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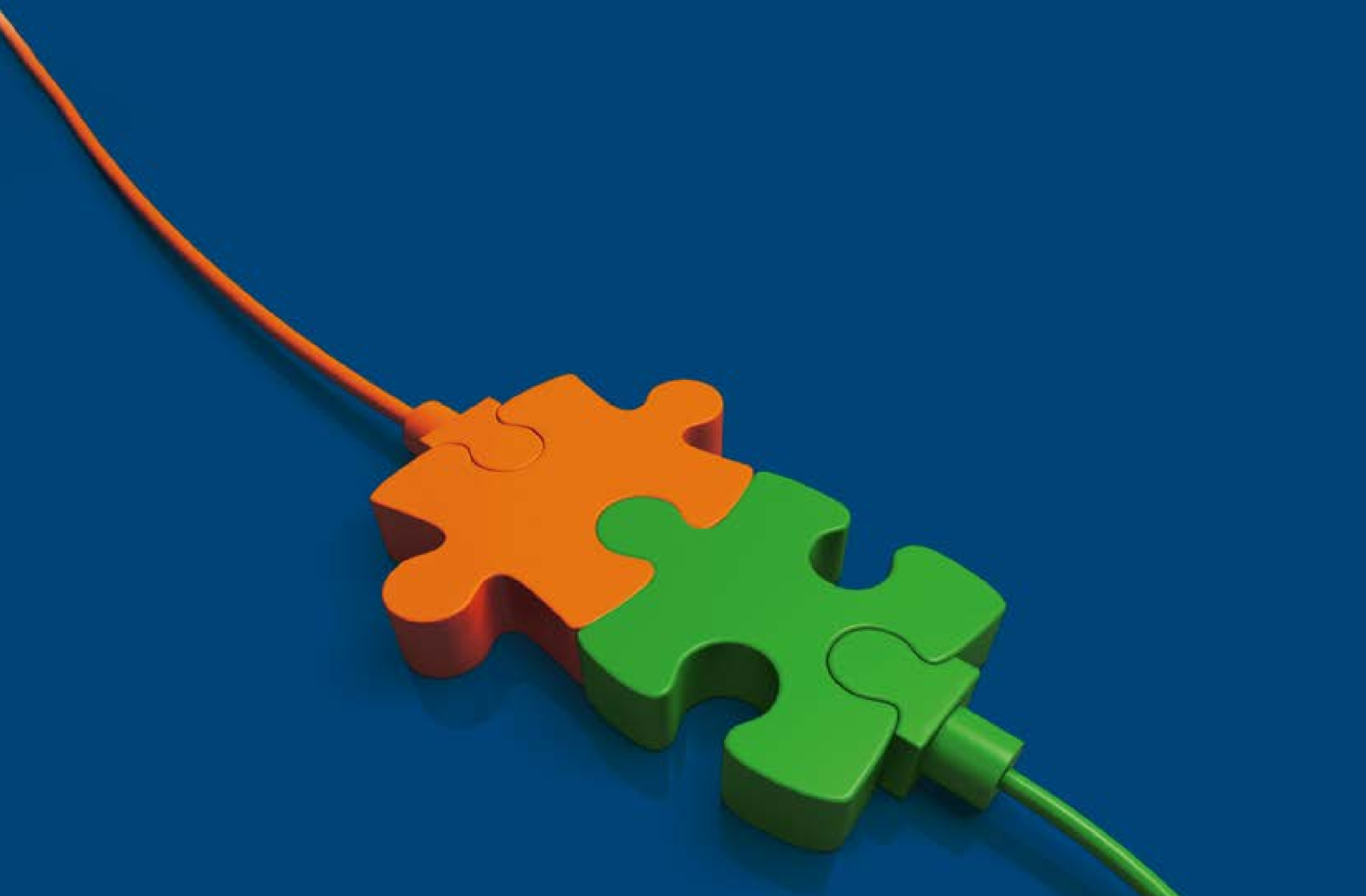
Energiewende
Switch to the Future



An Electricity Market for Germany's Energy Transition

Discussion Paper of the Federal Ministry for Economic Affairs and Energy (Green Paper)

Imprint

Published by
Federal Ministry for Economic Affairs and Energy (BMWi)
Public Relations
10119 Berlin
www.bmwi.de

Design and production
PRpetuum GmbH, München

Status
October 2014

Printed by
Bonifatius GmbH, Paderborn

Illustration
designsoliman – Fotolia.com (title),
Bundesregierung/Bergmann (p. 2)

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Zertifikat seit 2002
audit berufundfamilie

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This publication as well as further publications can be obtained from:
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Content

Foreword

An electricity market for Germany's energy transition

Dear Readers,

The transition to the new energy era – Germany's *Energiewende* – presents an enormous opportunity for modernising our industrial society. It provides incentive for innovation and new technologies, particularly for linking traditional industry with the IT-based control of a complex power supply system. The Federal Government's Digital Agenda clearly comes into focus here. In view of the intermittent nature of electricity generation from renewable sources, power generation and power consumption must be balanced at any given time. On days when the sun fails to shine and winds are low, power plants must take over electricity generation and, where economically viable, demand must adapt to supply or storage capacity must be used. There are many such flexibility options to help us accomplish this task. I am confident that an entirely new market will develop if the future design of the electricity market sends the right signals. The major challenge facing the future electricity market is to continue to guarantee a high level of security of supply at the lowest possible cost and in a clean, environmentally responsible manner. Security of supply and the development of energy prices are central challenges for guaranteeing Germany's competitiveness as a centre for industry.

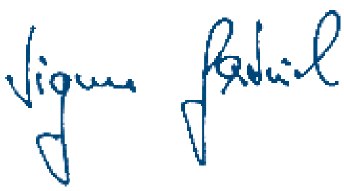
This Green Paper does not present decisions. Rather, the Green Paper is intended to provide the basis for the decisions to be taken in 2015. The priority here is not the speed of decisions, but rather thorough preparation in advance of decision-making. The Green Paper seeks to enable such careful preparatory work. It is based on scientific reports and intensive talks with all stakeholders in the Electricity Market Platform, established by the Federal Ministry for Economic Affairs and Energy (BMWi).

With this as the basis for discussion, the central issue to be debated in the weeks ahead is as follows: Will the continued development of the electricity market suffice, or will we need a capacity market to guarantee long-term security of supply? This is the central question that needs to be addressed. Within the context of a European electricity market, however, security of supply cannot simply be considered from a national perspective, as otherwise national regulations could run the risk of fragmenting the European electricity market. Therefore, while work on the Green Paper progressed, the Federal Ministry for Economic Affairs and Energy also invited neighbouring countries and the European Commission to consider how best to organise cross-border collaboration to ensure security of supply in a cost-effective manner. This cause is supported by all parties involved. The working group that has been set up will help ensure that the future electricity market design integrates well in the European context.

The Green Paper is part of the 10-point energy agenda we have defined to systematically transition the energy system on a step-by-step basis in this legislative term. The first big undertaking was the reform of the Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz, EEG), which managed to break the pattern of cost dynamics in the expansion of renewable energy. Furthermore, there is now clarity concerning the speed of the expansion, thereby providing planning security for the first time for pending structural change in conventional power supply and for the role of renewables in a future electricity market. Other steps, such as pilot auctions for renewable energy, the future development of combined heat and power generation and the rollout of smart meters to consumers with high power demand, will follow shortly.

The success of the *Energiewende* depends largely on ensuring that the many measures are optimally aligned, a high level of supply security is maintained, and costs are kept in check to provide affordable electricity prices. The Federal Government cannot take up this important challenge alone. I would like to express my thanks for the many contributions received, which have been incorporated into this Green Paper, and would encourage everyone involved to play an active role in the debate on the electricity market of the future.

Yours,



Sigmar Gabriel
Federal Minister for Economic Affairs and Energy

Zusammenfassung

Der Strommarkt durchläuft eine Phase des Übergangs. Erneuerbare Energien werden mehr Verantwortung in der Stromversorgung übernehmen, die Nutzung der Kernenergie in Deutschland endet 2022 und die europäischen Märkte für Strom wachsen weiter zusammen.

Die Aufgabe des Strommarkts bleibt identisch. Er muss auch bei steigenden Anteilen von Wind- und Sonnenenergie Erzeugung und Verbrauch synchronisieren. Hierfür muss er zwei Funktionen erfüllen: zum einen dafür sorgen, dass ausreichend Kapazitäten vorhanden sind (Vorhaltefunktion), und zum anderen, dass diese Kapazitäten zur richtigen Zeit und im erforderlichen Umfang eingesetzt werden (Einsatzfunktion).

Das Grünbuch beschäftigt sich damit, wie diese Funktionen zukünftig erfüllt werden. Dabei steht im Fokus, das zukünftige Marktdesign und den Ordnungsrahmen für den Stromsektor so zu gestalten, dass die Stromversorgung sicher, kosteneffizient und umweltverträglich ist. Für die zwei Funktionen des Strommarktes besteht vor diesem Hintergrund unterschiedlicher Handlungsbedarf.

Der Einsatz verfügbarer Kapazitäten muss optimiert werden. Das Grünbuch enthält eine Reihe von Maßnahmen, um die Einsatzfunktion des Strommarktes sicherer und effizienter zu erfüllen. Hierzu zählen insbesondere die Verbesserung der Bilanzkreisbewirtschaftung, der Netzausbau und die Weiterentwicklung der Regelleistungsmärkte. Diese verstehen sich als „Sowieso-Maßnahmen“, d. h. sie sind in jedem Fall sinnvoll und wichtig für den sich wandelnden Strommarkt.

Die Vorhaltung ausreichender Kapazitäten erfordert eine Grundsatzentscheidung. Für die langfristige Entwicklung des Strommarktes stehen zwei grundsätzliche Lösungsansätze zur Verfügung: Wollen wir einen optimierten Strommarkt (Strommarkt 2.0) mit einem glaubwürdigen rechtlichen Rahmen, auf den Investoren vertrauen können, und in dem Stromkunden in eigener Verantwortung über ihre Nachfrage bestimmen, wie viele Kapazitäten vorgehalten werden – oder wollen wir neben dem Strommarkt einen zweiten Markt für die Vorhaltung von Kapazitäten einführen (Kapazitätsmarkt)?

Die Unsicherheiten der Übergangsphase sollten in jedem Fall mit einer Kapazitätsreserve als zusätzlicher Absicherung adressiert werden. Dies gilt sowohl für den Fall, dass der Strommarkt optimiert, aber in seiner heutigen Grundstruktur beibehalten wird, als auch bei Einführung eines Kapazitätsmarktes. Internationale Erfahrungen zeigen, dass die Schaffung von Kapazitätsmärkten von der Grundsatzentscheidung bis zur vollen Funktionsfähigkeit mehrere Jahre in Anspruch nimmt. Es ist daher in jedem Fall geboten, für die Übergangsphase ein Sicherheitsnetz in Form einer Kapazitätsreserve einzuziehen.

Das Bundesministerium für Wirtschaft und Energie konsultiert das Grünbuch. Der Konsultation wird Ende Mai 2015 ein Weißbuch folgen. Auch das Weißbuch wird öffentlich konsultiert werden (bis September 2015). Daran wird sich die notwendige Gesetzgebung anschließen.

Summary

The electricity market is undergoing a period of transition. Renewable energy will take on a greater role in the power supply as the use of nuclear energy in Germany will end in 2022 and the European markets for electricity will continue to grow together.

The role of the electricity market will remain the same. It must maintain a balance between power generation and consumption, especially in view of the fact that the shares of wind and solar energy in the power supply mix increase. To achieve this, it has to fulfil two tasks: Firstly, it must ensure that sufficient capacity is available (i.e. reserve function) and secondly, that this capacity is used at the right time and to the extent necessary (i.e. dispatch function).

The Green Paper is concerned with how these two tasks will be fulfilled in the future. It focusses on how to develop a future market design and regulatory framework for the electricity sector that ensures that the power supply is secure, cost-efficient and environmentally friendly. Against this background, various actions must be taken to accomplish the two tasks.

The use of available capacity must be optimised. The Green Paper contains a number of measures that seek to fulfil the task of appropriate use of capacity in a more secure and efficient way. They include improving the balancing group management, expanding the network and further developing the balancing energy markets. These measures are deemed to be "no regret" measures, i.e. they make good sense in every scenario and are important for the changing electricity market.

The maintaining of sufficient capacity requires a decision of principle. Two basic approaches are available for the long-term development of the electricity market: Do we want an optimised electricity market (electricity market 2.0) with a credible legal framework that investors can rely on and which allows electricity consumers to independently determine through their demand how much capacity is maintained – or do we want to set up a further market alongside the electricity market for the maintaining of reserve capacity (capacity market)?

The uncertainties of the transition period should be addressed in each case by maintaining reserve capacity as an additional safeguard. This applies both in the case that the electricity market is optimised while its current fundamental structure is maintained and in the case that a capacity market is introduced. International experience shows that the creation of capacity markets takes several years from the fundamental decision until the time that they become fully operational. It is therefore necessary in any case to build a safeguard into the system in the form of reserve capacity for the transition phase.

The Federal Ministry for Economic Affairs and Energy shall consult the Green Paper. The consultation will be followed by a White Paper at the end of May 2015. The White Paper will also be publicly consulted (until September 2015). This will be followed by the drafting of the necessary legislation.

Introduction

Security of supply, economic viability and environmental compatibility: this triad of energy goals signals the direction of German energy policy. The aim is to make energy supply more environmentally friendly, while also ensuring it remains secure and cost-effective. The actual restructuring of the power supply system is founded on the Federal Government's Energy Concept, unveiled in 2010, and the decisions of the German Bundestag in 2011 to transition to a system based on renewable energy, Germany's *Energiewende*. All parties in the German Bundestag are in favour of the *Energiewende*. The Federal Government has specifically reaffirmed its commitment to the goals of the Energy Concept, most recently in the second monitoring report on "Energy of the Future", released on 8 April 2014. In transitioning the energy system, greater focus will be placed on the aspect of economic viability in order to uphold the competitiveness and innovative capacity of Germany as a centre of business and production, and to ensure affordable prices for end customers. With this approach, the transition to the renewable age can become an economic and environmental success.

Quantitative goals guide the medium- and long-term restructuring of the electricity sector. By 2020, the goal is to reduce greenhouse gas emissions by 40 percent compared to 1990 levels, and cut primary energy consumption by 20 percent over rates for 2008. Renewables are to have a 40 – 45 percent share in electricity production by 2025, and a 55 – 60 percent share by 2035. The Federal Government has set additional goals for 2050: By then, greenhouse gas emissions are to be reduced by 80 – 95 percent compared to 1990 levels, and primary energy consumption is to have halved compared to levels for 2008. This will be supported by a reduction in power demand. At the same time, the Federal Government seeks to increase the share of renewables in the electricity mix to at least 80 percent.

The electricity market will undergo a period of transition in the years ahead. Market liberalisation and the European internal market enhance the efficiency of the power supply system and the resulting smoothing effects reduce the need for generation capacity in the European system. The increase in generation capacity, particularly renewable capacity, and the reduction in overcapacity which can be witnessed today will continue in the years ahead. Further to this, roughly 12 gigawatts of output from nuclear power plants in Germany will go offline by the end of 2022. At the same time, we are transitioning from a power system in which controllable power stations follow electricity demand to an efficient power system overall where flexible producers, flexible consumers and storage systems respond to the intermittent supply of wind and solar power. New renewable energy facilities will need to accept the same responsibility for the overall system as conventional power plants.

The electricity market should continue to synchronise power production and power consumption efficiently. It should ensure that sufficient capacity is available – i.e. producers or flexible consumers – so that supply and demand can be balanced at any time (reserve function), while at the same time making sure that this capacity is used in such a way that power generation and power consumption are always in equilibrium (dispatch function).

Today the priority is to find the best architecture for the electricity market of the future. This is the central question that needs to be addressed: What form should the future market design and regulatory framework for the power sector take in order to guarantee a secure, cost-effective and environmentally sound power supply system taking into account an increasing share of wind and solar energy in electricity production?

With its Green Paper "An Electricity Market for Germany's Energy Transition," the Federal Ministry for Economic Affairs and Energy (BMWi) wishes to facilitate a structured debate and an informed political decision on the future design of the electricity market:

- Part I analyses the **operation and challenges of the current electricity market** (chapters 1 – 3).

