been activated because of overcapacities and the resultant prices, which make demand response largely unattractive. Nevertheless, demand is currently elastic within certain limits. For instance, EWI (2012) point out that some major industrial consumers have been participating actively in the spot and balancing power markets for some time now. At the same time, EWI (2012) express doubts that making demand flexible with demand response will be enough over the medium term to ensure the market-driven delivery of security of supply – at least at the national level. Other studies, such as Consentec (2012) and r2b (2011), put forward the view that there is, in principle, sufficient potential on the demand side.

National or EU-wide security of supply

Apart from the identification of the relevant actors, it is of fundamental significance whether security of supply is defined at the national or European level. BET (2011) and EWI (2012) primarily discuss national security of supply. Consentec (2012) put forward different recommendations for action depending on the level at which security of supply is defined. If the objective is national security of supply, the necessity of a comprehensive capacity market is regarded as evident because a functioning energy-only market may incentivise sufficient capacity within the European framework, but will not guarantee the desired regional distribution. For this reason, there is a possibility that

sufficient capacity to ensure security of supply would be present within the European framework, but the additional target of being able to secure a country's load with national capacities at all times would not be achieved. Consentec (2012) see a need for comprehensive capacity markets to ensure the additional capacity that might then be required is provided efficiently. By contrast, if the objective is European security of supply, Consentec (2012) argue that it is not necessary to intervene, provided that the energy-only market is functioning. The fundamental decision whether security of supply should be pursued at the national or European level is left to policymakers. By contrast, DICE (2011) advise against the introduction of a comprehensive national capacity market because a mechanism of this kind could lead to free-rider behaviour of other countries. They argue a comprehensive capacity market could only be introduced at the European level. DICE (2011) and r2b (2012) aim for a solution that could guarantee national security of supply and be compatible with the European internal market. Both come to the conclusion that, of the capacity mechanisms under discussion, a strategic reserve would be most likely to fulfil this condition because it would not influence the power market to any significant degree and could be removed again without market distortions if it ceased to be required. Consentec (2012) also regard the strategic reserve to be expedient as a transitional solution on the way to a European internal market. LBD (2011) are concerned primarily with regional security of supply.

Necessity of action

Frontier Economics (2011), DICE (2011) and r2b (2011/2012) see no short-term need for action to introduce a capacity market because the current challenges have been caused either by short-term policy measures (the phasing-out of nuclear power plants) or are local in nature (the situation in southern Germany). Consentec (2012) make the need for action dependent on the geographical definition of security of supply. With regard to national security of supply, Consentec (2012), like BET (2011) and EWI (2012), come to the conclusion that a capacity market should be introduced. r2b (2012), DICE (2011) and Consentec (2012) recommend that a strategic reserve be used (at least provisionally) to ensure the goal of national security of supply is attained, although, particularly according to r2b (2012), only if the need is proven. In the variants proposed by r2b (2012) and Consentec (2012), it would primarily function as an insurance if market clearance was not possible on the power market in the short term.

In spite of their differing assessments of capacity mechanisms, the studies discussed are not contradictory in principle. For instance, the study by EWI (2012) assumes a missing money problem for new power plants, so that a permanent solution in the form of comprehensive capacity markets would be preferable to a strategic reserve. By contrast, DICE (2011) and r2b (2011, 2012) see no fundamental missing money problem on the energy-only markets at present and no threat to security of supply on the European internal market, and therefore plead for a strategic reserve as an insurance if this is needed.

2.2 Explanation of the fundamental approaches

Two approaches to capacity mechanisms taken from the current policy discussion are set out below. They have different rationales and are based on different assumptions. The approaches in question are a strategic reserve, with two designs proposed by r2b (2011, 2012) and Consentec (2012), and security-of-supply contracts based on the description by EWI (2012) as a proposal for the implementation of a comprehensive capacity market.[3]

2.2.1 Strategic reserve

One of the main assumptions concerning the strategic reserve adopted in the analyses by r2b (2011, 2012), DICE (2011) and Consentec (2012) is that the energy-only market is functioning well, at least over the medium term. In the proposed designs, the strategic reserve constitutes a form of insurance against involuntary rationing of supply due to short-term market imbalances (e.g. extreme situations) or a form of insurance for achieving national security of supply. Capacity would be both procured and dispatched solely in exceptional situations and when there was a proven need for measures of this kind. A strategic reserve could serve additionally to ensure that price signals were received on the market in scarcity situations. The goal of a strategic reserve would be to maintain the efficiency and innovativeness of the market – even in extreme situations. Since a strategic reserve could be built up relatively rapidly, if there is a need for comprehensive capacity markets it could also be a transitional solution to give an appropriate amount of time to develop a comprehensive capacity market.

Under a strategic-reserve system, a certain amount of generating capacity prescribed by the administration would be kept available as a form of insurance. If the market did not clear in scarcity situations on the power market, i.e. if supply and demand did not find equilibrium, the capacity of the strategic reserve could be offered to the market in a second auction at very high prices (e.g. 3,000 €/MWh) in order to make market clearance possible.

In any event, the strike price chosen should be so high that if such a situation occurred it could incentivise investment in technologies that would contribute to the resolution of scarcity situations. Since no technological restrictions would be placed on investments, a large number of options would in principle be available, on the supply side as well as on the demand side, nationally and across national borders.

Where there is danger of market failure in a classic energy-only market, a strategic reserve could also represent an additional flexibility option analogous to the 'value of lost load' (VOLL) on the demand side. This could be a solution for the energy-only market if it is not possible to completely

[3] Partial or selective capacity markets that only incentivise individual elements of the power market are not examined any further because they do not result in either an increase in security of supply or efficient solutions, and they might not be compatible with the current regulatory policy parameters. For more detailed discussions of this assessment, reference is made to DICE (2011), r2b (2011, 2012) and Consentec (2012).

rule out the risk that the demand side is not entirely capable of reducing demand to a sufficient extent in the short term, or did not have sufficient incentives to do so. For this reason, the pricing of VOLL would be simulated by the strategic reserve and where necessary a price chosen that would be more consumer-friendly than the commonly assumed VOLL price of 10,000 €/MWh. Instead of a demand response at very high prices, an additional supply response would therefore be made possible at moderately high prices.

With regard to the design of the procurement process, there are two proposals:

- The proposal made by Consentec (2012) does not distinguish between new and existing power plants. In such cases, demand would usually be met by existing power plants that would be due for decommissioning in the near future (similar to the experiences in Sweden) and might have lower costs than new gas turbines. The power plants placed under contract would then be kept available as a strategic reserve and would no longer be available to the power market.
- The proposal made by r2b (2012) focuses primarily on new power plants, in particular gas turbines, in order to avert any possible distortion of the power market. The intention would be for the new power plants to be available to the transmission grid operator as operating resources, which would enable the operator to guarantee security of supply when there are short-term market imbalances.

A major difference between these two designs is that the Consentec proposal requires a procurement process to take place at an early stage before existing power plants are decommissioned, so that they can take part in the competition. This would mean that there is still sufficient competition in the auction. The r2b proposal requires an initial examination to discover whether a strategic reserve is needed. Ideally, if an annual review does not demonstrate the need for this step, no strategic reserve would be established and consequently no costs incurred either. Once it is determined that it is needed, the capacities will be built up and kept available. Both proposals envisage it would be possible to finance the strategic reserve by recovering its costs in the form of grid charges. The costs to end consumers would be moderate and would amount to less than 0.1 cents per kilowatt hour (r2b, 2012, see also subsection 3.2.1).

Süßenbacher *et al.* (2011) mention that, if necessary, a strategic reserve could easily be built up on decentralised markets and removed again without greatly modifying the design of the power market and regulatory system or affecting dispatch decisions on the power market.

Furthermore, a strategic reserve could also be used temporarily to support the grid in particular regions, something that is currently being discussed for southern Germany in order to bridge the period until the completion of the required (north-south) power line upgrades. To facilitate this, the strategic reserve power plants could be deployed in southern Germany.

2.2.2 Security-of-supply contracts

The proposal for security-of-supply contracts is one approach to the design of comprehensive capacity markets. The main basic assumption concerning the necessity of security-of-supply contracts is that the energy-only market is not functioning, i.e. it does not offer sufficient incentives for

investment, or that although the energy-only market is functioning, sufficient capacities are not being installed in Germany to achieve security of supply at the national level.

In this case, in addition to the power market, a new market for capacities would be created. The security-of-supply contracts are then intended to ensure that power generators provide sufficient capacity and generate enough power in times of scarcity. A central agency (coordinator of the security-of-supply market) would call for bids for security-of-supply contracts to cover the estimated future peak loads five to seven years in advance. In an auction, sufficient security-of-supply contracts would be contracted with the power generators, who would be placed under obligations to make adequate capacity available. The costs of the auction, i.e. the costs for the secured capacity, would be passed on to end customers, in exchange for security of supply.

As a consequence, investors would receive two market signals, one from the security-of-supply-contracts market for secured capacity and one from the power market for the energy provided. To prevent these markets from tending to overfinance generators at the expense of consumers, EWI (2012) propose that the two markets be linked together. The capacity that is awarded contracts in the capacity auction would have to participate on the power market with a defined proportion, while the energy prices would only flow to the generator up to a predefined strike price. If prices rose above the strike price, the difference between the power price and the strike price would be used to reduce the capacity payments of the consumers.

A prequalification process would be introduced to regulate admission to the capacity auction. Defined reliability standards would be set, which could result in the secured capacity being calculated just as a proportion of the offered capacity. The total demand to be auctioned could be defined as a set target quantity or as a demand function. Under the mechanism that is proposed, existing power plants would have to submit bids of 0 €/kW in order to reduce potential market power. Capacity not offered on the market would have to be decommissioned. Furthermore, several auctions are proposed for each supply year. This would serve the aim of adjusting demand for capacity over time, but leads to the evolvements of submarkets. Another reason for the proposal of further auctions is to open the market for suppliers who could not offer their capacity reliably five to seven years in advance, e.g. existing power plants and demand response. In this respect, the central coordination agency would have to determine what percentage of the quantity to be procured should be put up for bidding in each auction round.

In order to integrate demand response, a system is proposed in which demand-side measures would be weighted differently and could be aggregated. By way of example, it is suggested that a committee of experts could set weighting factors that would be oriented towards the estimated contributions the various technologies could provide to secure security of supply. In total, sufficient reliability contracts should be committed in the auction to ensure that there would be sufficient capacity in the market. If a generator was awarded a contract in the auction, for example, their capacities are not allowed to be decommissioned, and they would face penalty payments if this did occur.

3 Discussion of the central approaches to capacity mechanisms

This section begins by defining the criteria for assessing the approaches that are being discussed by policymakers before they are applied to these proposals in the second part of the section. It discusses the implications of the two proposals for a functioning energy-only market and a market failure, with security of supply being pursued at a European or a national level. This is necessary because the different assumptions and goals have a considerable influence on the assessment of the two instruments.

3.1 Definition of assessment criteria

Effectiveness

A mechanism is effective if it can guarantee security of supply.[4] This includes all options that help to balance supply and demand in the power market. This definition therefore extends beyond the mere creation of incentives for investment in generating capacities.

Efficiency

A mechanism is efficient if it achieves its goal with the least effort. However, this aspect of the matter goes beyond pure static efficiency because incentive effects have to be examined with regard to their dynamic efficiency. An efficient mechanism therefore has to meet the short-term and long-term challenges of security of supply with the least effort.

Regulatory-policy assessment, regulatory risks, distribution effects, distortions of competition

'Regulatory policy is aimed at developing rules of conduct for private actors and the government that accommodate the interdependence of economic circumstances' (Donges and Freytag, 2001, p. 223). Regulatory-policy assessment accordingly examines whether the parameters of economic activity (market design) are set in such a way that market actors are incentivised to behave in conformity

[4] In addition to this, it has to be taken into consideration that no market design can ensure one-hundred-percent security of supply without total elasticity of demand, and only a certain level of security of supply can ever be achieved.

with the goals of the law on the energy industry (EnWG).[5] From a regulatory-policy point of view, market interventions should only be undertaken if there is a market failure. When it comes to the intensity of any intervention in the markets, consideration needs to be given to the danger of regulatory failure and any resulting inefficiencies. Every regulatory intervention is subject to certain risks because errors can entail subsequent adjustments. Furthermore, regulatory interventions frequently have distribution-relevant consequences, something that inevitably makes them susceptible to influences by interest group representatives, which can then have impacts on the effectiveness and efficiency of the original measure as well.

Environmental compatibility

A mechanism is environmentally compatible if it supports, or does not undermine, the goals of environmental policy. Mechanisms should consequently not have their own environmental policy aims, but be compatible with existing environmental policy mechanisms (e.g. Renewable Energy Sources Act (EEG), emissions trading). Compatibility with the medium and long-term goals of the expansion of renewable energies is accordingly particularly significant for mechanisms in the power market. Therefore, incentives should be put in place that ensure large market shares of renewable energies can be integrated effectively and efficiently into the system.

3.2 Assessment of the proposals for functioning energy-only markets

In this subsection, the two approaches under discussion are assessed and compared to a theoretically efficient solution of a functioning energy-only market. The same level of security of supply is assumed in all cases.

3.2.1 Strategic reserve

If a short-term imbalance between supply and demand occurs, a strategic reserve would serve as an insurance to prevent involuntary rationing of consumption. As long as no fundamental market failure of the energy-only market had occurred, there would be a low probability of situations with involuntary rationing.

[5] The purpose of the law is the most secure, economical, consumer-friendly, efficient and environmentally compatible possible network-based supply of electricity and gas to the general public, which is increasingly based on renewable energies.

Effectiveness

The size of a strategic reserve would depend on the desired level of security of supply. Its effectiveness could be ensured in accordance with its size.

At the same time - if it were dispatched when the event insured against occurred - a strategic reserve would supply the power market with scarcity signals in the form of very high power prices, which would provide incentives for efficiency and innovation. As a consequence, all market participants, both current and future, on both the generation side and the demand side, would be able to respond to these scarcity signals. On a functioning energy-only market of this kind, it could be assumed that if price spikes occurred repeatedly, there would be market participants who would respond to this signal and technologies to hedge against peaks in demand would consequently enter the market. A strategic reserve could therefore ensure effectiveness over the long term as well.

It is to be expected that, if it was part of an insurance **for a functioning energy-only market**, only a small amount of capacity, if at all, would be needed for a strategic reserve in a **European context**. The expectation is that on a functioning energy-only market a strategic reserve would tend to require a greater capacity to ensure that **security of supply** is achieved **at the national level rather** than at the European level. Provided investment conditions and fuel prices are essentially uniform across Europe, the capacity needed for a strategic reserve should remain stable over the longer term as well. This is largely to be expected for hard coal prices at coastal locations and natural gas, at least. If the elasticity of demand is sufficiently large in the countries in question, this would also stabilise the amount of capacity required for a strategic reserve. There is at least some evidence for this because the expansion of elasticity of demand would not just be incentivised by scarcity prices, but also by the volatility of power prices and the more frequent occurrence of extremely low power prices when wind and photovoltaic power plants are supplying large volumes of power. Regional locational factors (e.g. combined-heat-and-power generation) and grid bottlenecks between countries – which would increase prices in scarcity situations – would also counteract any rise in the strategic reserve at the national level.

Efficiency

On **a functioning energy-only market**, the provision of additional capacity by the strategic reserve, which would rarely if ever be dispatched, would be similar to a classic insurance policy. On a market with uncertain future development, such an insurance could be efficient if the costs when the event insured against occurred were higher than the costs of the insurance (taking into consideration the probability of its occurrence). This would be the case if there were blackouts over large areas.