- Part II discusses measures that ensure the secure, cost-effective and environmentally compatible dispatch of producers and flexible consumers. These measures make sense, irrespective of the fundamental policy decision in Part III **("no regret measures")**. In addition to the design of the electricity market, the regulatory conditions and complementary instruments – i.e. the entire regulatory framework for the electricity sector – are also relevant. Specifically this concerns strengthening the pricing signals in the electricity market (chapter 4), grid expansion and operation (chapter 5), maintaining a single price zone (chapter 6), the European integration of the electricity market (chapter 7) and measures to deliver on the climate protection goals (chapter 8).

- Part III looks at solutions that ensure that **sufficient capacity** is available at all times. The focus here is on a **fundamental policy decision**: do we trust in an optimised electricity market (electricity market 2.0) or do we additionally introduce a second market (the "capacity market") to hold capacity available (chapter 9)? Either way, collaboration with our European neighbours is of central importance (chapter 10). Further to this, there is also some uncertainty associated with the current period of transition. For this reason, power supply should be safeguarded by a capacity reserve (chapter 11).

This Green Paper opens a public consultation. This consultation will be concluded in March 2015. A White Paper with concrete, defined measures will follow the consultation at the end of May 2015. There will also be public consultation on the White Paper (until September 2015). This will be followed by the drafting of the necessary legislation. At the same time, given the cost advantages afforded by joint solutions in the context of the European internal market, the Federal Ministry for Economic Affairs and Energy will hold talks with neighbouring states and the European Commission.

Comments on the Green Paper can be submitted to the following address until 1 March 2015: gruenbuch-strommarkt@bmwi.bund.de.

Part I: The electricity market today and in the future.

The following three chapters describe how the electricity market[1] operates (chapter 1), analyse the challenges the market faces (chapter 2), and look at the importance of the development of supply and demand flexibility for the electricity market in the future (chapter 3).

1 The Green Paper deals with the wholesale markets for electricity, not how public utility companies sell electrical energy to end users.

Chapter 1: How the electricity market operates

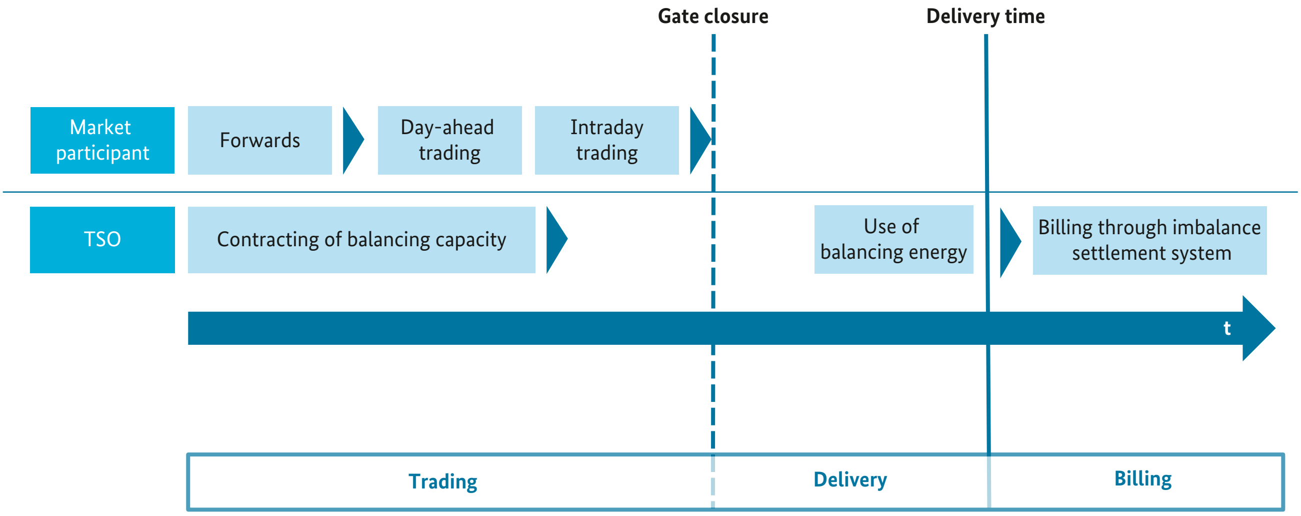
The electricity market consists of a number of "submarkets" (1.1) that generate the pricing signal which electricity production and consumption align to (1.2). The transmission system operators use balancing capacity to balance out any unanticipated differences (1.3). The system of balancing groups and imbalance settlement controls synchronisation (1.4). As a result of the interaction between these mechanisms, the electricity market provides remuneration for energy and capacity (1.5). Transmission system operators rectify bottlenecks in the grid by expanding and upgrading the power grid, and, on an interim basis, by using redispatch measures (1.6).

1.1 The submarkets enable efficient electricity trading

Electricity is traded on the exchange and over the counter. Standardised products are bought and sold in a transparent process on the exchange, which, for Germany, is the European Energy Exchange EEX in Leipzig, and the European Energy Exchange EPEX SPOT in Paris. However, companies primarily still enter into direct supply contracts with electricity producers. Trade with these supply contracts which are agreed outside the exchange is known as over the counter trading (OTC).

Trading takes place on forward, day-ahead and intraday markets. On the forward market, companies can agree deliveries up to six years in advance, with trading for the next three years being particularly liquid. The products that are traded in this way are referred to as "futures" on the exchange and "forwards" in OTC trading. The spot market encompasses the day-ahead market and the intraday market. Electricity deliveries for the next day are auctioned on the day-ahead market, with suppliers and buyers having to submit their bids by 12 midday on the previous day. The closer it gets to the agreed time of electricity delivery, the better the market participants can estimate the actual feed-in and real consumption. To keep shortfalls or surpluses to a minimum and ensure the cost-effective dispatch of the available power generation facilities, market participants can – after the day-ahead auction closure – have recourse to the intraday market and trade on a very short-term basis with electricity volumes for periods ranging from quarter hours to hour blocks. Intraday trading on the exchange closes 45 minutes before delivery ("gate closure"). Companies can engage in OTC trading up to 15 minutes before delivery.

Figure 1: Submarkets of the electricity market in Germany, chronological representation



Source: Own graphic based on data provided by Frontier

The German electricity market is coupled with the electricity markets of 15 neighbouring countries[2]. The exchange price on the day-ahead market is determined jointly for coupled markets. Electricity providers and electricity purchasers submit their bids in their national day-ahead market zones[3]. In an iterative process, the demand for electricity in the market zone is served by the lowest price offers of electricity from all the market areas until the capacity of the connections between the market zones (cross-border interconnectors) is fully utilised. As long as the cross-border interconnectors have sufficient capacity,[4] this process aligns the prices in the coupled market areas. On account of market coupling, the national power demand is covered by the international offers with lowest prices. The upshot is that on the whole less capacity is required to meet the demand (see section 2.1).

1.2 The electricity pricing signals guide producers and consumers

The price quoted on the exchange is the point where supply and demand intersect. In the electricity market, the generation facilities with the lowest variable costs are the first in line to meet demand ("merit order"). This helps minimise the cost of supplying electricity. As a general rule, the exchange price for electricity corresponds to the variable costs of the most expensive generation plant in use. This plant is known as the "marginal power plant". The exchange price is therefore also referred to as the marginal cost price.

Generation facilities whose variable costs are lower than the variable costs of the marginal power plant can achieve a contribution margin. If the variable costs of a power station are below the costs of the marginal power plant, this power station generates a margin. Fixed costs of the plant (such as labour and capital expenses) can be covered by this margin (contribution margin). The variable costs of a power station primarily depend on the fuel costs, the degree of plant efficiency or the cost of CO_2. In Germany, wind farms and photovoltaic installations (close-to-zero marginal costs), nuclear and coal-fired power plants as well as the majority of gas-fired power plants with combined heat and power generation currently generate a contribution margin for many hours of the year.

If the electricity market price is set by power demand or by producers that include fixed costs in their price offer, very expensive marginal power plants can also achieve a contribution margin. If the available generation capacities are utilised to the limit, supply and demand can be balanced either by demand side management (i.e. flexible consumers reduce their demand) or by the last generation unit. In this scenario, the price on the electricity market can exceed the variable costs of the most expensive generation plant. Here, pricing is based on the consumers' willingness to pay (demand side management) or by producers that include fixed costs in their price offer. Therefore, consumers that benefit greatly from electricity consumption are prepared to pay high prices for the electricity in individual hours. These prices can be higher than the variable costs of the marginal power plant. If the price exceeds the associated benefit, consumers are free to reduce their electricity consumption. In this case, electricity already bought on the forward market could be resold for a profit. This pricing is also referred to as "peak-load pricing".

1.3 Balancing capacity balances out unforeseeable differences on the short term

A distinction must be made between the commercial market result, i.e. the balance between supply and demand, and the physical equilibrium between generation and consumption. If the outcome of electricity trading is a market result where supply and demand are balanced in the electricity submarkets, this does not necessarily mean that physical electricity generation and electricity consumption are also in equilibrium. The latter can differ from the commercial market result, for example, if unforeseen events (such as power plant failures, altered weather conditions or a short-term change in consumption) cause the actual power supplied or the actual power consumed to deviate from the forecasts on which electricity trading is based.

2 Germany and Austria have a common bidding zone. Via a common market clearing algorithm, Germany is directly coupled with the Nordic countries (Denmark, Finland, Norway and Sweden), Great Britain and the other countries of central-western Europe (Belgium, France, Luxembourg, Netherlands) and is indirectly coupled with the Baltic states and Poland, which are coupled with the Nordic market via a common market coupling algorithm.

3 Also known as a price or bidding zone.

4 Bottlenecks should be managed as efficiently as possible.

Balancing capacity balances out unforeseeable imbalances. Transmission system operators procure balancing capacity to secure the physical equilibrium between production and consumption. They calculate the capacity they need for system security, procure this capacity on the balancing market in competitive bidding procedures, and thereby have the ability to adjust generation or consumption at short notice. Transmission system operators make a distinction between three different types of balancing capacity: Primary balancing capacity must be fully available within 30 seconds of being requested, secondary balancing capacity within five minutes and the minute reserve (tertiary balancing capacity) within 15 minutes. The transmission system operators also distinguish between positive and negative balancing capacity. Positive balancing capacity is delivered through higher production or lower consumption, while negative balancing capacity, in contrast, is delivered through lower production or higher consumption.

1.4 The system of balancing groups and imbalance settlement controls synchronisation

The system of balancing groups and imbalance settlement is the central synchronisation instrument. Together with balancing capacity, the balancing group and imbalance settlement system ensures that precisely the same amount of electricity is fed into the power grid as is simultaneously drawn from the grid. In particular, it involves the obligations to incorporate all producers (generators) and consumers into balancing groups (balancing group obligation), report balanced schedules on the basis of load and generation forecasts and adhere to them (obligation to uphold balancing group commitments) and to charge for any unforeseen imbalances using the imbalance settlement system.

The balance between production and consumption is settled through balancing groups. A balancing group is a type of virtual energy-volume accounting, managed by a balance responsible party (BRP). For example, a balancing group comprises the power stations of a power station operator or the total generation and total demand of an energy provider. There are also trade balancing groups that deal exclusively with traded volumes of electricity. Every producer and every consumer in Germany is assigned to a balancing group. As part of schedule reporting, for each quarter hour of the following day the BRPs report how much electricity they will supply to the grid and from which particular generation facility, or from which particular grid connection point they wish to take electricity from the grid. The schedules also include any planned electricity exchange with other balancing groups according to the results of the electricity market.

The cost of imbalance settlement is the central incentive to synchronise electricity production and consumption. The use of balancing capacity to balance physical imbalances between electricity production and consumption ensures that the differences between the reported schedule and the actual balance in the energy account are balanced over the entire control area. The costs for the use of balancing capacity are settled through the imbalance settlement system. This means that if the balance of a balancing group is at odds with the area’s schedule, the balancing group must bear the costs for utilising balancing capacity. Therefore, the costs of settling the imbalance are to act like a fine for deviating from the reported schedule. They are the central incentive for ensuring the balancing groups are balanced (cf. section 4.2).

1.5 The electricity market provides compensation for energy and capacity

In addition to paying for energy, the electricity market also pays for capacity. Energy describes the energy provided (in kilowatt hour or megawatt hour), while capacity describes the generation capacity and therefore the ability to provide energy (we then refer to kilowatt or megawatt). Only electrical energy is explicitly traded on the spot markets. Therefore, it is often referred to as the “energy only market” (EOM). The electricity market implicitly provides compensation for capacity on forward markets, spot markets (particularly in the form of contribution margins explained in section 1.2) and in power purchase agreements. The electricity market explicitly provides compensation for capacity on the balancing capacity market, in option agreements or hedging contracts.

With electrical energy, the capacity required for the energy is also always implicitly traded and remunerated. The implicit compensation of capacity results from the balancing group and imbalance settlement system (cf. section 1.4) and the imperative delivery obligations for the energy traded. The providers are obliged to meet their delivery obligations for the energy traded.

They must maintain or contract appropriate capacities to do so. In the event of a mismatch, they must pay the costs of imbalance settlement. Therefore the current system of balancing groups and imbalance settlement already provides incentive to maintain sufficient power plant capacity or consumer flexibility in order to meet delivery obligations (see Frontier/Formaet 2014 and r2b 2014) and to safeguard against pricing and volume risks (r2b 2014). In times of overcapacity, this implicit remuneration of capacity is low, and increases the scarcer capacities become in the electricity market.

1.6 Redispatch – the answer to temporary grid congestion

Bottlenecks in the grid hamper the transmission of electricity between producers and consumers. In Germany, electricity is increasingly produced in wind farms in the north and east of the country. However, many load centres are primarily located in the south and west. Failure to expand and upgrade the grid sufficiently could further aggravate the grid congestion that already exists between the north and south (see also chapters 5 and 6).

Transmission system operators adjust power station operation when bottlenecks occur. On the basis of the schedules reported, inter alia, the transmission system operators calculate the expected flow of electricity through the lines of the transmission grid. If grid bottlenecks or critical grid situations can be expected on the basis of this calculation, the TSOs can instruct power stations, wind farms and solar power plants to adjust their planned production of electricity in order to specifically avoid congestion. This process is known as redispatch (see chapter 5).

Redispatch can guarantee safe system operation even in the event of grid bottlenecks. Transmission system operators advise electricity producers on the oversupplied side of the bottleneck to reduce production in their plants. Conventional plants are first advised to reduce production. If this does not deliver adequate results, the output of plants that generate electricity from renewable energy is also curtailed. On the other side of the grid bottleneck, power stations are ramped up to replace the reduced electricity production to the same extent. The plant operators on both sides of the grid bottleneck receive financial compensation for regulating production down and up respectively. The costs of redispatch are redistributed to electricity consumers through the network charges, and amounted to € 115 million in Germany in 2013 (Federal Ministry for Economic Affairs and Energy 2014).

Chapter 2: Challenges

The electricity market will undergo a period of transition in the years ahead (2.1). The central responsibility of the electricity market will be to ensure cost-effective security of supply, and to synchronise electricity production and consumption to this end (2.2). Minimum generation in the system can aggravate the secure, cost-effective and environmentally compatible synchronisation of production and consumption (2.3).

2.1 In the years ahead, the electricity market will undergo a period of transition

The electricity market is now liberalised. Up until 1998, electricity providers had set supply areas, and power supply and grids were usually owned by the same company. Liberalisation has ended this monopoly, and competition has made electricity production and electricity supply more efficient.

The European markets are largely coupled and continue to grow together. The coupling of national electricity markets is a central element in the completion of the European internal market. In coupled markets, electricity is traded simultaneously, taking into account the transmission capacities available. As a result, production capacities and grids can be better utilised (cf. section 1.1).

The liberalisation of the electricity markets and the EU internal market for electricity are contributing factors to current overcapacities. Thanks to competition and the coupling of national markets, electricity is produced and traded more efficiently today than before, and fewer power plants are needed. This has given rise to overcapacity, a fact which has been aggravated by the increase in power from renewables, the operation of new fossil-fired power stations and the economic crisis in Europe, which has resulted in an unexpectedly low demand for electricity (CEPS 2014). Overcapacities currently amount to roughly 60 gigawatts in the electricity market region relevant for Germany (cf. chapter 7).

Overcapacities and low CO_2 prices are currently driving down wholesale prices. While the current situation relieves the financial burden on electricity consumers that buy electricity on the wholesale market, it reduces the economic viability of existing and new power plants and increases the need for funding for renewable sources of energy. Operators are currently retiring numerous power stations. This necessary consolidation process will continue in the years ahead.

Many studies suggest that the economic viability of power stations will improve over the medium term. As overcapacity is reduced, prices are expected to stabilise (Frontier et al. 2014, r2b 2014). In turn, this will improve the financial viability of existing and new power plants, renewable energy and storage systems. This is particularly true if demand for electricity occasionally sets the electricity market price in the future (cf. “peak-load pricing” in section 1.2). The question as to whether an optimised electricity market will ensure the constant, secure supply of electricity to consumers, or whether a capacity market should also be introduced, is discussed in Part III.

The current electricity market has essentially proved to be successful in the first phase of the *Energiewende*. During this period, the share of renewable energy in electricity production has risen to around 25 percent. In 2011, eight nuclear power plants with a total output capacity of around eight gigawatts were closed down permanently. The market has proved to be remarkably adaptable. For example, due to the pricing signals received, operators of conventional power plants have adapted operation to the increasingly volatile residual load to an extent that was not considered technically possible just a few years ago. At the same time, innovative demand side management solutions have been trialled.

Germany will phase out nuclear energy by 2022. As a result of the nuclear phase-out, a further 12 GW of generation capacity will be retired.

The strong expansion and penetration of renewables will continue as part of the corridor for expansion defined in the Renewable Energy Sources Act. Wind energy and photovoltaic installations will play a central role in this development. Wind and sun are the sources of energy with the greatest potential and the lowest costs. However, they are intermittent sources in that electricity production depends on the weather. This can fluctuate greatly depending on the season or time of day.

There is a decreasing need for base load and mid-merit power plants. The expansion of renewable energy is changing requirements with regard to the thermal power plant fleet. The overall need for fossil-fired power stations, and for base load and mid-merit power plants in particular, is decreasing while the demand for flexible peak load technologies and demand side management is rising.

The electricity market is increasingly flexible in its response to intermittent electricity production with renewables; larger consumers are becoming more and more active in the electricity market if this allows them to increase their profitability (demand side management). We are transitioning from a power system in which controllable power stations follow electricity demand to an efficient power system overall where flexible producers, flexible consumers and storage systems respond increasingly to the intermittent supply of wind and solar power. This transition will take place over the coming years.

2.2 Synchronisation: One task, two functions

At its core, the electricity market performs a synchronisation task. Electrical energy cannot be stored in the power grid. The electricity market must make sure that precisely the same amount of electricity is fed into the power grid than is drawn from it at any one time. The electricity market has two central functions to perform this synchronisation task: that of maintaining sufficient capacity (reserve function), and that of ensuring the appropriate use of capacity (dispatch function).

One function of the electricity market is to maintain adequate reserve capacity: Adequate capacity must be available on the market either through producers or flexible consumers so that supply and demand can be balanced at any time. Pricing signals must ensure that market players provide an appropriate and efficient technology mix of flexible producers and flexible consumers make timely investments in new capacities at the production or consumption end (demand side management). The market players base their investment decisions on market price forecasts and quotations in the forward market. If these indicators suggest that investment would be worthwhile, a main condition is met for a decision in favour of investment.

Adequate capacity is available on the short to medium term. The current capacities available can guarantee the secure provision of electricity to consumers in the coming years (TSO 2013; r2b 2014; Frontier et al. 2014; see also chapter 9). The low wholesale prices currently observed underline the fact that there is considerable overcapacity in the market at present. With power plants being retired or shutdowns scheduled, this is an indicator that the electricity market is sending the right signals. Overcapacity must be eliminated.

Talks currently centre on how the electricity market will also ensure sufficient capacity over the long term in order to perform its role of maintaining adequate capacity. The question as to whether the electricity market provides incentive for sufficient capacity to guarantee the secure supply of electricity to consumers, or whether there is also a need for a capacity market, is discussed in Part III.

The second function of the electricity market is to ensure the appropriate use of capacity (dispatch function). Electricity production and consumption must be in balance at any time. Therefore it is not enough for sufficient capacity to be available technically (installed generation capacity and flexible capacity on the consumer side). For supply to be secure, the pricing signals on the electricity market must ensure at all times that the capacity available is contracted and actually utilised to the extent required (i.e. matching the level of anticipated consumption). The particular measures that are required for the secure, cost-effective and environmentally compatible deployment of producers and flexible consumers are discussed in Part II.

Capacities are a necessary but not sufficient condition to guarantee security of supply.

Example 1: Germany, February 2012. The supply situation was tense for many hours even though sufficient capacity was technically available. For several hours, the only way to keep the system stable was through the use of a large amount of balancing capacity and other reserves that could be activated at short notice. This situation was caused by balancing groups with a systematic shortfall: A large number of BRPs had purchased insufficient volumes of electricity on the market to cover the actual consumption in their balancing group. This example illustrates how important the dispatch function of the electricity market is for security of supply, particularly with regard to correct incentives for the system of balancing groups and imbalance settlement and the removal of any barriers.

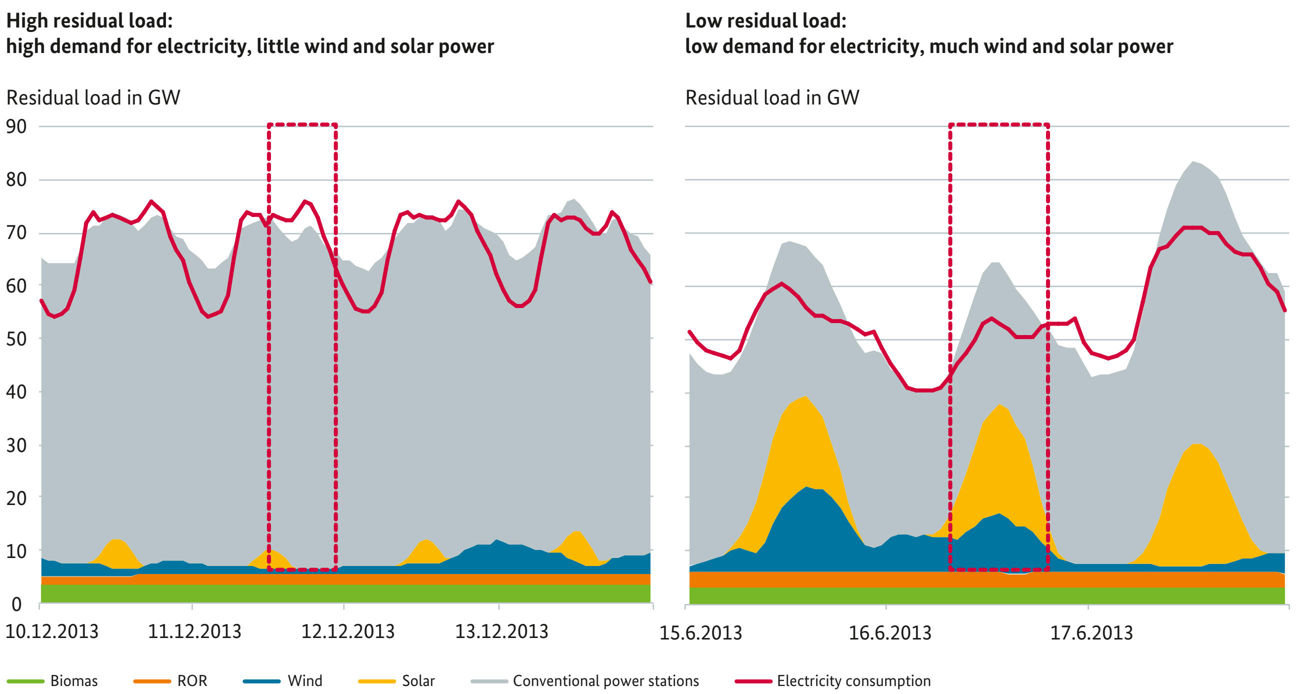
Example 2: United States, January 7 2014. On the east coast of the US, a very critical supply situation was experienced in the power grid of energy provider PJM[5] even though more than enough generation capacity was held available by the capacity market there. On this particular day, over 40 gigawatts, or 22 percent of the generation capacity, was not available to the wholesale market when it was urgently needed. The reason was because these plants did not have sufficient incentive to be ready for operation and be actually dispatched. PJM therefore announced that it would revise its electricity market regulation (PJM 2014).

The synchronisation of production and consumption must also work in the two extreme situations, with high and low residual load. The residual load is the power demand that cannot be met by renewable energy sources and instead must be served by conventional power plants, electricity imports or storage facilities. Two extremes can occur:

1. **Maximum residual load:** The demand for power is high and, at the same time, the amount of electricity produced by wind and solar installations is low. This can happen, for example, on a cold, calm winter evening.

2. **Minimum residual load:** The demand for power is low and, at the same time, the amount of electricity produced by wind and solar installations is high. This can occur on a windy and/or sunny weekend or public holiday.

Figure 2: Examples of situations with high and low residual load



Source: Connect Energy Economics

5 PJM is a regional transmission organisation in the United States, serving Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia.

Both extremes present the electricity market with challenges that the market must address in a secure and cost-effective manner. In times of high residual load (high demand for electricity, low output from wind and solar power installations), flexible, conventional power stations, storage systems or electricity imports from abroad must cover the demand. Alternatively, flexible consumers can reduce their demand for electricity and, for example, sell electricity already purchased on the market for a profit. In the case of low residual load (low demand for electricity, high output from wind and solar power installations), thermal producers should be ramped down, storage and export options should be used or flexible consumers should increase their demand. In this way, wind and solar-based electricity, which is provided at low marginal costs, can be integrated efficiently and securely into the system. Only extreme feed-in peaks of wind and solar electricity ("last kWh"), which are rare, should be limited (cf. chapter 5).

The challenge presented by minimum residual load will grow with an increasing penetration of renewable energy. With renewable energy currently contributing around 25 percent of the electricity consumed, the minimum residual load today is roughly 15 gigawatts. Therefore, the electricity market is far from having an "oversupply" of renewable energy. The minimum residual load could be minus 25 gigawatts in 2035 (Fraunhofer ISI 2014, cf. Figure 3). In such scenarios, opportunities for exporting electricity to neighbouring markets will probably no longer suffice. It is therefore important for domestic thermal conventional producers to be able to reduce their generation capacity to the greatest extent possible (cf. 2.3) and for flexible electricity consumers to be able to increase their demand at such times. In the future, these flexible consumers are also likely to come from other sectors such as the heating and transport sector (sector coupling, cf. chapter 3). Further to this, electricity storage systems, for example in the form of pumped-storage power stations, can make a key contribution to stabilising the residual load by drawing electricity from the grid in times of high electricity feed-in.

2.3 Conventional minimum generation can hamper synchronisation

At low residual load (low demand for electricity, high electricity output from wind and solar installations), there is still a very high level of conventional minimum generation. In this context, minimum generation refers to the production of electricity by certain thermal conventional power stations which even takes place at low residual load and exchange prices of zero or below ("minimum load problem"), particularly because electricity generation is required for ancillary services (balancing capacity, reactive power, redispatch or other ancillary services). Depending on the situation, minimum generation can currently reach up to 25 gigawatts, which is equivalent to more than a third of the average load. To be able to guarantee security of supply on the long term even with a low residual load, minimum generation should be reduced on the one hand, and, on the other hand, it should be technically feasible to curtail renewable installations to a large extent in order to avoid "excess" electricity feed-in (Ecofys/Consentec 2013).

There are many reasons for minimum generation at present. Minimum generation occurs if a power plant needs to provide balancing capacity (cf. chapter 4), reactive power (cf. chapter 5) or heat (cf. chapter 8). The high levels of electricity produced from lignite-fired power plants and nuclear power stations at low residual load can also act like minimum generation. This is mainly due to the fact that lignite-fired and nuclear power plants are expensive to start up and shut down and usually take several hours before they are up and running. Fossil-based onsite private production, too, can also have the effect of minimum generation if its response to pricing signals is lacking or limited on account of exemptions from paying the EEG surcharge under the Renewable Energy Sources Act (hereinafter referred to as the EEG surcharge) and privileges as regards the network charges or the concession levy.

With a high penetration of renewable energy, minimum generation can hamper the cost-effective and environmentally compatible synchronisation of production and consumption at a low residual load. If the level of minimum generation were to remain high, this would then lead to greater curtailment of renewable electricity and low or even negative electricity prices would be more frequent. Therefore it makes sense to reduce minimum generation gradually.

Curtailment of renewable energy installations is not a sensible alternative to reducing minimum generation. In rare, extreme situations, it can make economic sense to impose moderate restrictions on the output of renewable energy installations so as to save on grid capacity and storage for rare feed-in peaks, for instance (cf. chapter 5). However, curtailment of renewable energy installations is not a sensible alternative to reducing minimum generation. If curtailment is extensive, the resulting costs could be higher than the costs that would be saved through minimum generation at the power plant end. The graphic below illustrates the interrelations, taking the example of the German electricity generation system (without any further development in the flexibility of generation and demand):

With minimum generation remaining at the same level and renewables having a 60 percent share in the electricity mix, 15 percent of the electricity generated from renewable sources would need to be exported, or curtailed if export opportunities were lacking (Fraunhofer ISI 2014).

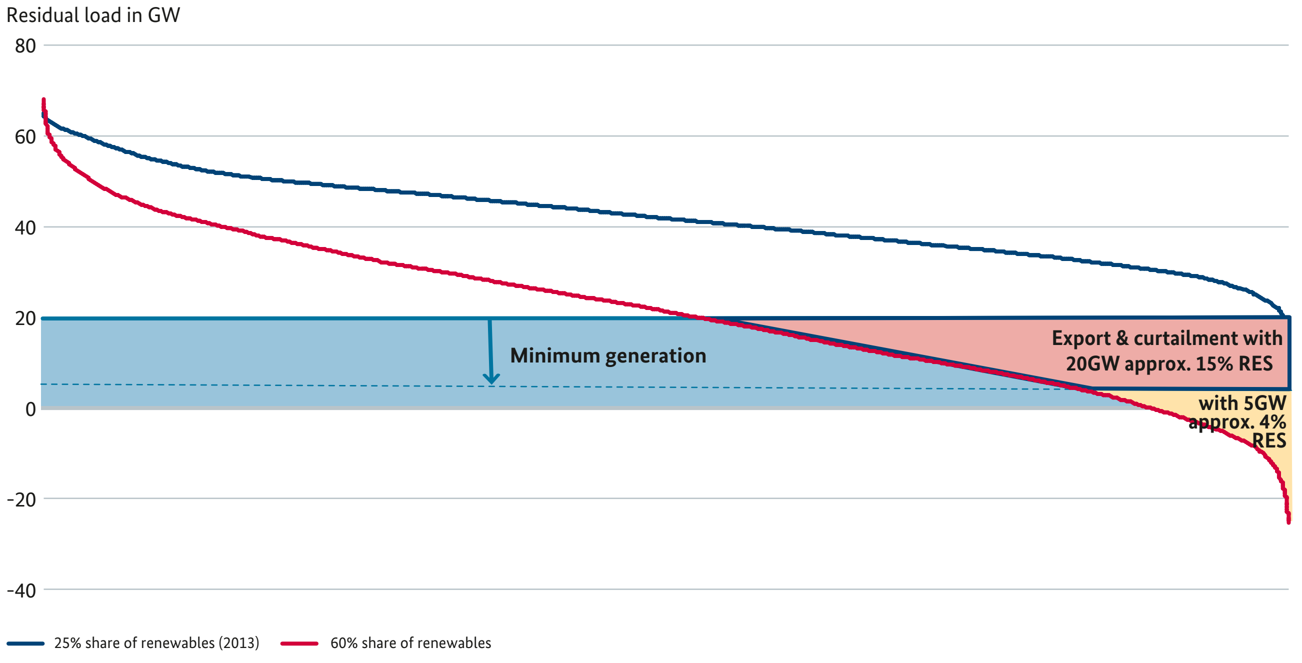
The role of energy efficiency:

Increasing energy efficiency also reduces the power demand of "traditional" electricity-powered appliances and facilities, while "new" consumers, such as electric vehicles and heat pumps, have batteries or heat storage systems that can be flexibly charged and can help add flexibility to the electricity system.

Saving electricity is a particularly cheap way of reducing system costs. Cost reduction is achieved through lower costs for fossil- and renewable-based power stations and through lower fuel expenditure. Ever since the all-time high of 2007 (622 TWh), German power consumption has declined and is steadily on the decrease (2013: 598 TWh; Federal Ministry for Economic Affairs and Energy: energy data 2014a). If this trend continues and Germany continues to make progress towards its energy efficiency goals, the system costs will fall significantly. By saving electricity, a cost reduction of € 10 – 20 billion could be achieved in 2035 (Agora 2014).

Electrical efficiency and electricity savings brought about by more efficient appliances and facilities can _permanently_ reduce the residual load as increased electrical efficiency is effective particularly in times of high residual load.