If solely focused on the dispatch, as discussed for example in EWI (2012), a strategic reserve would not be statically efficient, because options might come to be dispatched that had higher marginal costs or greater marginal utility than the power plants in the strategic reserve. However, it would be necessary to withhold the reserve and therefore accept a degree of static inefficiency in order to ensure efficient allocation over the long term (dynamic efficiency) in the energy-only market, from a comprehensive perspective. When the trigger price was sufficiently high, scarcity signals would be sent out, which would incentivise a competitive solution. This criterion is not to be neglected, above

all, from the perspective of the transformation of the energy system. Only if the market can signal challenges, in particular those due to the expansion of renewable energies, by setting appropriate prices can market actors respond appropriately. This would be the case in an energy-only market that was not (or not significantly) affected by the strategic-reserve proposals under discussion, in particular due to the extensive involvement of the demand side with the associated incentives to increase flexibility of demand.

The involvement of existing power plants could lead to lower procurement costs than those for a scheme limited to new power plants. According to estimates made by Consentec (2012), these costs would run at €140m a year for the establishment of a strategic reserve of 4 GW. However, the involvement of existing power plants could deprive the power market of capacities that would no longer be available for efficient dispatch on the power market. It is not easy to prove that these power plants would alternatively be decommissioned or mothballed. In consequence, the cheaper procurement costs might be accompanied by higher costs on the power market. This trade-off would not apply if consideration was given exclusively to new power plants. In exchange, higher procurement costs would be incurred if these power plants were needed. Positing that an identical capacity of 4 GW would be needed, r2b calculate costs of €188m-€242m a year.[6] Were this sum to be recouped in the form of grid charges, it would increase prices by a maximum of 0.05 cents per kilowatt hour if a 4-GW strategic reserve were established (derived linearly from r2b, 2012).

It would, however, be decisive for the dynamic efficiency of a strategic reserve that its capacities were not transferred to the energy-only market, and it was dispatched solely at very high prices and only in cases where supply and demand could not be balanced on the market. Otherwise, a strategic reserve would tend to result in reluctance towards investment in the construction of new power plants or the activation of elasticities of demand, as a result of which, apart from efficiency, it might also lose effectiveness.

It is not possible in this short study to clarify conclusively which of the two approaches to the implementation of a strategic reserve is to be preferred – the exclusive use of new power plants or the additional involvement of existing power plants. Overall, the differences between the two proposals are modest, and they both have their individual strengths and weaknesses. In either case, however, an efficient and effective insurance would be available at relatively low additional cost.

Essentially, the same remarks apply for functioning energy-only markets at the national and European levels: Compared to a theoretically efficient solution on a functioning energy-only market, systematically low efficiency losses would be suffered due to the additional power-plant capacity of the strategic reserve, and the efficiency risks would be low. The efficiency losses suffered at the national level would tend to be higher than at the European level because a national strategic reserve would require greater capacity for structural reasons.

[6] The full annual costs for a gas turbine assumed in r2b (2012) amount to between €47 and €61/kW. Depending on the local supply situation, additional investments could be necessary to secure the supply of fuel.

These additional inefficiencies at the national level compared to the European level would therefore be caused not by the strategic reserve itself, but by the adoption of the additional target of national autarchy, the maintenance of which might require a (larger) strategic reserve.

Regulatory-policy assessment, regulatory risks, distribution effects, distortions of competition

It is relatively easy to carry out a regulatory-policy assessment of a strategic reserve for **functioning energy-only markets at the European level** because the existing market design of the power market would merely be supplemented with a reserve product. The strategic reserve would consequently not lead to any fundamental restructuring in the current market processes, because there are three reserve markets already. In this respect, the r2b proposal has the advantage that the other markets would not be affected at all, while the Consentec proposal might use capacities from the other markets. The rationale for Consentec's design, however, is a focus on existing power plants that would otherwise be decommissioned in the near future. Apart from the options for procurement, the number of parameters to be set would be relatively modest. A strategic reserve could be introduced in the short term, would be reversible and would not lead to any fundamental change in the design of the market.

As far as the size of the strategic reserve is concerned, EWI (2012) point out that, apart from the calculation of the total capacity required in the years in question, newly built and decommissioned plants would also have to be taken into account. In addition to this, it is emphasised that it could become politically difficult to persevere with a high strike price on account of the limitations on the dispatch of the power plants that are discussed above. Since consumers would have to pay high power prices (e.g. if prices were set by the demand side), while the unused power-plant capacity of the strategic reserve could generate power at lower prices, it is feared that it would not be possible to uphold a high strike price over the long term without losing political credibility. In this case, an eroding strike price would weaken the incentive effect for new investments. This would bring about "wait-and-see" behaviour when it comes to investments and therefore result in a lack of new investment, which would tend to lead to higher demand for the strategic reserve, and a loss of effectiveness and efficiency. Conversely, it is possible to interpret the EWI analysis as implying that action should be taken to signal political credibility in such a system, as it would be of central significance if the functioning of the energy-only market was to be ensured.[7] At the same time, the need for regulation, e.g. the monitoring of potential market power abuse, could increase because there would be a greater incentive to exploit price spikes.

Price spikes increase producers' contribution margins. The potential distribution risks therefore relate primarily to consumer and producer rents in the short term, e.g. if consumers protest against price

[7] In an analysis of a strategic reserve in the situation under discussion here, an energy-only market that functions well in principle, i.e. a strategic reserve as a form of insurance, these aspects are of markedly less relevance than where a fundamental market failure of the energy-only markets is presumed, in which case a strategic reserve would take over the function of a price setting mechanism at times of scarcity.

spikes. However, since the currently low producer rent might prompt reluctance towards new investments, there appears to be relatively little need for further regulatory interventions that would possibly correct redistributive measures in the long-term balance. Fundamentally, the incentives would therefore be set in a conducive way because a rise in the producer rent would incentivise new actors to enter the market, which would also cause competition to intensify. In view of the free access to the market, these market entries could also include demand-side measures that might absorb some of the producer rent.

In functioning energy-only markets, the introduction of a strategic reserve would not result in geographical distortions of consumer and producer rents in neighbouring countries, either **from the European or the national perspective**. As long as interconnectors permit a pure market solution, they would be used. The strategic reserve would only come into play when the capacity of the interconnectors is exhausted, and all generation and demand-side options are being used simultaneously. In this case, the price signal would stay within the market area where there are shortages and merely create national incentives for adaptation, which means that there would not be any geographical distortions.

Environmental compatibility

The impacts of strategic reserve on environmental compatibility cannot be assessed conclusively in the context of this study. In all probability, the power system of the future will be characterised by large market shares for variable generation from renewable energies. For this reason, elastic demand would be desirable so that it would be possible to balance out the fluctuations in generating capacity associated with the expansion of variable renewable energies. By extensive involvement of the demand side with the associated incentives to increase flexibility of demand, the necessary incentives would be put in place so that large market shares of renewable energies could also be integrated effectively and efficiently into the system in an energy-only market that was not (or not significantly) disrupted by the strategic reserve.

3.2.2 Security-of-supply contracts

Effectiveness

The capacity needed would be determined in accordance with the desired level of security of supply. Due to the obligation to provide secured capacities, the effectiveness of the mechanism should also be ensured in **functioning energy-only markets**. However there would remain the question of incentive effects for consumers to manage their demand variably in the short term.

The effectiveness assessment indicates that, in principle, the system's introduction would be possible from the perspectives of both **European and national security of supply**. This is, however, restricted by the likelihood that, without corresponding capacity markets in other countries, the security-of-supply-contracts approach might result in capacities only being shifted to Germany. This would mean that it is possible that, although the desired level of security of supply would be achieved at the national level and therefore more secured capacity would be localised in Germany than in an

energy-only market, the overall level of security of supply across the European interconnected system might not be raised compared to an energy-only market.

It is not possible at this point to assess conclusively whether the proposed approach would result in a comprehensive capacity market. Since existing and new power plants might have different minimum and maximum prices and different payback periods, there would be at least partial elements in such a system. Whether they would influence effectiveness would depend on the details of the design.

Efficiency

In theory, the same allocation results could be attained with an ideal, comprehensive capacity market as with a theoretically efficiently well functioning energy-only market. However, efficiency losses could be suffered for various reasons.