Figure 3: Effect of minimum generation with an increasing share of renewable energy



Source: Fraunhofer ISI

Chapter 3: Flexibility is an answer

From a technical point of view, sufficient options – known as flexibility options – are available to the electricity market to synchronise generation and consumption at any time (3.1). For cost-efficiency reasons, it is necessary to remove barriers and enable technology-neutral competition among the flexibility options (3.2).

3.1 Flexibility options

The technical potential of the flexibility options is far greater than the actual need. Numerous options are available to guarantee the secure, cost-effective and environmentally friendly synchronisation of electricity production and electricity consumption. This is also true for scenarios with maximum and minimum residual load. Therefore, precedence can be given to selecting the most inexpensive options from the wide flexibility portfolio in the electricity market. The market is also continuously developing additional solutions. The options can be categorised as follows (Interaction Working Group, 2012):

- **Flexible conventional and renewable production:** Thermal conventional and bioenergy power stations can adapt their electricity production to fluctuations in consumption and the variable generation of wind farms and solar installations. Wind and solar power installations, in turn, can reduce their generation if the residual load is very low or grid capacity is limited (curtailment).

- **Flexible demand:** Industry, commerce and households can reduce their power demand to some extent in times of high residual load and shift their demand to times of low residual load if this allows them to increase their profitability. It is possible, for example, to store heat, cold or intermediate products, or to adapt production processes. If the residual load is low, electricity can be used to generate heat directly and therefore save on heating oil or gas. The batteries of electric cars can also be charged more in times of low residual load.

- **Storage systems,** such as pumped-storage and battery storage systems, can also help balance power production and consumption, and particularly help balance fluctuations in the residual load. Up to now, additional, novel storage systems have generally been more expensive than other flexibility options. Ancillary services could present the first commercial application of novel storage systems. Additional, novel long-term storage systems that can balance seasonal fluctuations will only become necessary with a high penetration of renewable energy.

- **Powerful grids:** Well-developed power grids facilitate the balancing of fluctuations in demand, and power from the wind and sun across regions. Further to this, with market coupling, the different technologies available can also be used more efficiently (e.g. wind and sun in Germany, hydropower storage in the Alps and Scandinavia). Grid development also reduces the necessary extent of redispatch measures and the need for ancillary services that support the grid.

3.2 Competition among flexibility options

There should be continued competition among the various flexibility options in the future. Given that the potential of flexibility options is so broad and far greater than the actual need to be served, and that the technologies themselves are constantly being improved and refined, there is no need to specifically support and promote individual technologies beyond the parameters of research funding. From an economic perspective, competition that is open to all technologies should arrive at the most cost-effective solutions. To this end, the market must provide the right incentives – from both a static and dynamic perspective – to develop and deploy flexibility options.

The broader and more direct the pricing signals, the lower the costs. The broader and more direct the effect of the pricing signals, the lower the costs for tapping the necessary technical potential. In this way, the pricing signals from the electricity markets (level and volatility of the wholesale prices, prices on the balancing markets, opportunity costs in the heating and transport sector) can automatically provide incentive for the most cost-efficient option.

Due to a number of barriers in the energy market design, however, some electricity producers and consumers face distorted price signals. Examples are the structure of the fixed components of the electricity prices in the electricity sector, and the interface to the heating and transport sector. It is necessary to examine and address these barriers to flexibility in order to strengthen the market price signal (cf. chapter 4.3).

Example of strengthened market price signals: direct marketing of renewable energy

The Renewable Energy Sources Act, amended in 2014, requires new installations to directly sell electricity from renewable sources to the market. In contrast to the system with fixed feed-in tariffs, with the floating market premium the fluctuating market prices affect the production and feed-in behaviour of producers of green energy.

Operators of renewable energy installations in the market premium system are themselves responsible for future production forecasts and for balancing any differences. In this way, they have the same responsibility as conventional power stations. They are incentivised to improve the forecast methodology and data that act as the forecast base, and thereby reduce any imbalances or balance them as efficiently as possible.

Renewable energy plants in the market premium system shut down when prices are moderately negative, provided the technical conditions are already met. Therefore, these installations contribute to system security and ease the burden on the EEG surcharge system compared to installations that receive fixed compensation for electricity feed-in. From a static perspective, the EEG surcharge increases to a greater extent when plant output is curtailed when prices are moderately negative than when curtailment takes place with the price at zero. In a dynamic model curtailment at moderately negative prices proves to be cost-efficient as low negative prices send an investment signal to make conventional production and demand more flexible.

If technical conditions are met, operators in the market premium system can also offer their renewable energy plants in balancing markets (cf. chapter 4.1). Biomass plants, in particular, increasingly provide balancing capacity. In future, the aim is for wind and photovoltaic installations to also be able to participate in the market for (negative) balancing capacity. This could help reduce the minimum generation of fossil-fired power stations.

With the market and flexibility premium, operators of renewable energy installations are given the incentive to optimise their plants according to demand. The flexibility premium incentivises biomass plants to add flexibility to their plant design and to feed in electricity in future particularly when electricity prices are high. By using turbines that work in low wind or an east/west alignment, wind and photovoltaic installations can also achieve a more even feed-in pattern and better meet high demand in times of high electricity prices.

Part II:
Measures for the secure, cost-effective and environmentally compatible dispatch of all producers and consumers ("no regret measures")

Part II of the Green Paper discusses measures that are required for the secure, cost-effective and environmentally friendly dispatch of producers and flexible consumers. These measures affect the entire regulatory framework for the electricity sector. The market design itself, as well as the regulatory conditions and complementary instruments, are relevant in this context (chapters 4 – 8). The measures should be introduced irrespective of whether adequate capacity is available. There are no regrets associated with the implementation of such measures, regardless of the direction the decision on capacity markets takes, which is described in Part III.

Chapter 4: Strengthening market price signals for producers and consumers

Producers and consumers should be increasingly flexible in their response to the intermittent supply of electricity from wind and sun. The market prices indicate what type of flexibility is required and to what extent. To ensure the secure, cost-effective and environmentally sound use of the flexibility options, undistorted market price signals, where possible, should reach the producers and consumers and new market participants should be unobstructed in gaining access to the market (cf. chapter 3). This chapter presents measures for strengthening the market price signals, including the further development of the spot market and balancing market (4.1), increasing incentives to uphold balancing group commitments (4.2) and the refinement of the structure for fees, surcharges and levies (4.3).

4.1 Developing the spot and balancing markets further

Section 4.1 looks at possible improvements to the spot markets and balancing markets. Both markets have been enhanced and refined in the past but there is still room for improvement.

Boosting competition on the day-ahead and intraday markets

Competition on the spot markets is already very pronounced. A large number of buyers interact with a large number of suppliers when trading on the day-ahead and intraday market of the EPEX SPOT exchange. Following a transparent procedure, the exchange ensures that the cheapest bids are the first to be considered. The spot market therefore supports the cost-effective synchronisation of supply and demand. The exchange has improved upon the product design considerably in recent years and aligned it with the needs of suppliers and purchasers.

Quarter-hour products facilitate the integration of renewable energy. Since 2011, the exchange on the intraday market has allowed traders to trade electricity deliveries in 15-minute units. Previously, the smallest unit was an hour. This change resulted in greater competition and improved the ways to market and integrate renewables and to manage the balancing groups. For one, new providers, such as storage facilities and loads, for example, can more easily provide these short-term products. Secondly, the supply of solar energy, in particular, changes significantly within a period of one hour in the morning and evening time. Quarter-hour products can better reflect such changes. Thirdly, BRPs can adhere more closely to their schedules if they balance gaps in the schedule on a 15-minute basis rather than an hourly basis. This also reduces the need to provide balancing capacity, and the associated costs. It is therefore a welcome development that EPEX SPOT is introducing another trading opportunity for quarter-hour products starting in autumn 2014, whereby it will be possible to trade the 96 quarter hours of the following day simultaneously in an opening auction before the start of intraday trading.

Negative prices send important signals to the market players. Ever since September 2008, the electricity exchange has permitted negative prices on the German-Austrian day-ahead market and since 2007 on the German intraday market (EPEX SPOT 2014). Negative and low prices allow power plant operators to factor into their bids both the short-term costs of electricity production and the costs of shutting down their power stations. If prices are in the minus range, operators of power plants producing electricity incur costs (or at least lose profit). Consumers are incentivised to shift their power demand to times when prices are negative. Negative prices therefore increase the incentive to actually shut down generation capacity that is not needed, and to align electricity consumption with the supply of electricity, thereby sending key investment signals for the increased flexibility of generators and consumers (Energy Brainpool 2014a, see also section 3.2).

The exchange is examining other improvements to the product design. The pricing signal for flexibility can be strengthened further by extending short-term trading or increasing the market area through EU market coupling. For example, the close of trade on the intraday market could be brought closer to the delivery time: short-term forecasts of demand and production of renewable energy are better than projections with a longer lead time. If trading closed closer to the delivery time, this could reduce the need for balancing capacity. At the same time, however, grid operators require sufficient time after the close of trade to check system stability and take any necessary measures in good time. Up to now, market coupling between Germany and its neighbours has been based on hourly products. Extending market coupling to quarter-hour products could leverage additional potential for flexibility. All further improvements must be consistent with the integration of the EU internal market and guarantee system stability.

> Next step
>
> The Federal Ministry for Economic Affairs and Energy will force the pace on the market coupling of spot markets, also as part of the network codes (cf. chapter 7). This also involves an examination of new methods to manage congestion.

Reducing minimum generation and the costs of balancing capacity

The balancing markets must be developed further. Balancing capacity balances out unforeseeable gaps between the commercial market result and actual production and consumption. To ensure it can continue to secure supply in a cost-effective and environmentally friendly manner, the balancing markets must be developed further and enhanced. In this perspective, the electricity market is facing three main challenges: First of all, the need for balancing capacity is expected to increase with the expansion of renewable energy. This will particularly concern situations involving a low demand and high levels of wind and solar power being fed into the grid. Secondly, the minimum generation of conventional power stations that is currently required must be reduced (cf. section 3.2). The need for balancing capacity is currently one reason for this minimum generation. Thirdly, balancing markets are becoming more harmonised and coupled at the European level.

From a technical perspective, many providers can supply balancing capacity. Apart from conventional power stations and pumped-storage power plants, CHPs, standby power units, large-scale batteries and flexible consumers are all currently active in the balancing markets. Even remote-controlled wind and PV installations are, in principle, technically able to provide balancing capacity.

Balancing markets should not discriminate among players. All suppliers that can reliably provide balancing capacity should be able to compete. Alternative providers should be able to replace conventional power stations, particularly if the latter are no longer needed to meet the load on the electricity market due to the high level of electricity supplied from renewable sources (BDEW, BEE, VKU et al. 2013). System stability will remain the top priority.

The Federal Network Agency has already removed several barriers. As early as 2011, the Federal Network Agency revised the bid invitation conditions in the balancing markets. It shortened the tendering periods for primary and secondary balancing capacity, reduced the minimum bid size for all three balancing capacity products and improved the framework for block bids for minute reserve capacity. These measures have helped improve competition, with the number of prequalified providers of primary balancing capacity increasing from 5 to 20 between 2007 and 2014, providers of secondary balancing going from 5 to 27 in the same period, and those in the minute reserve market increasing from 20 to 38 (50Hertz et al., 2014).

Other adjustments should strengthen the competition and flexibility in balancing markets. For example, storage systems, renewable energy providers and consumers can generally provide balancing capacity more easily over shorter periods and with a short lead time. Up to now, primary balancing capacity has only been tendered weekly, and for an entire day in each case. Similarly, secondary balancing capacity is currently also tendered weekly for peak and off-peak times. At the weekend, off-peak times can last up to 60 hours. In contrast, the minute reserve is tendered in 4-hour blocks every business day. The transmission system operators have determined the need for secondary balancing capacity and minute reserve on a quarterly basis up to now. They also define the prequalification standards.

Concrete proposals have been made for improving the competitive bidding and prequalification standards. Experts and market players often suggest shortening the product length and lead times. In particular, secondary balancing capacity and the minute reserve should be tendered every calendar day. Alternatively, or indeed in addition, a short-term balancing energy market or a secondary market for the provision of balancing capacity could be introduced. The prequalification standards should be revised so that wind farms, in particular, can provide negative balancing capacity in the future. Experts and market players also suggest to separate bid invitations for positive and negative primary balancing capacity. In future, the volume of balancing capacity put out to tender could also be adapted to the particular supply of wind and solar energy (adaptive sizing).

Next steps

- The Federal Ministry for Economic Affairs and Energy will support efforts to harmonise the balancing markets at the European level within the framework of the network codes (see also chapter 6).
- The Federal Network Agency will examine the competitive bidding conditions in the balancing markets in order to strengthen competition and integrate "new electricity consumers". System stability will remain the top priority.
- In co-operation with the transmission system operators, the Federal Network Agency will examine the possibility of a situation-based balancing capacity bidding process that depends on the supply of wind and solar energy. In addition, it will oversee talks between TSOs and plant operators to modify the prequalification standards.

4.2 Strengthening balancing responsibility

The system of balancing groups and imbalance settlement plays a central role in the process of synchronising generation and consumption. The balance responsible parties (BRPs) are required to keep their position balanced at all times (cf. section 1.4).

Insufficient incentives in the system of balancing groups and imbalance settlement put system safety at risk. It is estimated that only 30–50 percent of BRPs actively manage their balancing group on the intraday market (Energy Brainpool 2014a). The result of a system structured in this way is that system operation is less secure because too much balancing capacity is utilised, with the danger that there might not be sufficient reserves of balancing capacity to balance production and consumption. Further to this, if balancing groups are inadequately managed, relatively expensive balancing energy is used to balance production and consumption instead of the relatively cheap electricity available on the spot markets.

The Federal Network Agency has already improved incentives for BRPs to uphold their balancing group commitments. The cost of imbalance settlement basically acts like a fine for the balancing groups with an imbalance. The Federal Network Agency significantly overhauled the imbalance settlement system at the end of 2012 to give BRPs greater incentive to adhere to balancing group commitments. Ever since, the imbalance settlement charge (reBAP) has been pegged to the exchange price on the intraday market. This seeks to prevent it being cheaper for a BRP to pay the imbalance settlement charge than to buy or sell the specific volumes of electricity on the intraday market. If more than 80 percent of the balancing capacity contracted in Germany is utilised, BRPs must pay a fine if there is an imbalance in their schedules that puts a burden on the balance zone. This penalty is at least 1.5 times the intraday price. As the maximum intraday price is € 10,000/MWh, the imbalance settlement charge can therefore already amount to more than € 15,000/MWh.

The scientific community recommends examining and strengthening incentives for upholding balancing group commitments (cf. Frontier et al. (2014a), r2b (2014a), Connect (2014)). A central aspect is the level of the penalties to be paid in situations in which the bulk of the balancing capacity has already been utilised to balance production and consumption. The balancing energy prices could also be determined in the future through a uniform pricing procedure. Up to now, when their balancing capacity is utilised providers of the balancing capacity receive payment that depends on their particular bid (pay-as-bid method). As the imbalance settlement charges are calculated on the basis of the balancing energy prices, this could increase incentive to uphold balancing group commitments. The modernisation of the standard load profiles is still under discussion. These profiles are used to estimate the demand from customers whose consumption is not measured on an hourly basis.

Next steps

The Federal Network Agency will step up efforts to ensure compliance with requirements regarding active management and balanced positions for all balancing groups. It will monitor the effect of the system of balancing groups and imbalance settlement and adapt it where necessary. In particular, it will study the incentives provided by the system structure.

4.3 Optimising network charges and state-imposed price components

The wholesale price constitutes just one part of the electricity costs for end users. For their power consumption, end users must also bear other additional costs as fixed price components, including the EEG surcharge, the concession levy, value-added tax and electricity tax. The network charges, which are levied to transmit the electricity, are among the biggest price components that are passed on to end consumers. There are different reasons behind the structure and amount of these electricity-related price components. Currently, the network charges are fully borne by the electricity customers. Electricity producers do not pay network charges.