For instance, the identification of the desired level of security of supply would in itself tend to cause efficiency losses compared to a theoretically efficient solution in a functioning energy-only market because (as with a strategic reserve) the level of security of supply would be set exogenously. Furthermore, the efficiency of the security-of-supply-contracts proposal would depend on the details of its design. The tendencies towards the introduction of the partial design elements discussed above could impair efficiency as well as effectiveness.

For example, because of market power concerns an administratively set maximum price of 0 €/MW is proposed for existing power plants. As a result, existing power plants would face a price risk because if there was sufficient capacity, even a price of 0 €/MW could be a market result. This risk might result in them not participating in the auction, but being decommissioned early (see the discussion in EWI, 2012, pp. 66f).

Furthermore, on account of the long lead time and the predefined volumes put up for bidding in the various auctions, in combination with prequalification criteria that would need to be specified in greater detail, the scope for solutions could easily be restricted, and efficiency losses therefore suffer in comparison to a theoretically efficient solution. For example, the long-term secure planning environment required for new power plants, and the practicality of medium-term planning for existing power plants and short-term planning for potential demand response measures would pose challenges on the call for bids. In the approach under discussion, demand response would tend only to be included in the security-of-supply-contracts capacity auctions or incentivised subject to certain restrictions, as well as being limited by the weighting or splitting of the total capacity between the auction rounds.

The extent to which new market entrants could enter the energy-only market without participating in the security-of-supply-contracts auction remains open. Participation in the security-of-supply-contracts auction would only be possible if the prequalification process demonstrated the market entrant's suitability. By contrast, it is not clear whether new market participants with innovative ideas would be excluded from the power market. For example, should demand response measures come into the power market without participating in the security-of-supply-contracts auction? The participants in the security-of-supply-contracts auction could argue that they had not taken the new

market entries (and therefore new competitors) into account when calculating their security-of-supply-contract bids and their bid calculations were therefore no longer correct. Consequently, in order to create a consistent system, there would have to be stringent rules for market entries. As a result of this, there would be a danger of technological lock-in effects, particularly if the criteria for participation and the auction periods were unsuitable for certain technologies. An extreme case in which gas turbines would represent the only possible solution is quantified in EWI (2012). This would have the consequence that the highest possible price on the wholesale market for power would be equivalent to the marginal costs of a gas turbine. However, these power plants would only be dispatched for a few hours, amongst others due to the European internal market.

If price spikes in the power market were smoothed out by cost allocation schemes or averted, demand would tend to remain inelastic. On account of the lower level of the price of power and the lower price volatility relative to the energy-only market, the possible times for which demand response measures would be dispatched on the power market would presumably be less, since enough gas turbines would always be available that would have a higher availability factor in the capacity auction and might command lower prices for their dispatch on the power market than demand response measures. However, this would not mean that demand response measures were less suitable in principle, but only that there was a possibility of distortions being caused by the prequalification process and the modified power prices.

Compared to a theoretically efficient solution on a functioning energy-only market, there would be considerable efficiency risks – on account of the various interaction effects of security-of-supply contracts when implemented in practice. The assessment of the efficiency of security-of-supply contracts from **the European and the national perspective** is similar to a great extent. However, the tendency would be for efficiency losses to be higher at the national level than at the European level, since the need for capacity tends to be higher at the national level.

Regulatory-policy assessment, regulatory risks, distribution effects, distortions of competition

The security-of-supply-contracts approach is characterised by a large number of parameters to be formulated with major distribution effects and regulatory risks. Ultimately, the fine adjustment of the regulatory intervention means it would be necessary to weigh up a large number of options for a large number of policy levers that would have to be defined. It is consequently highly probable that some of these policy levers would be set less than perfectly by the central coordination agency (e.g. if the representatives of interest groups exerted influence), which would entail efficiency losses and inevitably make subsequent adjustments necessary. This illustrates the typical dilemma of regulation.

On this topic, Cramton and Ockenfels (2011) write, 'there is a long history of flawed capacity market designs, resulting in large inefficiencies and costs. These flaws are well-understood theoretically, so policy makers and administrators can avoid them, but often policy makers and administrators appear guided by political forces that are vulnerable to the adoption of flawed approaches.'

EWI (2012) discuss very transparently the complexity involved in the consideration of existing power plants, the introduction of minimum and maximum prices, both in a capacity auction and on the

power market, and different payback periods. In this respect, the point is made that there could be inefficiencies as well as uncertain distribution effects.

Because of the economically significant sum of the capacity payments, there would be a danger of distribution aspects becoming the central issue in the design process rather than effectiveness and efficiency aspects. EWI (2012, p. 61) explain that in the long-term equilibrium the difference between the capacity payments and the cash settlements on availability options paid by the generation side to the demand side when prices rise above the strike price would have to correspond precisely to the missing contribution margins ('missing money') for the last required unit of power. The modelling results suggest that, in particular from a national perspective, investments would be made in gas turbines, the deployment of which would not be driven by the market. In this case, the missing contribution margins would correspond exactly to the annuity costs of a gas turbine. Since the study does not give any figures for the volume of the auctions, the same assumptions as for the calculation in the r2b example discussed above are used, which give a range of full annuity costs (investment, maintenance and labour costs) of approx. 47-61 €/kW. If the installed capacity of Germany's conventional power plants, which is calculated at 95 GW for 2020, was valued at the price to be expected from this auction, the volume of the auction would have to range from €4.5bn to €5.8bn a year in the long-term equilibrium.

Considerable distribution risks would arise, for example due to the burdens placed on consumers when capacity costs are passed on. The fundamental argument for the introduction of comprehensive capacity markets is that security of supply is a public good when demand is inelastic (EWI, 2012, p. 56).[8] It is now a possibility that, for example, industrial consumers to whom this assumption does not apply and who are price-elastic might draw attention to the fact that they would like to respond to prices in principle, but were not able to offer this within the defined parameters of the prequalification process. In such a case, an alleviation of the cost burden might be appropriate. This would have the consequence that domestic customers find themselves shouldering a greater burden. A comparable arrangement is laid down in the Renewable Energy Sources Act to protect energy-intensive industries from unacceptable additional burdens.

Another example of distribution risks would be demands for the producer rent from existing power plants to be skimmed off. For instance, when the operating lives of Germany's nuclear power plants were extended, an additional tax on fuel elements was introduced. Following this, there is a danger that any capacity payments to these power plants would no longer be sufficient for their continued operation and they would therefore be decommissioned prematurely. This would result in further inefficiencies.

One essential attribute of the security-of-supply-contracts approach is that it is intended to be long term and permanent, and would require stable long-term parameters if it was to be effective. Any return to an energy-only market would presumably be ruled out. On account of the regulatory risks

[8] This assumption is not shared by all studies. For instance, r2b (2012) argue security of supply was a common pool resource for consumers without real time metering.

that have been discussed, further extensive modifications to the design of the market would probably be necessary.

Should a **European perspective** on security of supply be adopted on a **functioning energy-only market**, a national security-of-supply-contracts approach would not make an effective contribution to increasing European security of supply and would therefore not be relevant either. At the European level, therefore, only a coordinated European security-of-supply-contracts approach could deliver security of supply effectively and make efficient geographical allocation possible.

The introduction of a national security-of-supply-contracts model into a **functioning energy-only market** is only a relevant option from a **national perspective**. However, in this case (without comparable mechanisms in the other European countries), in view of the circumstances on the European power market, there would be geographical distortions in power-plant allocation, and therefore in consumer and producer rents. The tendency would be for power plants to be built and paid for in Germany, while their power might end up being exported at short-term marginal costs.

Environmental compatibility

The impacts of security-of-supply contracts on environmental compatibility cannot be conclusively assessed in the context of this study. As it has been discussed above, however, the security-of-supply-contracts system would allow considerable influence on the energy-only market, in particular when it comes to the flexibilisation of demand. A well coordinated auction period with adequate prequalification criteria could, in principle, result in the potential of demand response being developed. In the approach under discussion, however, this potential would tend only to be included in the capacity auctions (security-of-supply contracts) or incentivised under certain restrictions, and would furthermore be limited by the weighting or splitting of the total capacity between the auction rounds. Partly due to the absence of price signals on the power market, this potential would not be used optimally or incentivised because it would primarily be the gas turbines placed under contract that would be dispatched. As a consequence, there would be a danger of a failure to put in place the incentives for flexibility needed for effectively and efficiently integrating large market shares of renewable energies into the system.

3.2.3 Discussion of the results

Both mechanisms have advantages and disadvantages in terms of their feasibility. One essential reason for the divergent remarks made in the studies is that they adopt different assumptions concerning the initial situation on the power market and the objective of the two instruments.

In this subsection, the two mechanisms are discussed and compared from the European and the national perspectives subject to the assumption of a functioning energy-only market. In the following subsection, the mechanisms are discussed subject to the assumption of a market failure. A conclusive analysis as to whether security of supply should be pursued at the national or at the European level would exceed the scope of this short study.

Effectiveness

Given an adequate design, both mechanisms would in principle be capable of achieving direct security-of-supply targets. Under a security-of-supply-contracts approach with a national security-of-supply target, however, it would be possible that, although the desired level of security of supply would be achieved at the national level and therefore more secured capacity would be localised in Germany than in the case of an energy-only market, the overall level of security of supply across the interconnected European system might not increase compared to an energy-only market. This effect could occur if a security-of-supply-contracts market was introduced in Germany without corresponding capacity markets in other countries. The consequence would be a shifting of capacities to Germany.

A strategic reserve would be effective from both the national and European perspectives. However, the capacity that might be needed from a national perspective would tend to be higher. This statement is certainly true for both mechanisms. European coordination of security of supply would tend to require less secured capacity than equivalent national measures.

All the published studies explicitly state that both supply and demand-side measures should be incentivised in order to maintain security of supply. As a matter of principle, both mechanisms would be capable of doing this, provided they are designed suitably. A strategic reserve would inevitably cover the whole market, as long as the strike price was set sufficiently high. Under the security-of-supply-contracts approach, the extent to which the demand side is involved would depend on the concrete design and the parameters that are set.

Efficiency

From a European perspective, a strategic reserve would entail systematically low efficiency losses compared to a theoretically efficient solution on a functioning energy-only market, as well as low efficiency risks. The efficiency losses for the strategic reserve would tend to be higher for an implementation at national level compared to the European level, because greater additional power-plant capacity would potentially be required for the strategic reserve. The scale of the additional efficiency losses suffered at the national level would depend on various parameters and the development of elasticity of demand. However, these additional inefficiencies would not be caused by the strategic reserve as such, but by the adoption of the additional goal of national autarchy, the maintenance of which might require a larger strategic reserve. On an energy-only market that was not (or not significantly) affected by the strategic reserve proposals under discussion, there would be extensive involvement of the supply and demand sides.

Under the security-of-supply-contracts approach, considerable inefficiency risks would arise compared to a theoretically efficient solution of a functioning energy-only market – due to the various interaction effects of the security-of-supply-contracts auction when implemented in practice. As a result of its prequalification process and long auction periods, the security-of-supply-contracts approach would potentially rule out some options, in particular on the demand side, as a result of

which there could be inefficiencies in relation to investment decisions and, ultimately, market processes. In addition to this, price spikes would be reduced (on account of the tendency for power-plant capacity to be greater than in a theoretically efficient solution on a functioning energy-only market), and as a result the incentives to expand elasticity of demand could be reduced. The security-of-supply-contracts approach would involve relatively intensive regulation because a considerable number of details of its design would have to be weighed up against each other. As a consequence, further inefficiencies might arise. Under a security-of-supply-contracts approach, as with a strategic reserve approach, the tendency would be for efficiency losses to be higher if implemented at the national level rather than at the European level.

It is not to be expected that the overall economic costs of a security-of-supply contracts solution would be lower than those of a strategic reserve, as a system with greater generating capacities and therefore higher costs would be the overall result. The reason for this would be the different specific planning periods for demand response measures and existing power plants in comparison to new power plants that, together with the splitting of the volumes put up for bidding between the different auction rounds, would potentially lead to efficiency losses. Furthermore, it is not to be expected that the system would be more cost-effective for the end customer than a strategic reserve, because the capacity payments would be passed on to consumers on top of the wholesale power prices.

In a comparison between the two strategic-reserve approaches, the lower costs of the Consentec approach might contrast with the higher wholesale prices of the power market, since in certain circumstances existing power plants could be removed prematurely from the power market. The detailed design of the strategic-reserve approach should be investigated further and weighed up. In either case, an effective and largely efficient form of insurance would be available at relatively low additional cost.

Regulatory-policy assessment, regulatory risks, distribution effects, distortions of competition

For the security-of-supply-contracts approach to work as efficiently as possible, stable policy parameters would be required over the long term. However there would be considerable regulatory risks under the security-of-supply-contracts approach on account of the complexity of the market design and the regulatory system, which would make it quite probable that inefficiencies would arise. In addition to this, there is the fact that no experience has as yet been gathered of such complex capacity mechanisms in decentralised markets, but merely in pool markets, e.g. in the north-east of the USA (Frontier Economics, 2011). This fact alone would make subsequent adjustments probable in the near future.[9] In addition to this, there would be the danger that, on account of the economically

[9] With regard to the suitable market design for capacity markets, Cramton and Ockenfels (2011) write, 'It is desirable to firmly address these issues before a capacity market is adopted. No capacity market can function well if there are impediments to long-term investment, such as political uncertainties, regulatory imperfections, causing poor implementation, insufficient development of locational and real-time pricing, etc.'

significant sum of capacity payments, distribution aspects would become more significant compared to effectiveness and efficiency aspects when the system is being designed.

On decentralised markets, a strategic reserve could be introduced and removed again without adjusting the market design (Süßenbacher et al., 2011; de Vries, 2004). The regulatory policy risks would therefore be smaller. Furthermore, it would be possible for it to be scaled up into a European mechanism without difficulty. The regulatory risks of a strategic reserve would relate not to the complexity of its design, but to the possibility of political influence being exerted when the instrument's central attributes were being defined – something that is, in principle, an issue for all capacity mechanisms. For instance, it could become politically difficult to persevere with a high strike price for the strategic reserve because consumers would have to pay high prices for power, while the unused power-plant capacity of the strategic reserve could generate power at lower prices. This is why EWI (2012) express the fear that it might not be possible to uphold a high strike price over the long term without losing political credibility. In this case, an eroding strike price would weaken the incentive effect for new investment, which could lead to a lack of new investments and a trend towards higher demand for the strategic reserve, therefore resulting in a loss of effectiveness and efficiency. Conversely, the implication is that action should be taken to signal political credibility in such a system, as it would be of central significance if the functioning of the energy-only market was to be ensured. At the same time, the need for regulation, e.g. to reduce market power or enhance competition, could rise, as there would be an increased incentive to exploit price spikes.

There continues to be a trade-off between **national and European security of supply**. In this context, Haucap (2012) says, 'We should not take decisions at the German level. We see the markets growing together. Here, it is less the German Federal Government that has a duty to act than the European Commission. It would therefore be necessary to think about whether we do not need a European strategic reserve. Much of the time, we do not even have pan-European peak load times. If load is peaking in Germany, it may not necessarily be peaking in France.' The consequence of European coordination would therefore lead to considerable efficiency gains.

On an integrated European internal market for power, the introduction of capacity markets would lead to market distortions in individual countries. A comprehensive capacity market should therefore, if necessary, be introduced solely at the European level (see also DICE, 2011). Furthermore, the EU mentions the maintenance of security of supply in its internal market package as an explicit goal of the EU's internal market. For instance, the European Union has already proposed a possible tendering procedure for capacity mechanisms to deal with scarcity situations (Directive 2009/72/EC, Article 8). As a matter of principle, the strategic reserve would be in conformity with the EU internal market and could be coordinated easily as well as implemented by unilateral, national measures (Süßenbacher *et al.*, 2011).