Given these price components, the aim is to discuss to what extent the flexible response of producers and consumers can be facilitated. To this end, the structure of the price components should be examined to identify disincentives, and optimised where necessary, while maintaining any existing privileges. The aim is to examine to what extent the current structure of the network charges, and other state-imposed price components if applicable, weaken the signals of the wholesale market for producers and consumers. On the one hand, market participants have no influence on the bulk of the payments. This generally weakens the market price signal that producers and consumers receive. On the other hand, the structure of some price components can also act as a direct disincentive for making producers and consumers more flexible. Against this backdrop, it is important to take a closer look at the use of demand side management, storage systems and, in particular, the flexible operation of controllable private onsite generation facilities in the electricity sector. Furthermore, the effects on the flexible use of electricity in the transport and heating sector must also be studied. Changes could enable additional flexibility in the system:

Example 1: Some industrial businesses could use demand side management to reduce their electricity costs. Large consumers already perform demand side management to different degrees. Currently, however, their focus is primarily on minimising the network charges or participating in the balancing markets (r2b 2014). The structure of the network charges means that demand side management is not worthwhile for some industrial businesses. Factors in the area of network charges that do not favour flexibility include:

- **The capacity component in relation to the individual annual peak load might not support a load increase at low residual load:** For capacity-profiled customers, the network charges are divided into an energy component and a capacity component (Section 17 of the Ordinance on Electricity Grid Access Charges, StromNEV). The network charges of large consumers with more than 2,500 hours of use per annum contain a high capacity component. The annual capacity fee is determined on the basis of the individual annual peak load (= individual peak demand), even if this only occurs once a year and not at the same time as the system-wide residual load peaks. This can prevent a load increase in certain situations, even though the load increase would make sense from a macroeconomic perspective: The consumer concerned acts in a way to maximise profits. If additional consumption raises the individual annual load peak, the annual capacity fee increases. This increase in the network charges can then counterbalance any cost advantages arising from flexible electricity demand.

- **The current design of the special grid fees can discourage large consumers from demand side management:** Under section 19 (2)(2) of the Ordinance on Electricity Grid Access Charges, large consumers with at least 7000 hours of use per year (ratio between the annual electricity consumption and the load peak) and an annual power consumption of at least 10 gigawatt hours pay lower individual network charges. This, in turn, has two specific effects:
  - If a large consumer increases its load, the higher load peak can drive up the network charges as the hours of use are not reached.
  - If a large consumer reduces its load, it might lose its reduced-rate network charges by falling below the hours-of-use threshold.

Peak and off-peak tariffs at reduced network charges provide contrary incentives to spot market prices: With atypical grid use, grid operators are obliged to offer their customers network charges at a reduced rate. This concerns businesses whose individual maximum load occurs at different times than the overall peak load. This is generally implemented through peak tariffs (PT) and off-peak tariffs (OPT) for electricity. The intention here is to map grid needs in a power supply system that is characterised by base load power plants. However, the changing power supply system means that the windows for PT-OPT tariffs no longer necessarily tally with actual grid requirements and the specific prices on the spot market.

Example 2: Private onsite generation facilities could respond directly to pricing signals. Private onsite generation currently covers roughly 10 percent of power consumption, and is trending upwards (Energy Brainpool 2014b). Of this 10 percent, 94 percent is attributable to power stations run by industrial customers and 6 percent to photovoltaic installations in households and industry (Energy Brainpool 2014b). At present, operators of private onsite generation facilities gear generation to their own consumption in many cases. In contrast, the need for power generation capacities in the overall system is of secondary importance. The market price for electricity is also often not a relevant factor, particularly if the CHP is operated to primarily cover heat demand and the electricity produced is only a secondary product. The type of privilege can provide an incentive to optimise electricity production in a way that is nearly independent of the need in the system. The operators of the facilities then gear production towards their own consumption instead of adjusting to the market price. Even if electricity prices on the exchange are slightly in the minus range, it can still work out cheaper for industrial private producers to generate electricity onsite instead of shutting down their facilities and purchasing electricity from the grid as they would have to pay network charges and state-imposed price components for the electricity purchased. The question is how to better align own production and the electricity market on the whole.

Example 3: The electricity, heat and transport sectors could, potentially, be more closely interlinked. In the energy system of the future, energy consumption will be technically and economically interlinked in the electricity, heating and transport sectors much more than it is today. Additional power consumption in the heating and transport sector facilitates the integration of wind and solar power if electricity production levels are high. It increases the share of renewables in the heating and transport sector, which has been quite small up to now, and can also stabilise the electricity price at low residual load. New additional consumers should use the electricity as efficiently as possible and not increase the residual peak load in the electricity market. Examples of suitable consumers include heat pumps and bivalent electrical heaters that are combined with a second heating system, such as a natural gas boiler. Such consumers can adapt their operation flexibly to the pricing signals of the electricity market. Compared with the technologies mentioned, monovalent night storage heaters are often still unable to provide flexibility. In winter they might actually consume electricity at peak load times during the day and therefore increase the need for power plants and fossil-based electricity production (IZES 2013). Currently, there are two main barriers to coupling the sectors: For one, electricity is, on average, subject to a higher taxation burden than heating oil or natural gas, and secondly the price components mentioned weaken the market price signals.

Possible approaches to optimising the structure of the network charges and state-imposed price components – while maintaining existing privileges – comprise:

1. **Optimise special regulations:** Special regulations surrounding network charges and state-imposed price components are maintained. The Federal Ministry for Economic Affairs and Energy examines whether and to what extent these special regulations can be optimised so that the privileged parties can respond with flexibility to the pricing signals without losing their privileges in the process.

2. **Strengthen capacity prices (charge on the basis of kW instead of kWh):** Network charges and state-imposed price components could be levied more on the basis of capacity (kW) instead of energy (kWh), wherever possible and reasonable. The capacity can be measured at the grid connection or from the individual annual peak load. If the prices were based around the size of the grid connection, consumers would not need to fear higher fees if they increased their demand temporarily.

3. **Make components more dynamic (percentage tariffs instead of fixed surcharges):** Up to now, there have been fixed price components on energy (kWh). Where legally possible, percentage-based surcharges on energy could strengthen market signals. For example, making the EEG surcharge dynamic could be one way to unlock demand side management potential, get private consumption to serve the system more and ease sector coupling (Ecofys/RAP 2014). The pros and cons of such approaches must be examined.

Next steps

- The Federal Ministry for Economic Affairs and Energy will examine the structure of the network charges and improve it – while taking the impact of such measures on consumers into account – to make flexible consumer behaviour more attractive. The following steps, inter alia, should be examined:
  - Opening of the special network charges for more load flexibility
  - Examination of the energy and capacity pricing system under Section 17 of the Ordinance on Electricity Grid Access Charges
  - Examination and possible modification of existing PT-OPT windows

  Secure and reliable system operation will remain the guiding target when examining these measures, and sets the external framework for any attempt at optimisation.

- The Federal Ministry for Economic Affairs and Energy will discuss a long-term target model for the structure of the network charges and some state-imposed price components to further enable the efficient development of flexibility among producers and consumers in the electricity, heating and transport sectors. This target model should provide guidance for individual reforms and guarantee long-term consistency. The Federal Ministry for Economic Affairs and Energy will examine the system of network charges to determine whether it is aligned with the requirements of the *Energiewende* and ensures that the burden of financing the grid infrastructure is distributed fairly.

Chapter 5: Expanding and optimising the power grids

Apart from measures to strengthen the market price signals for producers and consumers, grid expansion (5.1) and system operation (5.2 and 5.3), in particular, are central for the secure, cost-effective and environmentally compatible deployment of flexible producers and consumers.

5.1 Expanding the power grids

Grid expansion is necessary for the cost-effective and environmentally sound deployment of producers and consumers. Well-developed networks allow electricity to be purchased cost-efficiently in Germany and in the internal market. The interregional exchange of electricity balances out fluctuations in wind, solar irradiation and demand. The effects of balancing across Germany and Europe reduce the maximum residual load that occurs simultaneously and increase the minimum residual load compared against the total maximum and minimum values in the individual regions. Cross-regional electricity transmission has the effect of driving down costs:

1. The facilities with the lowest deployment costs are used across regions, thereby driving down the variable costs of the overall system.

2. The overall need for generation capacity, demand side management and storage systems decreases. This also curbs the investment and maintenance costs of the overall system.

Compared to the potential for savings, the costs for grid expansion are significantly lower.

Increasingly decentralised electricity generation and well-developed grids complement one another. Electricity from wind and solar irradiation is primarily generated at decentralised locations, sometimes far from load centres. A good national and European interlinked network is essential to be able to develop locations sufficiently and take advantage of smoothing effects. Largely independent decentralised systems are much more expensive and are unable to meet the demand of consumption centres such as conurbations or energy-intensive industries. At the same time, attention must also be paid to cost efficiency when expanding and upgrading the grid.

The grids must be expanded at the transmission and distribution level. With the help of specific scenarios, the grid development plan and federal requirements planning, legislators plan the development and expansion of the transmission grids ahead. These plans complement the top-priority projects identified in the Energy Line Expansion Act (*Energieleitungsausbaugesetz*, EnLAG) of 2009. The expansion of the distribution grids is just as important as the expansion of the transmission grids. At the lower grid levels, conditions must also be adapted to future challenges. In addition to the majority of consumers, 98 percent of the renewable energy generation facilities and many smaller conventional plants are connected to the distribution grids.

It makes economic sense not to extend the networks for the "last kilowatt hour generated". If minor grid congestion is permitted, i.e. grid load peaks are shaved by generation management, this can also help to reduce the required grid expansion efforts, alongside the implementation of various grid optimisation measures (see below). When planning the grid at the distribution and transmission grid level, it should therefore be permitted to factor in peak shaving of a maximum of three percent of the annual energy that can be produced by wind and photovoltaic installations. Full compensation to all plant operators should be maintained. When planning the extension of the transmission grid, at least the same limitation of feed-in peaks as supposed in the distribution grid plans must be taken as the basis. With regard to system operation, it is necessary to improve generation management and align concepts for distribution and transmission grids.

The use of innovative equipment can be worthwhile at the distribution grid level. Voltage issues are the primary reason for the need for grid expansion at the low-voltage level. New grid technologies such as regulated distribution transformer can, in many cases, reduce the volume of cables additionally required, or eliminate the need for these conventional expansion measures. Additional investment is associated with the "controllability" of local network stations. Such investment is, however, often more financially viable than investments in purely conventional grid expansion (Federal Ministry for Economic Affairs and Energy 2014).

Next steps

- The grid expansion projects identified as necessary and confirmed by legislators, including the development of priority cross-border interconnectors (Energy Line Expansion Act (*Energieleitungsausbaugesetz*), Federal Requirements Plan Act (*Bundesbedarfsplangesetz*)), will be implemented.

- TSOs and the Federal Network Agency will regularly examine grid expansion needs at the transmission grid level (Grid Expansion Programme 2014, Grid Expansion Programme 2015 etc.).

- Cross-border interconnectors and lines of interregional importance will be developed further on the basis of the Ten Year Network Development Plan (TYNDP) 2014 of the European Transmission System Operators (ENTSO-E) and within the framework of implementing projects of common interest.

- The Federal Ministry for Economic Affairs and Energy will enhance the framework for modernising the distribution grids in 2015. In particular, the Ministry will examine ways to improve investment conditions on the basis of the Federal Network Agency's evaluation report on incentives regulation and the results of the grid platform study entitled "Modern Distribution Grids for Germany" (including the amended Incentives Regulation Ordinance and the "Smart Grids" ordinance package).

- The Federal Ministry for Economic Affairs and Energy will put in concrete terms the strategy to factor in peak shaving of a maximum of three percent of the annual energy that can be produced by wind and photovoltaic plants ("last kWh") when operating and planning grids at the distribution and transmission grid level.

- The Federal Network Agency will examine whether the regulation framework conditions must be adjusted to make efficient investment in controllable local network stations more financially appealing for grid operators.

5.2 Ensuring secure system operation

Redispatch enables secure system operation in the event of grid congestion.

There are bottlenecks in the German grid. The majority of the load centres are located in the south and west of the country. Furthermore, in response to market demands Germany often exports electricity to its southern neighbours. As a result of the nuclear phase-out, nuclear power stations in the south of Germany will be decommissioned while new wind farms are primarily being built in Germany's north and east. Further to this, additional fossil-fired power stations are expected to go offline in the south of Germany. In many hours, this will increase the need to transmit electricity from the north to the south. Given that grid expansion, which the 2009 Energy Line Expansion Act identified as essential for the energy industry and assigned a priority status, will be delayed by a few years, bottlenecks in the grid will increase further in the coming years.

Electricity trading assumes the existence of a grid without congestion. Electricity trading within a price or bidding zone (e.g. Germany/Austria) assumes there are no bottlenecks in the grid. The assumption seeks to allow as many producers and consumers as possible to trade with a single price on the same market. The aim is to render trading transparent and liquid, while also ensuring that large providers have less power over the market result. When markets are coupled, bottlenecks between the bidding zones (e.g. between Germany/Austria and France) are taken into consideration (cf. section 1.1). Pricing beyond the borders of the bidding zones means that available capacities of the cross-border interconnectors are used efficiently.

While redispatch enables secure system operation even when the grid is congested, it causes additional costs. Redispatch is used if there are bottlenecks within a market area (cf. chapter 2). Conventional and renewable generation facilities are curtailed on one side of the bottleneck and ramped up on the other. In 2012, these measures affected 2.6 TWh of conventional production and 0.4 TWh of renewable production (2013 Monitoring Report of the Federal Network Agency). As redispatch results in less efficient deployment of generation facilities, it cannot be considered a substitute for grid expansion.

Compensation for generation management prevents grid congestion having negative effects on the electricity market. The operators of the curtailed conventional and RES plants as well as the operators of conventional plants that are ramped up receive financial compensation from the grid operators. The costs are distributed to electricity customers via the network charges. This is of central importance in a single price zone in order to prevent distortion of electricity trading. Plants at favourable locations from a grid management perspective are frequently ramped down, while the output of other plants is rarely or never reduced. If no compensation were offered, investors would bear the risk of curtailment, which would increase the costs for conventional and renewables-based generation. From a system security perspective, it is essential that grid operators can decide freely which plants to down or up, and in which order. Such unequal treatment is acceptable if adequate financial compensation is provided for all plants.

Reserve power plants guarantee sufficient redispatch capacity

In the transition phase, the network reserve offers adequate potential for redispatch until grid expansion has been completed successfully. The network reserve incorporates power plants outside the electricity market. Redispatch requires sufficient generation capacity that can be started up in case of bottlenecks. If there are not enough active power plants in the region to perform this task, the capacity required must be secured in the form of reserve power stations. These power stations are available for redispatch and guarantee system security. The technical availability of the reserve power stations themselves and of the fuel required to produce the electricity – particularly gas – must be taken into account.

The network reserve will only become superfluous after grid expansion. Grid expansion, as set down by law, is set to take place in the coming eight years. After this, the network reserve will be superfluous. The completion of central projects under the Energy Line Expansion Act will ease the situation temporarily. However, in the course of these eight years additional nuclear power stations in the south of Germany will also be retired, and the expansion of wind farms to the north of the grid bottlenecks will continue.

Additional fossil-fired power stations are expected to go offline in the south of Germany. As anticipated, the annual system analyses to be performed by the transmission system operators indicate a growing need for redispatch in the winters ahead. This redispatch need can only be addressed with reserve power plants in the network reserve.

Additional redispatch potential can minimise the need for a network reserve. To tap redispatch potential outside the network reserve, control technology could be fitted to existing back-up power systems, for instance. This would have the additional advantage that the plants would also be available in the future for balancing capacity or to cover the peak load. Even today, some emergency back-up power systems already meet the technical requirements of the balancing markets and provide reliable balancing capacity. Grid operators and the Federal Network Agency are currently analysing the potential available.

The Ordinance on Reserve Power Plants is to be extended through to 2022 approximately and reformed at the same time. The network reserve will be required as a transitional instrument until the grids have been extended and upgraded to a sufficient degree. It can become part of a capacity reserve which differs from region to region (cf. chapter 9). With a view to the nuclear phase-out in 2022, transmission system operators will need to make grid calculations that project further into the future so that necessary measures can be put in place in good time if the need arises.

Next steps

- The Federal Ministry for Economic Affairs and Energy will amend the Ordinance on Reserve Power Plants and will replace it by a regionally nuanced capacity reserve (cf. chapter 9).
- The Federal Ministry for Economic Affairs and Energy will examine whether it will be possible to activate back-up power units for redispatch in order to reduce the need for a network reserve.

5.3 Providing ancillary services with less minimum generation

Ancillary services must always be reliably available. The permanent and sufficient provision of ancillary services is essential to ensure a high level of reliability and security in the transmission and distribution of electricity: Frequency is maintained, inter alia, by balancing capacity, inertial reserve and interruptible loads. Reactive power is required to maintain voltage stability. To be able to restore supply at any time, black-start generators are required, i.e. generators that can start up after a blackout without support from the electricity grid. In addition, grid operators must be able to coordinate the restoration of the grid. System operation management also involves the coordination and implementation of generation management and ancillary services.