Furthermore, it is of central significance for the regulatory-policy risk analysis that the strategic reserve could be removed again over the long term if there was a lack of necessity or it functioned poorly. By contrast, an essential attribute of the security-of-supply-contracts approach is that it would be intended to be long term and permanent, and stable long-term parameters would be required if it was to be effective. A return to an energy-only market would presumably be ruled out and further extensive modifications to the market design would probably be necessary on account of

the regulatory risks that have been discussed. For this reason, the facts to determine a necessity should be adequately clarified before any such profound and irreversible regulatory intervention is undertaken.

Environmental compatibility

Elasticity of demand is desirable for the integration of renewable energies within the framework of Germany's long-term goals. In the long term, demand response is not only required to reduce peaks in demand, but also to adjust consumption to peaks in generation from variable renewable energies.

In an energy-only market that is not (or not significantly) disrupted by a strategic reserve, the extensive involvement of the demand side with the associated incentives to increase flexibility of demand would create the incentives required so that large market shares of renewable energies could be integrated effectively and efficiently into the system.

As discussed above, the security-of-supply-contracts approach would encourage the expectation that a considerable influence would be exerted on the energy-only market, in particular when it came to the flexibilisation of demand. In consequence, there would be a danger of a failure to put in place the incentives for the required flexibility to effectively and efficiently integrate large market shares of renewable energies into the system.

Assessment matrix for functioning energy-only markets

	Strategic reserve	Security-of-supply contracts
Effectiveness		
- Security of supply	Assured	Assured
Efficiency		
- Efficiency losses (compared to theoretical optimum)	Low	Low
- Risk of inefficient design	Low	High
Regulatory-policy assessment		
- Intensity of intervention	Low	Very high
- Regulatory risks	Low	Very high
- Distribution risks	Low	High
- Reversibility	Yes	No
Environmental compatibility		
- Flexibility incentives	Assured	Uncertain

3.3 Assessment of the proposals for non-functioning energy-only markets

If a market failure of the energy-only market is assumed, it is not possible to assess the two proposals in the context of this study. In order to do this, it would be important to know what the causes for the assumed market failure were, whether these causes could be remedied and whether the intention was to pursue security of supply at the national or European level over the long term.

In general, two central strategic solutions are possible:

1. Remedy the causes (e.g. by expanding elasticity of demand) instead of treating the symptoms (by introducing capacity mechanisms, e.g. with capacity payments to replace missing contribution margins for the construction of new power plants).
2. Introduce capacity mechanisms if a market failure is to be expected and its causes cannot be remedied over the long term.

If possible, the causes for an expected market failure should be remedied to allow the efficiency and innovation advantages of the energy-only market to be utilised. If capacity mechanisms would be required because the causes of an expected market failure could not be remedied, it would have to be examined what capacity mechanism would be best suited, in particular giving consideration to price formation on the European internal power market with (at least partially) elastic demand. Possible options would be e.g.:

- A comprehensive capacity market, e.g. a security-of-supply-contracts approach (with capacity specified exogenously)
- A strategic reserve (to replace missing elasticity of demand, see subsection 2.2)

Since it would be possible to build up a strategic reserve relatively rapidly, it could also bridge over the time that would be required before a comprehensive capacity market had been established if the introduction of comprehensive capacity markets had become necessary.

If the causes of the assumed market failure make the introduction of a capacity market unavoidable, the parameters would have to be set in such a way that efficiency and regulatory risks are minimised. However, if the cause of the market failure is a lack of political credibility, so that repeated regulatory adjustments were anticipated, a comprehensive capacity market would not help the situation either, or would result in considerable inefficiencies due to risk premiums.

4 Discussion of a possible failure of the energy-only market

The assumption of a possible failure of the energy-only market influences the selection of an efficient solution. The strategic-reserve concept would serve as an insurance for an energy-only market that was functioning well, at least over the medium term. In the case of a market failure, a comprehensive capacity market may become necessary in order to guarantee an appropriate level of security of supply efficiently. It is for this reason that this section, which is based on the discussed studies and the current state of knowledge, discusses whether the energy-only market is functioning and to what extent there are signs of a possible market failure, i.e. the structural incentives for investment are not sufficient to balance supply and demand on the power market at all times.

Security of supply and energy-only markets

Since power is a good that cannot be stored economically on a significant scale, generation and consumption must always be in equilibrium. For the power market, security of supply means that supply and demand always have to match up. This has the consequence that there is a market price at all times (r2b, 2011). If there is no intersection between supply and demand for structural reasons, this may be indicative of a failure of the market that would require involuntary rationing. This must not be confused with the impact of short-term shocks, e.g. the phasing-out of nuclear power plants. As mentioned above, r2b (2011) write that security of supply would be guaranteed if there was complete price elasticity of the supply curve or the demand curve. In reality, however, partly due to the incomplete price elasticity, but also for other reasons, e.g. problems in the grid, there is in principle no such thing as one-hundred-percent security of supply. This is true for all forms of market design. In practice, it is only possible to deliver a certain level of security of supply, which is influenced by the elasticity of supply and demand. Since both supply and demand alter over the short, medium and long terms in response to price signals, this requires dynamic analysis.

Economic theory provides a foundation from which the possible causes for the failure of energy-only markets can be deduced,[10] e.g. missing or insufficient short-term elasticities on the supply and demand sides. In fact, neither the supply side nor the demand side are completely elastic in the short term.[11] On the contrary, the lack of elasticity of demand in the short term is frequently referred to as

[10] In economic theory, market failure can occur for various other reasons, e.g. external effects, natural monopolies, information asymmetries and the existence of public goods. In the context of this analysis, the functioning of markets is restricted to the central question of an efficient level of security of supply. An efficient level of security of supply is achieved if there is a sufficiently high probability that an equilibrium between supply and demand will be ensured.

[11] Complete price elasticity means that demand responds to price signals over the whole range of load conditions.

one of the main fundamental assumptions about power markets, since a large proportion of consumers do not respond to wholesale price signals because they lack the technology or economic incentives to do so. r2b (2011) and Cramton/Ockenfels (2011) mention the assumption that security of supply is a public good as a reason for market failure that is cited in many cases. Even with inelastic demand, however, r2b (2012) view it not as a public good, but as a common pool resource, since there is rivalry of consumption. This distinction should be taken into consideration when the appropriateness of significant market interventions is assessed.

Without capacity markets it is, above all, the price signals on the power market that play a decisive role. While, for example, negative prices signal that flexibilities are required (Nicolosi, 2010), positive price spikes signal the need for additional generating capacity. In the academic literature, the VOLL price (commonly assumed in the literature to be 10,000 €/MWh) is usually proposed as a demand-side market signal, which should result in market clearance and at the same time incentivise new investment (see e.g. Stoft, 2002).

Elasticity of demand

Elasticity of demand is not a fixed constant, but may increase in future on account of market incentives in the form of price signals. Today, some major consumers are already active on the spot and balancing power markets (EWI 2012). This shows that some of the available potential for demand response is now being activated as elasticity of demand. In addition to this, rapid technological and regulatory developments are taking place in this field at the moment. For instance, Cramton/Ockenfels (2011) and Consentec (2012) mention the extension of demand response measures, smart meters, smart grids and the spread of electric cars as hopeful developments for the flexibilisation of demand.[12] r2b (2011), Consentec (2012) and EWI (2012) identify consumers who already use real time metering to offer potential that could be developed in the short term. Both r2b (2012) and Consentec (2012) calculate on the basis of the Federal Network Agency's *Monitoring Report* that at least 30 GW of German demand is metered in real time. EWI (2012) suggest the potential that could technically be exploited would amount to 12.5-14 GW for the critical hours of annual peak load on winter evenings. The time that is needed to provide demand-side flexibilities is given by Consentec (2012) as a few weeks. As an example, r2b (2011) mention the reformulation of contractual conditions as a short-term option for increasing flexibility of demand.

[12] Cramton and Ockenfels (2011): 'The need for a capacity market is partly reduced as the current demand-side flaws are addressed by new technology and improved electricity market designs. And the future of demand response is becoming brighter with each year as smart metering and smart grid solutions are rapidly developing. This development is likely to accelerate as consumers shift to electric cars, which will introduce a vast array of electric storage when cars are plugged into the grid.'

Elasticity of supply

The supply side is not completely elastic in the short term either, as the installation of new capacities requires a certain lead time, depending on the technology. On the supply side, with increasing use of direct marketing for renewable energies, at least some of the previously out-of-market feed-in is subject to price signals.[13] Furthermore, in situations of greater scarcity the development of additional capacities would become more attractive, so other available options, e.g. standby generators, could also be activated on the market.

BET (2011), Consentec (2012) and EWI (2012) show modelling results to justify the action they argue is needed. On the basis of their quantifications, they arrive at the conclusion that in the future financial incentives will not be enough to ensure sufficient investment in power plants or the operation of some existing power plants. In this regard, however, these calculations raise issues that need to be discussed from a methodological perspective. Both BET (2011) and EWI (2012) set capacity targets for their models. As a consequence, they find a significant number of additional gas turbines would be built because this would represent the most economical generation technology with which to fulfil this capacity condition in their models.[14] Subsequently, these capacities are assessed on the basis of short-term marginal cost prices[15] without other options (e.g. demand response) being available in the models, which permits prices to be set above the variable costs of the last dispatched power plant. There are numerous discussions in the energy-economics literature on the fact that short-term marginal cost prices translate into the missing money problem. For this reason, the evidence of the published quantifications is ideal for determining the need for peak-load power plants or demand response, but less suitable for answering questions about funding shortfalls or the need for capacity mechanisms. Consentec (2012) also assess the contribution margins of existing power plants on the basis of the short-term marginal costs of generating capacities in order to identify whether they could be decommissioned if insufficient capital costs were recouped. However, Consentec (2012) and EWI (2012) discuss the possibility that prices could be set by the marginal utility of demand, which would then result in higher contribution margins. According to the energy-

[13] With regard to the promotion of renewable energies, Cramton and Ockenfels (2011) write, 'the German market faces challenges with market integration of renewable resources that are currently out-of-market and supported by a collection of subsidies that are largely inconsistent with an efficient capacity market.'

[14] In order to prevent the disproportionate construction of additional gas turbines, Nicolosi (2012) introduces a 'superpeaker' technology that would have somewhat lower fixed costs and rather higher variable costs than a gas turbine. As a result of this, it would only be dispatched for a very few hours of the year. This 'superpeaker' technology would function as a backstop solution for the capacity specified to maintain security of supply. However, the idea is characterised by its technological openness, so this backstop solution would allow consideration to be given to, for example, demand response, standby generators or other technologies that might be developed in future. As a result, a significantly lower amount of capacity would have to be kept available in the form of gas turbines.

[15] The term 'short-term marginal cost prices' is used here to emphasise the conscious distinction from 'long-term marginal cost prices', which would factor in investment costs as well, e.g. in the form of mark-ups.

economics literature, in an extreme case this is the VOLL price, which refinances investments in power plants. For the reasons set out here, it would not be advisable to regard the quantifications of missing contribution margins that have been published as evidence of market failure.

As a theoretical explanation for the potential failure of the energy-only market, Cramton/Ockenfels (2011) mention that at times when sufficient capacities are available spot prices are not high enough to incentivise investments. This fundamental correlation is correct in principle. However, it does not follow from this that the observation of lower power prices on the market over a particular period of time would allow the conclusion that the market was failing. In this context, Haucap (2012) says, 'After all, it is also evidence for the functioning of the market that at a time of overcapacities even more capacities are not built up.'

In this respect, it is necessary to bear in mind that the development of the supply curve on the power market is relatively transparent. This means that a great deal is known about investments that are planned and power plants that are going to be closed down. For this reason, in addition to the responses to ongoing price signals, future market situations can also be anticipated. According to the current list of power plants scheduled to go online or offline issued by the Federal Network Agency (2012), there are plans for the construction of 12.5 GW of new conventional capacities up to the first quarter of 2015, while 6.6 GW of capacities will be decommissioned over the same period.

Is the energy-only market functioning or is there an urgent need for action?

The reasons for a potential market failure that have been addressed are more likely to weaken in the near future than strengthen. The restrictions on the demand side could be flexibilised in the near future by means of demand response measures, in particular the activation of real time metered power customers, smart grids to tap the potential offered by customers who do not yet use real time metering, and electric cars. With regard to the construction of new power plants, the present reluctance towards making investments is also interpreted as the efficient functioning of the market.

Empirically, there has not yet been any evidence of a market failure in the medium term, and economic theory does not foresee any imperative reasons why a market failure should be expected. From a long-term perspective, however, a possible failure also cannot be completely ruled out ex ante. The scaling-back of overcapacities in Germany at the beginning of liberalisation was indicative of inefficiencies in fields that had not previously been organised via markets. The current reluctance towards investments can also be understood as evidence that the market is functioning since no additional capacities should be built up at times of overcapacity. As far as the recommendation for actions are concerned, Haucap (2012) says, 'I have not yet seen the proof that the energy-only market, on which only produced kilowatt hours are paid for, is unable to function sustainably in Germany.'

5 Recommendations for action

The discussion has shown that the proposed capacity mechanisms have essentially been deduced from differing assumptions concerning a failure of the energy-only market.

Cramton and Ockenfels (2011), whose theoretical comments form the foundation for the security-of-supply-contracts approach, limit the validity of their statements to long-term market configurations: 'resource adequacy is a long-term measure. That is, the proposed capacity market can unfold its benefits only if it will be in place for several decades. On the other hand, a major motivation for considering a capacity market in Germany seems to be the current transition away from nuclear power and towards renewables. That is, Germany might not look for long-term solutions of the resource adequacy problem, but rather for targeted measures to supplement the current transition phase.'

This phase could be 'supplemented' over the short to medium term with a strategic reserve. It would be comparatively easy to establish, cost-effective and reversible. Should the energy-only market prove to be unsuitable, it would be a relatively simple matter to further develop the strategic reserve into another mechanism (Süßenbacher et al., 2011). By contrast, a comprehensive capacity market would involve major regulatory risks, would not be easily reversible, and would have the inherent danger that it would entail further regulatory interventions and ultimately the consequence of a restructuring of the existing market design. If the advantages of the integrated European internal market are to be utilised and market distortions averted, every capacity mechanism should be investigated to ascertain the consequences it would have for the European power market. In order to coordinate the compatibility of the efforts that are being made to set up capacity markets in the European countries, Eurelectric (2011) suggest that fundamental rules for the harmonisation of such mechanisms be laid down at the European level.

Should there be any chance of retaining the efficiency and innovation effects of the energy-only market, it should be grasped because alternatively the challenges posed by the transformation of the energy system (phasing-out of nuclear energy and increase of the market share of renewable energies) would have to be managed by means of a rigorous regulatory regime. If it is perceived there is a danger of a market failure on the fundamentally efficient energy-only market over the long term, action should, if possible, be taken primarily to remedy the causes, e.g. by expanding elasticity of demand, instead of treating the symptoms, e.g. the missing contribution margins for the construction of new power plants.

Since there are no convincing indications at present that the energy-only market cannot cope with the current challenges, a profound regulatory intervention in the form of a capacity market would entail unnecessary regulatory risks and could lead to consequential costs due to inefficient design. These risks should only be taken on board if this is truly necessary. The strategic reserve could therefore have the function of an insurance policy, for it would be relatively easy to build up, cost-effective and reversible.

Annex: Brief overview of relevant studies

This Annex gives an account of the studies and their positions, but does not discuss them in detail. It consequently does not reflect the position of Ecofys.