Action must be taken with regard to the ancillary services. Needs and supplies are changing. This is due to the shorter market-based dispatch times of conventional power stations in the future, growing network utilisation rates and increasing distances in electricity transportation. Alternative solutions are becoming increasingly important. The necessary adjustments and processes must be implemented in time in order to reduce minimum generation efficiently and maintain system stability.

Ancillary services are increasingly provided by alternative technologies and renewables. Currently, ancillary services are mainly provided by conventional power plants. Over the medium-term, it will be more important that ancillary services do not depend on electricity production in conventional power plants, particularly in times of low residual load. This will reduce minimum generation and will minimise both costs of curtailment of renewables and emissions from the use of fossil fuels (cf. chapter 1).

Technical alternatives are available or are currently being trialled. The transition must be gradual, and organised in a way that is viable from a technical, regulatory and economic perspective. Ancillary services are of central importance to system security, and are technically complex to deploy. New ancillary service technologies must be introduced gradually and carefully into system operation management and the technical rules and regulations. Challenges are presented in all areas of ancillary services. The challenges of balancing markets are explained in chapter 4.1. Up to now, all other ancillary services have not been provided on the basis of markets but rather on the basis of regulatory specifications and bilateral agreements between the grid operators and the plant operators. The following challenges can be expected in the coming years:

- **Frequency stability:** Technically, sufficient flexibility options are available to provide balancing capacity (cf. sections 3.1 and 4.2). At the same time, the challenges from older grid connection codes must be tackled. Currently, if frequency is at a critical level, decentralised generation facilities automatically disconnect from the grid ("50.2 Hz" and "49.5 Hz"). As such a scenario simultaneously affects many installations, this can result in an abrupt loss of capacity which can jeopardise system stability. For this reason, existing plants have to be retrofitted. In a first step, the System Stability Ordinance (*Systemstabilitätsverordnung*) which entered into force on 26 June 2012 regulated retrofitting measures for photovoltaic facilities. As part of a second step, the affected installations relying on wind power, solid biomass, combined heat and power generation, gas under the Renewable Resources Energy Act, liquid biofuel and small-scale hydropower plants now need to be retrofitted. There is also a need to clarify to what extent the inertial reserve, which has been provided up to now from the rotating masses of generators, can be replaced by energy storage systems or photovoltaic plants fitted with converters. The potential in question and the scope required for system stability will be determined in the next few years. Alternatively, phase shifting generators could also be deployed.

- **Maintaining voltage stability:** At the transmission system level, converter stations in the planned HVDC routes can supply reactive power. Alternatively, compensation plants (e.g. FACTS) or phase shifting generators can be used. Reactive power management in distribution grids can optimise exchange between the transmission grid and the distribution grid. The European network codes require the exchange of reactive power between the network levels in any case. Alternative sources of reactive power from decentralised generation plants, particularly from large-scale wind and solar parks, must be used to a greater extent and further refined. New strategies must be developed and implemented for the technically and economically viable provision of reactive power.

The Federal Ministry for Economic Affairs and Energy supports the transmission system operators in developing and implementing new strategies.

- **Restoring the supply:** The existing strategies for restoring the system in the event of an interruption in supply must be adapted continuously. It must be possible to control decentralised generation facilities during restoration.

- **Operation management:** System operation management concepts must be continuously adapted to the ever-increasing control and coordination requirements.

Next steps

- Within the context of the Energy Grid Platform and the Electricity Market Platform, the Federal Ministry for Economic Affairs and Energy will oversee the continuous further development of ancillary services.

- The Federal Ministry for Economic Affairs and Energy will oversee the process for the "Ancillary Services Roadmap 2030", led by the German Energy Agency (dena) with the participation of stakeholders.

- On the basis of the results of the aforementioned processes, the Federal Ministry for Economic Affairs and Energy will work in co-operation with the Federal Network Agency to continuously adapt the regulatory framework.

- The Federal Ministry for Economic Affairs and Energy and the Federal Network Agency will guide the Forum Network Technology/Network Operation (FNN) within the Association for Electrical, Electronic and Information Technologies (VDE) in implementing the European network codes.

- The Federal Ministry for Economic Affairs and Energy will present an amended System Stability Ordinance to eliminate the system risks posed by the frequency protection settings of decentralised generation facilities ("49.5 Hertz problem").

Chapter 6:
Maintaining a single price zone

A single market area – also known as a “single price zone” or a “single bidding zone” – currently allows the same wholesale prices for electricity in all of Germany (6.1). Grid expansion is central to ensuring that the single price zone is maintained (6.2).

6.1 Today, uniform wholesale prices for electricity are possible throughout Germany

Germany and Austria today act like a single market area for electricity trading. This single market area – also known as the “single price zone” or “single bidding zone” – is the reason why the same wholesale prices are offered for electricity across Germany and in Austria. Market players can buy and sell electricity nationwide at uniform wholesale prices. The grids should then transport the appropriate volumes of electricity from the producers to the consumers.

Uniform wholesale prices throughout Germany are only possible because regional grid bottlenecks are considered to be an interim problem. Currently there is sometimes not enough grid capacity in central Germany to transport the electricity traded on the electricity market from the generation centres in the north and east to the load centres in the south of Germany or southern Europe. In such situations, there are bottlenecks in the grid (cf. sections 1.6 and 5.2). This means that without measures to expand the grid, the grid would be unable to transport the electricity at all times from the generation plants to the point where it was sold. The single price zone assumes the existence of a grid without congestion. Electricity is traded without concern for bottlenecks in the grid.

While grid operators can rectify grid bottlenecks to a limited extent by targeted action (redispatch), this drives up costs. To ensure that electricity trading transactions can be followed by the physical delivery of electricity, substitute measures must be taken to eliminate the bottlenecks in the grid. Such measures are known as redispatch measures (cf. section 1.6). Grid operators advise electricity producers on one side of the anticipated bottleneck to reduce production in their plants. On the other side of the grid bottleneck, power stations are ramped up to replace the curtailed electricity production to the same extent. This process currently guarantees secure system operation but will reach its limits if grid congestion is aggravated.

6.2 Grid expansion is a key prerequisite for maintaining the single price zone

A single price zone is not possible if grid bottlenecks are extensive. If bottlenecks reach a certain level of intensity, i.e. their extent and frequency exceeds a certain level, redispatch measures can no longer effectively relieve the congestion in a way that guarantees security of supply. This is because every interference with system operation increases the risk of errors, particularly if a high number of simultaneous redispatch measures are performed. Interference also results in inefficiencies and higher electricity production costs. The additional costs for the redispatch measures are passed on to the electricity consumers through the network charges. Ultimately, sufficient power plant capacity must always be available behind the bottleneck, i.e. in south Germany, for redispatch measures.

Grid expansion is a central prerequisite for maintaining the single price zone – i.e. the single market area. Only a well-developed network can actually transport the electricity as it was bought and sold in the single price zone, i.e. from the (selling) producer to the (purchasing) consumer. If the single price zone is to survive, it must be possible to transmit electricity efficiently in the grid in a way that supply is secured.

If the market area became fragmented, there would be divergent wholesale prices in Germany. In the northern price zone, the wholesale prices would tend to sink while higher wholesale prices would be expected in the south. This would also entail a different approach to calculating the EEG surcharge in the north and south of the country as this surcharge depends on the wholesale prices. A division of the single bidding zone would ultimately reduce the liquidity of the electricity market, present challenges in terms of the exercising of market power and mean considerable transition costs.

Next step

Grid expansion including the expansion of priority cross-border interconnectors (Energy Line Expansion Act, Federal Requirements Plan Act) will be implemented swiftly.

Chapter 7: Intensifying European co-operation

The electricity market is European. Electricity has been traded intensively in a European setting for many years. The European markets are now even coupled to a large extent (7.1). Electricity trading makes the electricity system more efficient and reduces the need for production capacities (7.2). Additionally, it requires security of supply to be considered in the European context, and not as a national issue (7.3).

7.1 The wholesale market for electricity is European

Electricity trading has had a European basis for a very long time. The first internal market package in the mid 1990s marked the start of the integration of the European electricity and gas markets. Market integration was strengthened, the roles of the national regulation authorities specified, and an Agency for the Cooperation of Energy Regulators (ACER) was established with the second and third internal energy market package.

Electricity has been exchanged within Europe since the start of the interconnected European power system. Even before the liberalisation of the electricity markets, exchange had a balancing function to guarantee system stability and therefore security of supply. The market-driven exchange of electricity has grown continuously ever since.

German companies are actively involved in electricity trading. Electricity trading has progressed well in central-western Europe (CWE). In June 2007 Belgium, France, Germany, Luxembourg and the Netherlands signed a Memorandum of Understanding on the coupling of their electricity markets, and CWE market coupling was launched in 2010. The project counts three electricity exchanges and seven grid operators among its participants. This market coupling ensures that the available cross-border capacity can be utilised more efficiently. Electricity prices converge provided that there are no bottlenecks in the grid (cf. chapter 5).

Harmonisation measures such as the network codes make electricity trading European. Market players will face the same general conditions across Europe thanks to the network codes that have been defined for Europe. In particular, the network codes set the framework for general, day-to-day cross-border electricity trading. They deal with both the organisation of cross-border short-term trade and issues surrounding long-term trade and cross-border access to balancing energy.

7.2 Cross-border electricity trading drives down the total system costs

European electricity trading promotes the cost-effective and environmentally friendly deployment of producers and consumers. With European electricity trading, advantage can be taken of the large-scale smoothing effects and added efficiency with regard to demand, renewable energy and the use of conventional power stations. For example, Italy's annual peak load occurs in the summer as the use of air conditioning systems rises. Germany, in contrast, experiences its peak load in the winter months. This means that the common peak load is lower than the sum total of the national peak loads on account of these smoothing effects. Initial analyses estimate this contribution to be on the scale of between 11 and 18 gigawatts between Germany, its neighbours and Italy alone (r2b 2014). European electricity trading is restricted, however, by the availability of transmission capacities between the markets.

The smoothing effects are strengthened by Europe's diversity in expanding the use of renewable energy sources. If intermittent renewable energy sources are expanded and developed at different locations and using different technologies, they can better offset weather-related fluctuations in the supply of electricity to the grid. If winds are low in one area, wind farms or other renewable energy facilities at other locations can compensate for this lull to some extent. This benefits all EU countries. For example, one EU-wide evaluation puts the contribution of wind turbines to the reliably available capacity at roughly 14 percent of the total installed wind capacity (TradeWind 2009). When calculated nationally for Germany, this figure is at around seven percent. Thanks to smoothing effects, there is less need for power stations and storage systems, thereby reducing system costs.

Electricity trading affects both the costs of electricity consumption and the revenue of the electricity producers. Electricity is produced where the lowest marginal costs are incurred at that particular time. When foreign electricity is imported into Germany, the German electricity consumers benefit from the cheap electricity from abroad while a share of electricity production in Germany is pushed out of the market by the competition from abroad. When electricity is exported from Germany, the foreign electricity consumers benefit from the cheap electricity in Germany, while German electricity producers generate additional returns and push out some of the competition abroad.

In recent times, Germany has benefited from the exchange of electricity. Within the CWE region, Germany has comparatively low electricity prices on the exchange. In 2013, the average exchange price (day-ahead, baseload) was € 37.8/MWh. By comparison, the price in France was € 43.2/MWh, and € 52.0/MWh in the Netherlands. Therefore there is currently an above-average use of German electricity supply to meet foreign demand for electricity. Electricity trading gives producers in Germany additional opportunities to sell. In 2013, roughly 72 TWh of electricity was exported from Germany to neighbouring countries, and some 38 TWh imported from neighbouring countries to Germany. Electricity exports are particularly high in times of low domestic demand and high levels of electricity production from wind and solar power, lignite and nuclear power. Without the possibility to export electricity, nuclear and coal-fired power plants, as well as renewables facilities in the future, would need to ramp down their production to a greater extent. The exchange of electricity is therefore an important flexibility option.

7.3 Strengthening security of supply in the European context

The European internal market for electricity will have sufficient production capacities over the coming years. According to the current "Scenario Outlook and Adequacy Forecast" (SOAF) issued by ENTSO-E, Europe currently has an overcapacity of at least 100 gigawatts (ENTSO-E 2014). Of these, around 60 gigawatts (known as "RC-ARM" and "spare capacity") are in the electricity market that is relevant for Germany, which can approximately be defined as the region consisting of Germany, its neighbours and Italy. Considerable overcapacity can also be expected here over the next few years. This capacity can safeguard regional supply and increase security of supply in Germany provided that transmission capacity is available. Similarly, from a (purely mathematical) national perspective, more than enough power plant capacity is available in Germany in the medium term: in their recent system adequacy forecast for Germany for the 2014 – 2017 period, transmission system operators present a "spare capacity" of roughly 10 gigawatts (2014 TSO Report). This capacity is not needed to cover load in Germany and is available for export.

Security of supply can only be considered in the European context. A purely national take on security of supply cannot be reconciled with the concept of a European electricity market (DIW 2014). Up to now, Germany and other EU member states have primarily measured security of supply on the basis of the static approach of national system adequacy forecasts. Given that this approach is not very compatible with the internal electricity market that actually exists it needs to be revised. This is also true in light of the growing importance of intermittent renewable energy and stochastically available production. Due to the interregional effects of smoothing peak loads and the contribution renewable energy makes to the reliably available capacity, the European internal market generally has less need for generation capacity, demand side management and storage systems.

The Federal Ministry for Economic Affairs and Energy will discuss improvements to the monitoring of security of supply with stakeholders in Europe. The Ministry advocates that security of supply should be considered from an international perspective. Furthermore, in addition to considering conventional and renewable energy production units, regulators should also pay greater attention to flexibility options in the future. These flexibility options also include demand side management and back-up power plants, which can help synchronise production and consumption.

Transnational effects must be taken into consideration. Germany, its neighbours and the European Commission have recognised that joint monitoring strategies are essential in a European internal electricity market. The cost-effective supply can only be secured on the long-term if transnational effects are taken into consideration. Apart from the SOAF report, however, cross-border approaches have been rare up to now. Governments are working on a joint approach at the European level. At the regional level, the Federal Ministry for Economic Affairs and Energy has launched a process which seeks to establish an international definition of security of supply and, on the medium term, establish joint monitoring of security of supply with neighbouring countries. This process builds on the work of the regional Pentalateral Energy Forum, involving Germany, Austria, the Netherlands, Belgium, Luxembourg and France, and with Switzerland as an observer.

Other steps should force the pace on the completion of the electricity internal market. Apart from a common strategy for monitoring security of supply, there is also the need for additional agreements at least on a regional basis. Irrespective of the electricity market design which Germany, its neighbouring countries and other EU member states opt for, common rules, for example, should be set down for situations in which relatively high electricity prices in wholesale are simultaneously observed in several coupled electricity markets.

If the decision is made to introduce capacity markets, then they must be coordinated at European level at least. This is particularly important if the need for additional national production capacities is defined. There is a need for a joint decision on how foreign capacities are to be factored into the national level of security of supply and whether and how foreign capacities should have access to national mechanisms (cf. section 8.2).

Next steps

- The Pentalateral Energy Forum (DE, FR, AT, BENELUX, CH) will deepen collaboration among the countries in the common electricity market, inter alia, by issuing a security of supply report by the end of 2014.

- The Federal Ministry for Economic Affairs and Energy will work closely with neighbouring countries on the topic of security of supply. After the first meeting in July 2014, a follow-up meeting will be held in November 2014. The goals of the initiative are: a common definition of security of supply (uniform methodology and indicator); the creation of a joint adequacy report with intercountry monitoring; and, if possible, a system whereby security of supply is jointly guaranteed.

- The Federal Ministry for Economic Affairs and Energy will support the development of the network codes within the framework of ENTSO-E and ACER consultations, for instance, as well as the Electricity Coordination Group which meets several times per year, and the Electricity Cross-Border Committee of the European Commission.

- The Federal Ministry for Economic Affairs and Energy and the Federal Network Agency will adapt the national legal framework in order to further integrate the German electricity market into the European internal electricity market. A next step is the implementation of the network codes, such as through the Europeanisation of the intraday and balancing energy markets.

- In co-operation with neighbouring countries, the Federal Ministry for Economic Affairs and Energy will also develop common rules for dealing with situations of simultaneously high electricity prices.

Chapter 8: Delivering on climate protection goals

To ensure a secure, cost-effective and environmentally sound power supply with an increasing penetration of renewable energy, the support instruments and the regulatory framework that help deliver on the climate protection goals in the electricity sector are of central importance for the electricity market design. This is because the environmentally friendly deployment of producers and consumers particularly means achieving the national and European climate targets. To this end, carbon emissions in power production must (also) be reduced significantly. The reform of the European emissions trading system (ETS) should provide greater incentive to cut emissions in the energy sector and in industry.