Cramton and Ockenfels (05/2011), commissioned by: RWE AG

This study discusses the rationale for capacity mechanisms, drawing on theoretical reasons for a failure of the energy-only market. For the case of a proven market failure, a comprehensive capacity market is proposed that would be based on the design of the markets in the north-east of the USA and Columbia. The conditions under which such a capacity market would fail to achieve the desired results are delineated. The possible reasons include regulatory risks, political uncertainty, unresolved questions relating to the integration of renewable energies and an unsuitable power market design that, for example, does not take account of regional aspects. Cramton and Ockenfels recommend to initially incentivise long-term investments by creating stable and consistent parameters in order to, in particular, reduce political uncertainties as much as possible.

Frontier Economics (07/2011), commissioned by: RWE AG

Based on the theoretical reflections of Cramton and Ockenfels (2011), this study investigates whether there is market failure on the German power market and whether action is therefore needed urgently. Subsequently, a cost-benefit analysis of capacity markets is carried out, and the international experience of capacity mechanisms discussed. The point is made that, with the exception of the strategic-reserve mechanisms in Sweden and Finland, experience of capacity markets has only ever been gathered on centrally organised pool markets.

The study comes to the conclusion that the capacity-reserve situation in Germany is not critical at the moment, and this position is not forecasted to change. However, it is argued this does not prove whether the present energy-only market offers enough incentives for new investments, since the current situation could possibly be rooted in historic market distortions. Nor could an inadequate volume of capacity be cited as proof of a failure of the energy-only market because the short-term forced closure of generation power plants could lead to capacity shortfalls. For this reason, it is proposed to further research on capacity mechanisms and to develop a political consensus so that, if necessary, the market would have an idea of the possible form the design would take. The proposal put forward by Cramton and Ockenfels (2011) is cited as a suitable reference model.

BET (09/2011), commissioned by: Federal Association of New Energy Suppliers (BNE)

BET explain the rationale behind this study by referring to the present period of radical change, which is being driven, in particular, by the phasing-out of nuclear energy and the expansion of renewable

energies, and ask whether the existing market design is capable of offering sufficient investment incentives.

Model calculations are drawn on to show that under a basic scenario new capacity would have to be constructed by 2030, but approx. 10 GW of existing capacity could be decommissioned between now and 2020. The model would see approx. 30 GW of gas turbines added by 2030 in order to cover the capacity requirement prescribed. As of approx. 2025, combined cycle gas power plants would also replace decommissioned base-load power plants. The need for action to introduce a capacity mechanism is determined on the basis of the missing contribution margins calculated in the model with marginal cost prices being taken into consideration. Subsequently, comprehensive and selective capacity mechanisms are discussed.

As a result, a selective mechanism is proposed to incentivise new investments and prevent existing power plants from holding market power. The authors emphasise that their study is based on recent developments in the discussion, and the medium to long-term task of integrating renewable energies has the goal of putting in place a coordinated overall market design. BET therefore see a need for further research.

r2b (10/2011 and 03/2012), commissioned by: Federal Environment Agency (UBA)

This study investigates the extent to which security of supply is threatened in Germany, whether the introduction of capacity markets would make it possible to enhance security of supply efficiently and effectively, and whether energy-only markets result in inefficiencies with relevant economic costs.

r2b conclude preliminary that security of supply will not be endangered in Germany in the foreseeable future, provided no politically motivated interventions are undertaken into the market. Their investigation of various capacity mechanisms finds that both selective and comprehensive capacity mechanisms have the inherent danger of restricting the efficiency and innovativeness of the power market. For instance, various capacity mechanisms could be accompanied by significant distortions so that, for example, the development of flexibilities would be inhibited on the demand side, the supply side and among renewable energies, and the use of compensatory effects would be considerably restricted on the European internal market.

However, since there is a desire for national security of supply at present and imbalances could theoretically arise on the energy-only market, partly on account of political interventions in market processes, the possibility of a strategic reserve is suggested as an option. The design proposed by r2b would accordingly allow the establishment of a strategic reserve in short term that would be kept available as a form of insurance where there was a proven need for this. In the unlikely event that the market failed to clear, it would guarantee security of supply at the same time as making it possible for scarcity price signals to be sent out.

LBD-Beratungsgesellschaft mbH (11/2011), commissioned by: Ministry of the Environment, Climate Protection and the Energy Sector of the Land Baden-Württemberg

The starting point for this study is the Land Baden-Württemberg's desire to complement the phasing-out of nuclear energy by promoting climate protection and renewable energies, putting in place market incentives for investments in natural-gas power plants and CHP plants, and supporting innovations that expand energy grids and energy storage. The short-term need for action to introduce a capacity mechanism is motivated by the current low generation margins, as well as possible local imbalances in supply and demand due to the phasing-out of nuclear energy. As a result, a selective local capacity market is recommended.

Düsseldorf Institute for Competition Economics (DICE) (2011), commissioned by: RWE AG

This study discusses the economic foundations of various power market designs and draws on international examples to compare ways of implementing them. Subsequently, the necessity of a capacity mechanism and design options for Germany are discussed and commented on from the perspective of political economy.

The study comes to the conclusion that there is no need for the introduction of a capacity market in Germany at present. If a capacity mechanism were to be introduced, this should be done exclusively at the European level as otherwise neighbouring states could engage in free-rider behaviour. In order to ensure security of supply, slight modifications to the market design (e.g. raising the price ceiling to the VOLL price) or the introduction of a cold reserve that would be the equivalent of a strategic reserve could make valuable contributions. DICE expressly advise against the introduction of a capacity market on account of its complexity, the high degree of state intervention it would involve, its susceptibility to design errors and its questionable necessity.

Consentec (02/2012), commissioned by: EnBW AG

This study investigates whether the energy-only market offers potential investors in new power-plant capacities and operators of existing power plants appropriate incentives over the long term so that a sufficient overall level of conventional power-plant capacity can always be guaranteed.

In order to answer this question, Consentec identify one issue that has to be resolved by policymakers as an essential driver of the analysis: whether security of supply should be defined nationally or across the European interconnected grid. On the basis of marginal costs, a market model is applied to calculate whether there are sufficient incentives to retain the generating capacity on the market that will ensure national security of supply. The analysis finds that the market could be lacking approximately 4-8 GW of generating capacity within the next ten years.

The authors conclude from their results that the introduction of a capacity mechanism is unavoidable over the long term if security of supply is dealt with at the national level. The only option then would be a comprehensive capacity market, as this would be the only approach that would efficiently deliver a desired level of capacity. Should policymakers adopt a European perspective on security of supply,

no capacity mechanism would be necessary, at least over the long term. Since both perspectives have significant lead times, Consentec recommend that, if necessary, a strategic reserve should be established as a transitional solution, since it could be introduced comparatively rapidly, would involve minor parameterisation risks and could be discontinued again with slightest market repercussions.

Institute of Energy Economics at the University of Cologne (EWI), commissioned by: Federal Ministry of Economics and Technology (BMWi)

This study discusses whether the current characteristics of the German power market can ensure a sufficiently high level of security of supply at the national level over the long term. In order to answer this question, initially an exogenous national capacity target is set, then an analysis carried out on the basis of marginal costs to ascertain whether the required generating facilities would be able to earn their contribution margins. This is not the case in this analysis.

Subsequently, various options for demand flexibilisation are analysed and it is made clear, 'that on their own they will not alter the amount of capacity needed and the funding required sufficiently to ensure the level of security of supply that is aspired to' (EWI, 2012, p. 42).

Various capacity mechanisms are then analysed to resolve the 'missing money' problem that has been identified. The main focus is placed on a comparison of a strategic reserve with an initially comprehensive capacity market, a market for security-of-supply contracts. This security-of-supply-contracts market would procure secured capacity five to seven years in advance so that new investments could also be involved.

As a result, the study identifies that the energy-only market is increasingly being confronted with major challenges, while the security-of-supply-contract model sketched out in the study would be capable of guaranteeing the prescribed degree of security of supply efficiently and in keeping with market principles. EWI explicitly advise against the creation of a strategic reserve, as this would result in inefficient dispatch and could see decision-makers forced to deploy the strategic reserve more frequently than originally intended. Finally, it is recommended that, if a capacity mechanism were introduced, the detailed planning and implementation work should be carried out at an early stage so as to create incentives for the additional capacities that will be required at the beginning of the 2020s.

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