8.1 Reducing carbon emissions in electricity production

By 2050, electricity generation must be largely decarbonised if we are to achieve the national and European climate targets by 2050. The replacement of fossil fuel-based electricity production by renewable energy sources as defined in the corridor for expansion determined in the Renewable Energy Sources Act is making the biggest contribution to delivering on this goal. Under the Federal Government's Energy Concept, the share of renewables in electricity consumption should rise to at least 80 percent by this time. While the need for power from thermal power stations will drop, it will remain significant. In 2050, these power stations should:

- have very low emissions
- use fuels very efficiently
- offer very flexible start-up and shut-down
- only still be used for a comparatively low number of hours

The power plant fleet is adapting gradually. The development path for the fossil-fired power plant fleet as outlined above is made possible by retrofitting existing plants, retiring or reducing the operation of high-emission legacy plants and the construction of new gas-fired power plants.

Measures are needed to provide the right incentives. Emission levels in the electricity production sector have remained at around the same level in recent years. According to current forecasts, additional measures are needed if we are to achieve the national climate goal of reducing emissions in 2020 by 40 percent compared to 1990 levels and head in the direction of long-term climate goals. Given its large share in national emissions, the electricity generation sector must play its part in reaching this goal.

8.2 Reforming the emissions trading system

The European emissions trading system (ETS) and the reform of this system is to make a central contribution to reducing emissions in fossil-based electricity production. With over two billion excess certificates and a current certificate price of between five and six euros per tonne of CO_2, the ETS in its current form provides comparatively little incentive for investment in low-emission electricity generation. Given that the number of surplus certificates is likely to rise to even 2.6 billion at the end of the current trading period when back-loaded allowances return to the carbon market, a glut of certificates and very low carbon prices can be expected well into the 2020s.

The ETS should again offer more planning security for investment decisions. Surveys conducted on businesses indicate that the current price of carbon only plays a minor role in decisions to invest. For one, electricity production at present is already affected by fuel prices that do not favour a reduction in emissions by switching fuels (high gas prices and low coal prices). Furthermore, on account of the long investment cycles, the carbon prices that can be expected on the medium to long term are a significant factor anyway for businesses as the power plants must also be cost-effective at these prices. However, medium-term price expectations are currently low.

The Federal Government is putting every effort into a swift and sustainable reform of the ETS. It aims to introduce the market stability reserve proposed by the European Commission as early as 2017, and place the 900 million backloading certificates into this reserve. Further to this, the market stability reserve must be designed so that the thresholds and release volumes, in particular, do in actual effect reduce the certificate surplus swiftly. At the same time, effective carbon leakage rules that address both direct and indirect cost burdens must also be defined in order to protect energy-intensive businesses.

The ETS reform is of structural importance. While the reform proposed by the Federal Government would approximately reduce by half the surplus allowances which the European Commission forecasts through to 2020, there would still be a significant oversupply in the market up to 2020. Therefore, an increase in the price of certificates is likely at the end of this trading period, thereby also providing important signals for future investment.

Next step

Reform of the ETS: Further specification of Germany's position and winning of support. Reference to an "instrument for the stabilisation of the market" and measures to safeguard industrial competitiveness in the conclusions of the European Council is a first important step in this direction.

8.3 Clarifying the role of CHP plants in the restructuring of the power plant fleet

Savings on fuel and carbon emissions can be achieved by coupling the generation of power and heat. CHP plants can be more energy-efficient and – particularly if fuelled by gas – produce lower emissions than conventional condensation power plants and the separate provision of heating. The ETS is the central instrument for climate protection in industry and for low-emission electricity and heat generation. In addition, CHP plants can help cut national carbon emissions.

Cogeneration plants can be run with greater flexibility in the future and play a larger role in synchronisation measures. Investment in heat storage systems, heat networks and, potentially, power-to-heat facilities (heat pumps and electric boilers) is a prerequisite here because it makes electricity generation more independent of simultaneous heating needs. Therefore co-generation plants should have incentives to ramp down before renewable energy sources if grid bottlenecks occur or prices are negative. So far, many co-generation plants in industry and individual properties are operated very efficiently according to heat demand for business and technical reasons. They constitute minimum generation for the electricity market and system operation (cf. chapter 3).

The CHP Act promotes quality instead of quantity. The CHP Act (KWK-Gesetz, KWKG) promotes plants whose quality is compatible with the *Energiewende*, i.e. plants that are very flexible and have very low emissions. Therefore the CHP Act also promotes investment in heating networks and storage systems. The CHP Act seeks to promote low-emission CHPs in particular. To stabilise the current CHP share, new CHP plants need to be built to replace old facilities with a production volume of several gigawatts. As part of the current evaluation there is a need to clarify to what extent it would make sense to significantly increase the installed CHP capacity beyond the current installed base.

Next steps

- 2014: The Federal Ministry for Economic Affairs and Energy is currently consulting upon the study presented on the analysis of the potential and benefits of co-generation plants and the appraisal of the CHP Act. The Federal Ministry for Economic Affairs and Energy will then submit an interim report in accordance with Section 12 of the CHP Act.

- 2015: The Federal Ministry for Economic Affairs and Energy will prepare the amendment to the CHP Act.

Part III: Solutions for sufficient, cost-effective and environmentally friendly capacity maintenance

The measures outlined in Part II are necessary for the secure, cost-effective and environmentally friendly deployment of producers and flexible consumers, and should be implemented in any case. Part III of the Green Paper examines whether an optimised electricity market can be expected to maintain sufficient capacity to guarantee security of supply or whether a capacity market is additionally needed.

Chapter 9: Fundamental policy decision: Electricity market 2.0 or capacity market

Section 9.1 describes the need for a fundamental policy decision. Section 9.2 summarises the results of expert reports commissioned by the Federal Ministry for Economic Affairs and Energy.

9.1 A fundamental policy decision is needed

The electricity market will undergo a period of transition in the coming years. The German electricity market is liberalised and coupled with the electricity markets of neighbouring countries. While this boosts the efficiency of the power supply system, it also contributes to the current overcapacity in the market, a situation which has been aggravated further by the addition of renewable energy facilities and the operation of new fossil-based power stations. On top of that, a temporarily lower demand for electricity in the wake of the financial crisis in Europe can currently be observed. This results in low electricity prices on the exchange, which are currently defining the market and reducing the economic viability of power stations. On the other hand, Germany plans to phase out nuclear energy by 2022. This will involve taking roughly 12 gigawatts of generation capacity offline. Further to this, renewable energy sources are increasingly playing a central role in the power supply and reduce the need for electricity production from fossil-fired power stations. We are transitioning from a power system in which controllable power stations follow electricity demand to a power system where flexible producers, flexible consumers and storage systems respond to the intermittent supply of wind and solar power. This transition will shape the electricity market in the years ahead (cf. section 2.1).

The "no regret measures" described in Part II are sensible measures for the secure, cost-effective and environmentally sound deployment of capacity (producers and flexible consumers) regardless of the fundamental policy decision. Sufficient capacity alone cannot guarantee that power production and power consumption are in balance at all times. This is clearly illustrated in the examples in section 2.2 for generation systems with a capacity market (January 2014 in the case of US transmission organisation PJM[6]) and without a capacity market (February 2012 in Germany).

In both examples, the supply situation became tense even though sufficient installed capacity was available in the system. This demonstrates that for supply to be secure, the pricing signals on the electricity market must always ensure that the capacity available is contracted and actually dispatched to the extent required at all times (i.e. matching the level of anticipated consumption). While capacity markets can ensure that sufficient capacity is held available, they cannot guarantee a secure, reliable balance between consumption and generation[7].

The debate is whether an optimised electricity market can be expected to hold sufficient capacity available to guarantee security of supply or whether a capacity market is also needed. The report of 28 May 2013 presented by the Power Plant Forum within the Federal Ministry for Economic Affairs and Energy to the Federal Chancellor and the *Länder* Minister-Presidents structured the debate (Federal Ministry for Economic Affairs and Energy 2013). Expert reports on behalf of the Federal Ministry for Economic Affairs and Energy analysed the performance of the electricity market and the impact of capacity markets in detail (cf. section 9.2). The stakeholders concerned discussed the reports in detail in the Electricity Market Platform.

Security of supply is guaranteed if it is possible to balance supply and demand at all times. This means that sufficient controllable capacity must also be available at times of peak demand (not covered by wind and solar power). In this context capacity refers to both renewable-based plants and conventional power plants that run on fuel, as well as flexibility of demand (demand side management) and storage systems. Some of these capacities, i.e. those with the highest marginal costs, are only required for a few hours in the year.

At the heart of the debate is the question whether investment in capacities that are rarely used but are nevertheless necessary can be expected in an optimised electricity market. This would particularly require scarcity pricing to

6 PJM is a regional transmission organisation in the United States, serving Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia.

7 In principle, capacity markets offer producers incentives for availability. However, these incentives are not enough to fully guarantee the function to ensure the appropriate use of capacity.

affect market players, and investors would need to be confident that policy-makers would not intervene if scarcity pricing occurs. In times of shortage, capacity providers must be permitted to offer prices on the electricity market that are above their marginal costs.

If providers fear that policy-makers will put a cap on prices, thereby partially devaluing investment in retrospect, capital-intensive investments will not be forthcoming. Instead, driven by the obligation to fulfil balancing group commitments, imperative delivery obligations and the system of imbalance settlement (cf. sections 1.4 and 1.5), there will be a tendency to only develop capacities with lower investment costs, such as demand side management or internal combustion engines. At the same time, industrial electricity customers with high power demand, in particular, can effectively safeguard their electricity supply against shortage-driven prices on the forward market, with options or hedging contracts, produce the electricity they need themselves, or use demand side management to respond with flexible demand to scarcity pricing.

The current overcapacity in the electricity market will be rectified over the next decade. Only consumers that look ahead and safeguard supply through the medium of delivery contracts, or use demand side management to respond with flexible demand to scarcity pricing will be able to avoid scarcity pricing. According to scientific studies, an optimised electricity market that allows undistorted price signals to reach market participants, and is safeguarded by a credible legal framework, is possible without an additional capacity market. Any residual risks can be addressed by a "capacity reserve" (cf. chapter 11). This capacity reserve, however, must be designed in such a way that it neither acts like a price ceiling in the electricity market nor gives market players a comfortable alternative to fulfilling their delivery commitments, i.e. the procurement of electricity volumes to match anticipated consumption (cf. section 1.1).

If society and policy-makers are not prepared to support the development of an electricity market with scarcity pricing, a capacity market is needed. However, capacity markets also present challenges, disadvantages and risks which society and policy-makers must be aware of. The state will change the design of the electricity market and regulations will interfere with competition. The costs of the capacity market must be passed on to consumers.

Therefore a fundamental policy decision must be made: Do we want an optimised electricity market (electricity market 2.0) with a credible legal framework which investors can rely on and which allows electricity customers to independently determine through their demand how much capacity is maintained – or do we want a capacity market alongside the electricity market?

Capacity markets differ from existing electricity markets

The introduction of a capacity market will change the current electricity market design, as an additional market will be created alongside the existing electricity market. On capacity markets, only the maintenance of capacity is traded and explicitly remunerated. In addition to the costs of procuring the electricity on the electricity market, costs are also incurred for capacity remuneration. The electricity suppliers bear the costs and pass them on to the consumers.

In the current electricity market, capacity is only implicitly remunerated on forward markets, spot markets and in electricity procurement contracts through imperative delivery obligations. Capacity is explicitly traded and remunerated in the balancing market, in option agreements or in delivery contracts, for instance.

The electricity market 2.0 option

This option is based on the fundamental assumption that the electricity market 2.0 provides incentive for the maintenance of sufficient capacity and therefore an additional capacity market is not required. The necessary maintenance of capacity is refinanced through the electricity market which also provides implicit and explicit payment for capacity (cf. chapter 1). The state sets the rules of the market. The market players must uphold their delivery commitments as they face high penalties otherwise (system of imbalance settlement). Through their specific demand, the electricity customers are independently responsible for determining how much capacity is held available. Regulators are responsible for ensuring all parties abide by the market rules and for overseeing the development of capacity in a continuous monitoring process.

Proponents of this option presume normal market mechanisms will apply and (at least implicitly) make the following assumptions and assessments:

- The level of capacity attained in the electricity market is enough to meet the demand of consumers.
- Flexibility options, particularly demand side management or back-up power plants, are sufficiently available and can be developed quickly and at low cost.
- Price peaks occur in the spot market and are accepted. They will affect the average electricity price to a minor extent because they only occur in a few hours.
- Through price peaks, inter alia, the electricity market provides sufficient investment incentive, even for investment in peaking power plants. Investors are able to handle the associated uncertainties for long-lasting investment.
- Private consumers who are not real time metered are safeguarded against short-term price peaks on the wholesale market through their contracts with their providers; companies are free to decide whether to safeguard prices contractually or whether to participate in the short-term electricity market.
- Pricing volatility is the central incentive for developing the flexibility of the system overall.
- If, for the purposes of safeguarding against residual risk, a higher level of capacity should be held available than would result from the electricity market, a reserve presents a low-cost solution.

It is important that pricing remain free for the electricity market 2.0 option.

Price peaks are needed to make investment in power plants economically viable in the electricity market. Through the use of demand side management and back-up power plants, only occasional, moderate price peaks can generally be expected. However, higher prices should also be possible temporarily in extreme situations. Extreme situations occur, for example, if the failure of large production capacities coincides with a high load and low levels of renewable energy injected to the grid.

There should not be any restrictions on the occurrence of price peaks. There are no regulatory price ceilings in the current electricity market. There is only a very high technical limit, which the exchange can modify if necessary. To ensure that investors have sufficient planning security that the legal framework for this will remain unchanged, there is a need to clarify by law that state intervention in the form of price caps will not occur.

Price peaks are neither ruled out nor mitigated by the prohibition of abusive practices under anti-trust law. All undertakings are free in the submission of their bids. Power stations must have the possibility of offering prices above their marginal costs on the electricity market in situations of electricity shortage; there must not be a de facto mark-up ban. Under European and German anti-trust law, businesses with a dominant market position may not abuse their power in the market, however. Among other reasons, this regulation seeks to ensure that prices are not artificially inflated.

The ban on abusive practices under anti-trust law does not set an implicit price ceiling. If price peaks arise out of shortage in the market, and not from positions of market power, they cannot be challenged under anti-trust law. If a provider is not a dominant player, the ban on abusive practices would not apply to this provider in any case. In times of shortage, these providers are also able to push through higher prices. Providers with dominant market positions also benefit from these prices in the uniform pricing auction on the exchange. Therefore, the ban on abusive practices under anti-trust law does not affect the ability of the electricity market to function.[8]

8 Businesses with a dominant market position may, however, need to prove that they have not exercised market force in their bids on the electricity market. By way of precaution, dominant businesses see themselves subject to de facto mark-up prohibition.

The ban on abusive practices under anti-trust law has little practical relevance in the present market situation. There has been a downward trend in the exercise of market power in recent years. The coupling of the German electricity market with neighbouring markets, the commencement of Germany's nuclear phase-out and the growth in electricity from renewable sources, in particular, have stimulated competition in the electricity market. As a result of this increased competition and the overcapacities that exist in the market, the ban on abusive practices is currently not relevant in practice.

If the electricity market 2.0 option is selected, there will be need for action in the following areas:

- The electricity market will be optimised and improved upon to create the electricity market 2.0 for the energy transition.
- The central elements of the reform are:
  - The implementation of the no regret measures detailed in Part II. Action to strengthen incentives to uphold balancing group commitments (system of balancing groups and imbalance settlement) will play a central role.
  - Pricing must remain free; there is a need to clarify by law that no caps on prices will be introduced. This will give market participants a high degree of planning security.
  - The capacity reserve described in chapter 9 will be introduced, and continuous monitoring will be put in place.

The capacity market option

This option is based on the fundamental assumption that even an optimised electricity market does not provide sufficient incentive for the maintenance of capacity and that an additional market for the maintenance of capacity must be introduced. The necessary maintenance of capacity is refinanced through an additional capacity market which provides explicit remuneration for capacity. The costs are redistributed to the electricity customers. In choosing this option, the state is ensuring a higher level of capacity than would result from the electricity market. In a central and focussed capacity market, the state directly determines how much capacity is held available. In a decentralised capacity market, the state controls the level of capacity indirectly by the level of penalties to be paid (see box). Even with a capacity market in place, it is the responsibility of the market participants to contract sufficient capacities in order to meet their delivery commitments at any time. Regulators are responsible for ensuring all parties abide by the market rules and for overseeing the development of capacity in a continuous monitoring process.

Capacity markets can be implemented in many different forms

Three separate approaches to capacity markets are currently the focus of intense debate in Germany. They differ considerably in terms of the design, the necessary regulatory specifications and their impact on the electricity market:

In the **"central comprehensive capacity market with tendering and reliability contracts"** (EWI 2012), a central authority specifies the total capacity required. This capacity is tendered in auctions (capacity market). Operators of generation facilities offer generation capacity on this capacity market. If they are contracted, they receive compensation in the form of a uniform capacity payment for the capacity offered. At the same time, operators of generation facilities can sell the electricity they produce on the electricity market to other market participants. The costs of the capacity market are redistributed to the electricity price in the form of a capacity surcharge. The capacity payment obliges the power plant operators to make their generation capacity technically available in principle. If the exchange price exceeds a previously defined trigger price, the power plant operators pay the difference between the current exchange price and the trigger price to the authority (call option).

In the **"central focussed capacity market"** (Öko-Institut/LBD/Raue 2012), a central authority also specifies the total capacity required. Other essential features are also comparable to those of the central comprehensive capacity market. However, only a part of the capacity deemed to be required is procured in public tendering. An authority decides which facilities can take part in the auctions. Öko-

Institut/LBD/Raue envisage two market segments: one for new facilities and one for existing facilities "threatened by closure" and demand side management. As the capacity required is put out to tender in two submarkets, there is no uniform capacity payment.

In the **"decentralised comprehensive capacity market with capacity obligations"** (Enervis/BET 2013, BDEW 2013), the total capacity required is not directly specified and put out to tender by an authority. Instead the required capacity is specified indirectly by the level of a penalty to be paid. Retailers are required to prove that they have contracted sufficient capacity for their electricity purchases for situations of scarcity. They can supply such evidence by purchasing capacity certificates from operators of generation facilities (security of supply certificates). These certificates can be traded bilaterally between market players, or on the exchange. Depending on their power consumption and the use of demand side management, the businesses themselves decide how many capacity certificates they need to cover their consumption. If a defined trigger price is exceeded in times of shortage, retailers have to pay a penalty for the actual power usage for which they are unable to produce capacity certificates. Generators must pay a penalty if their generation capacity is not available in this situation. An authority sets the penalty level and the trigger price. In other models, (e.g. in France) an authority sets additional parameters that determine the amount of generation capacity which retailers need to stock up on. The retailers redistribute the cost of the capacity certificates to their electricity customers.

Advocates of this option (at least implicitly) make the following assumptions and assessments:

- The level of capacity attained in the electricity market is not sufficient.
- Flexibility options, particularly demand side management or back-up power plants, are not sufficiently available or cannot be developed to an adequate extent in the electricity market.
- A strategic reserve which is maintained and then dispatched when the market price hits a certain level does not *efficiently* ensure a sufficient level of capacity.
- Additional regulatory intervention is necessary: a capacity market must be introduced.
- The higher level of capacity justifies the additional costs (redistributed to electricity customers).
- Price peaks in the spot market are cause for scandal and are therefore not accepted.
- Price peaks are too unreliable to provide investment incentive for market participants, as they fear that policy-makers could intervene with price ceilings. Therefore investor uncertainties must be reduced through capacity markets.
- The higher level of capacity available means that capacity markets reduce price peaks in the spot market.

Specific consequences are associated with the different capacity market models

In a **decentralised or central comprehensive capacity market,** inflexible and high-emission power stations also receive payment. This has an effect on the need to transform the power plant fleet and make it more flexible, and delivery on national climate goals.

Decentralised capacity markets require the least amount of regulatory intervention and cause the least regulatory risk of all capacity markets. The development of demand side management is not hampered.

The specific challenge of **central comprehensive or focussed capacity markets** is to define the right level of capacity to be held available in order to guarantee security of supply. This is particularly true of central focussed capacity markets where only some of the total capacity required is put out to tender. In addition, there is also the need to ensure that the capacity that is put out to tender is actually built or remains in operation.

Central focussed capacity markets can specifically promote flexible and low-emission capacities.

If the capacity market option is chosen, there will be need for action in the following areas:

- The no regret measures detailed in Part II are implemented.
- A decision must be made as to which particular capacity market model should be introduced.
- The legal framework must be created. The design and structure of the capacity market must be defined in regulatory terms.
- Given that the European Commission categorises capacity markets as state aid, the regulations must be agreed with the European Commission.
- In the course of implementation, a government body directly or indirectly determines how much capacity should be held available[9].
- The capacity reserve described in chapter 9 is introduced.
- The adequacy of supply must be continuously monitored[10]. On the basis of this monitoring process, it is possible to continuously check whether additional measures are required.

The French capacity market leaves open the fundamental policy decision as to whether to opt for or against the introduction of a capacity market in Germany.

The French capacity market does not have a relevant effect on performance of the electricity market in Germany. The German and French electricity markets are coupled (cf. chapter 2 and 6). The introduction of a capacity market will probably provide incentive for additional capacity in France. This capacity contributes to security of supply in Germany. Power plant capacity in Germany can drop to the same extent as additional French power plant capacity is available for the electricity market in Germany through the cross-border interconnectors available. However, this will not alter the principle ability of the electricity market in Germany to provide incentive for sufficient capacity as the additional capacity in France merely acts like reduced demand in Germany. Therefore the French capacity market will not automatically force the introduction of a capacity market in Germany.

The French capacity market can bring about distribution effects. If the French capacity market is appropriately structured, investors will have greater incentive than before to build and maintain power stations in France. These power stations are supported by French electricity consumers through the capacity surcharge levied in the country. However they are also available to France's neighbours to cover load to the extent permitted by the capacity of the cross-border interconnectors.

9 In a central capacity market, the state directly determines how much capacity is held available. In the decentralised capacity market, the state controls the level of capacity indirectly through the level of penalties to be paid.

10 Currently, the transmission system operators, the Federal Network Agency, the Federal Ministry for Economic Affairs and Energy, the Pentalateral Energy Forum and the European Association of Transmission System Operators ENTSO-E, among other parties, monitor adequacy of supply.

The Electricity Market 2.0 OPTION *"An optimised electricity market guarantees security of supply"*	**The Capacity Market OPTION** *"The state must take action to ensure security of supply"*
How it works	**How it works**
• The electricity market provides incentive for the maintenance of capacity. The necessary maintenance of capacity is refinanced through the electricity market. • The state sets the rules of the market. Through their specific demand, the electricity customers are independently responsible for determining the capacity level. • Implicit payment for capacity on the electricity market and explicit payment on the balancing market and in options and delivery contracts, for instance.	• The capacity market provides incentive for the maintenance of capacity. The necessary maintenance of capacity is refinanced through an additional capacity market. • The state ensures a higher level of capacity than the electricity market. • Explicit payment for capacity on the capacity market.
Assumptions and opinions of proponents of this option:	**Assumptions and opinions of proponents of this option:**
• The electricity market provides sufficient capacity. • Sufficient flexibility options (demand side management, back-up power plants) are available, and can be developed quickly and at low cost. • Price peaks occur in the spot market. They are accepted because they affect the average electricity price only to a minor extent, and pricing volatility is the central incentive for added flexibility. • Through price peaks, inter alia, the electricity market provides sufficient investment incentive, even for investment in peaking power plants. • Private consumers are safeguarded against price peaks. Companies are free to decide whether to safeguard prices or whether to actively participate in the electricity market. • To safeguard against any remaining risks, a reserve can maintain a higher level of capacity at a low cost.	• The electricity market does not provide sufficient capacity. • Flexibility options, (demand side management, back-up power plants) are not sufficiently available or cannot be developed to an adequate extent in the electricity market. • Additional regulatory intervention is necessary. A capacity market is needed. • The higher level of capacity justifies additional costs (apportioned to electricity customers). • Price peaks in the spot market are cause for scandal and are therefore not accepted. • Price peaks are too unreliable to provide sufficient investment incentive. • The higher level of capacity available means that capacity markets reduce price peaks in the spot market.
Need for action	**Need for action**
• The no regret measures detailed in Part II are implemented. • It will be clarified by law that prices will not be capped. • There must not be a de facto mark-up ban. • A capacity reserve is introduced. • The adequacy of supply is continuously monitored.	• The no regret measures detailed in Part II are implemented. • A decision is made concerning the capacity market model, the design of the capacity market and the amount of capacity to be maintained. • Compatibility with the European internal market must be guaranteed. • A capacity reserve is introduced. • The adequacy of supply is continuously monitored.

9.2 Experts: The electricity market guarantees security of electricity supply with and without a capacity market

Expert reports commissioned by the Federal Ministry for Economic Affairs and Energy have examined whether the electricity market provides sufficient incentive for capacity to guarantee security of electricity supply to consumers, or whether a capacity market is additionally needed. The consultancies Frontier Economics, Formaet and Consentec, as well as Connect Energy Economics and r2b energy consulting were tasked with examining this question. They also studied the potential impact of capacity markets. The goal was to create a "meta study" that examines and evaluates the capacity market models which are currently the subject of intense debate (see also Frontier 2014 a and section 9.1). The expert reports themselves do not develop an individual model for a capacity market. These reports can be downloaded from the website of the Federal Ministry for Economic Affairs and Energy.[11]

Key results of the electricity market reports

The expert reports arrive at the conclusion that both capacity markets and the electricity market in its present form can provide sufficient capacity incentive to guarantee the security of electricity supply to consumers. The electricity market in its current form results in a capacity level that is in line with the preferences of the consumers. With capacity markets or reserves, it is possible to hold a higher level of capacity available than would result from the electricity market.

The experts advise against capacity markets. According to the experts, capacity markets present considerable risks in terms of organisation and structure. Capacity markets only guarantee security of supply if they are designed and organised correctly. Practical experience from the United States, for example, demonstrates that arriving at the correct market design is a difficult undertaking that takes many years and may require many adjustments to rectify regulation errors. Capacity markets result in higher system costs and also present considerable risks when it comes to Germany's energy transition (particularly in terms of overcomplexity, mismanagement potential, inefficiency, less incentive for the development of flexibility, irreversibility, path dependency).

The expert reports recommend the optimisation of the electricity market, and identify a number of measures to this end. These measures are not only necessary for the reserve function, however. As "no regret measures" they must be implemented anyway for the secure, cost-effective and environmentally friendly deployment of producers and flexible consumers (cf. section 8.1). At the same time, they boost the incentive for market players to maintain capacity and safeguard against pricing and volume-related risks. If policymakers prefer an additional electricity supply safeguard, i.e. a higher level of capacity should be held available than would result from the electricity market, the expert reports recommend the creation of a reserve outside the electricity market, stating that it would be an easy-to-implement, low-cost solution that would uphold the functioning of the electricity market.

Other central results of the expert reports are presented below:

Security of supply on the electricity market means: consumers can draw electricity if their willingness to pay (benefit) is higher than the market price (cost). Furthermore, it is also necessary to take a European perspective when appraising security of supply on the electricity market. The German electricity market is coupled with the electricity markets of neighbouring countries, resulting in considerable smoothing effects, particularly with regard to load and the supply of renewable energy. At the same time, flexibility options such as demand side management and back-up power plants must be taken into consideration.

Careful analysis is needed for reasons of regulatory policy and state aid. Capacity markets require considerable regulatory intervention. From a regulatory perspective, such intervention measures should only be taken if the structure of the electricity market means that too little capacity is held available (and not only on a short term basis as a result of adjustment processes in the transitional phase) and milder intervention does not deliver the desired effect.

11 The various studies are in response to a request of the Power Plant Forum within the Federal Ministry for Economic Affairs and Energy in May 2013 (see Report of the Power Plant Forum to the Federal Chancellor and the *Länder* Minister-Presidents).

Lost contribution margins is not an indicator per se for the need for state intervention. Currently, some conventional power plants cannot cover their full costs in the market, or are struggling to do so; new investment is only economically viable under particularly favourable conditions.

This situation is primarily due to the current overcapacity in the market, and the resulting downward pressure on electricity prices (cf. chapter 1). It is not an indicator of the need for market intervention.

It is economically rational that, at present, new investment will only pay off under particularly favourable conditions. This is because hardly any need for new power plants is expected in the next 10 years. In the next 10 years very little peak load capacity (e.g. internal combustion engines or gas turbines) will be required above and beyond the power stations currently under construction and the reactivation of some plants that had only been shut down temporarily[12]. Such capacities have lower investment costs, can be built quickly, offer flexible dispatch and can be operated at a profit even if utilisation is low. At the same time, other technical possibilities, such as demand side management and back-up power plants, will become increasingly important.

The experts have analysed fears and arguments that the electricity market does not provide incentive for sufficient capacity. They explain that

- the current electricity market also pays for the maintenance of capacity in addition to electricity production
- the power stations required will be able to make sufficient contribution margins in the future
- external effects for producers are minor and can be avoided
- investments can continue to be made (r2b 2014 and Frontier et al. 2014).

Model calculations demonstrate that all the power plants required to secure the supply of electricity can cover their fixed costs. For this, pricing on the wholesale market (spot market) must be possible through "peak-load pricing" (cf. section 1.2). This requires occasional price peaks. In such situations with a high residual load, demand will be covered by additional flexibility options, such as demand side management and back-up power plants, in addition to peaking power plants. Further to this, the reports state that it is efficient to safeguard supply with demand side management and back-up power plants. Otherwise other power plants which would need to be additionally held available would only be dispatched for a few hours or not at all.

The experts thoroughly examined the demand side management flexibility option. Analyses by r2b energy consulting put the available potential for demand reduction in industry at between 10 and 15 gigawatts over the medium to long term (r2b 2014). According to analyses conducted by Frontier, medium- to long-term potential for demand reduction in some areas of industry (with high power demand, low value added and high flexibility) is between 5 and 10 GW (Frontier et al. 2014). This potential can be developed quickly, and at a low cost. The ability to develop this demand side management potential is still hotly disputed at present, particularly with regard to the level of investment needed. However, even if no additional demand side management potential were developed, the experts are of the opinion that the electricity market would still be able to function (r2b 2014).

Back-up power plants are another flexibility option which the experts looked at. Many facilities, such as airports, football stadiums or data centres, use back-up power plants to safeguard against power failures as a result of grid events. These systems are therefore already available and could be used quickly and cost-effectively for the electricity market. While they are available to the electricity market, they continue to safeguard their own particular facility and act as an emergency electricity supply for their site if local grid events occur. Conservative estimates of r2b energy consulting put the potential of back-up power plants, which can be tapped quickly and at low cost, at 5 to 10 gigawatts. (r2b 2014). This potential is confirmed by other studies also considered in this analysis. The Federal Ministry for Economic Affairs and Energy will examine whether it is possible to activate back-up power plants for redispatch at short notice in order to relieve the network reserve.

12 This statement is also supported by other recent expert reports, such as the study by the Öko-Institut and Fraunhofer ISI for the Federal Ministry for the Environment (Öko-Institut/Fraunhofer ISI 2014).

Demand side management and back-up power plants reduce price fluctuations on the spot market. If this capacity is tapped to a larger extent, it will stabilise the electricity prices. This means that if demand side management can be used to a large extent, there will be lower price peaks on the electricity market for balancing supply and demand (situation of equilibrium). European electricity trading also has a dampening effect on pricing fluctuations as it increases the potential supply of generation capacity in Germany by including foreign capacity and takes advantage of smoothing effects in demand.

In r2b's model calculations, the price peaks required to refinance investments are far below the technical price threshold of the day-ahead market. The ten most expensive hours in 2020 are, on average, below € 200/MWh and the most expensive hour peaks at roughly € 400/MWh. In 2030, the ten most expensive hours are under € 700/MWh, with the most expensive at around € 1,200/MWh (r2b 2014). If demand side management and back-up power plants are available to a lesser extent than presumed in the report, the electricity market will still work as a result of peak-load pricing. Price peaks are then higher but occur less frequently (r2b 2014, Frontier et al. 2014).

Private households and many businesses can safeguard against pricing peaks in the spot market. Electricity suppliers offer their customers rates on the basis of average electricity prices. With the separation of wholesale trading and retailing, the effect of even significant price peaks in a few hours is only minor for these customers.

Through the forward market, industrial electricity consumers can hedge against price peaks on the spot market and benefit from demand side management. For example, industrial consumers can enter into forward contracts to safeguard electricity at low prices. This is known as hedging. If prices peak they can use demand side management to generate additional profit by taking the electricity they already bought at a lower price and reselling it on the wholesale market.

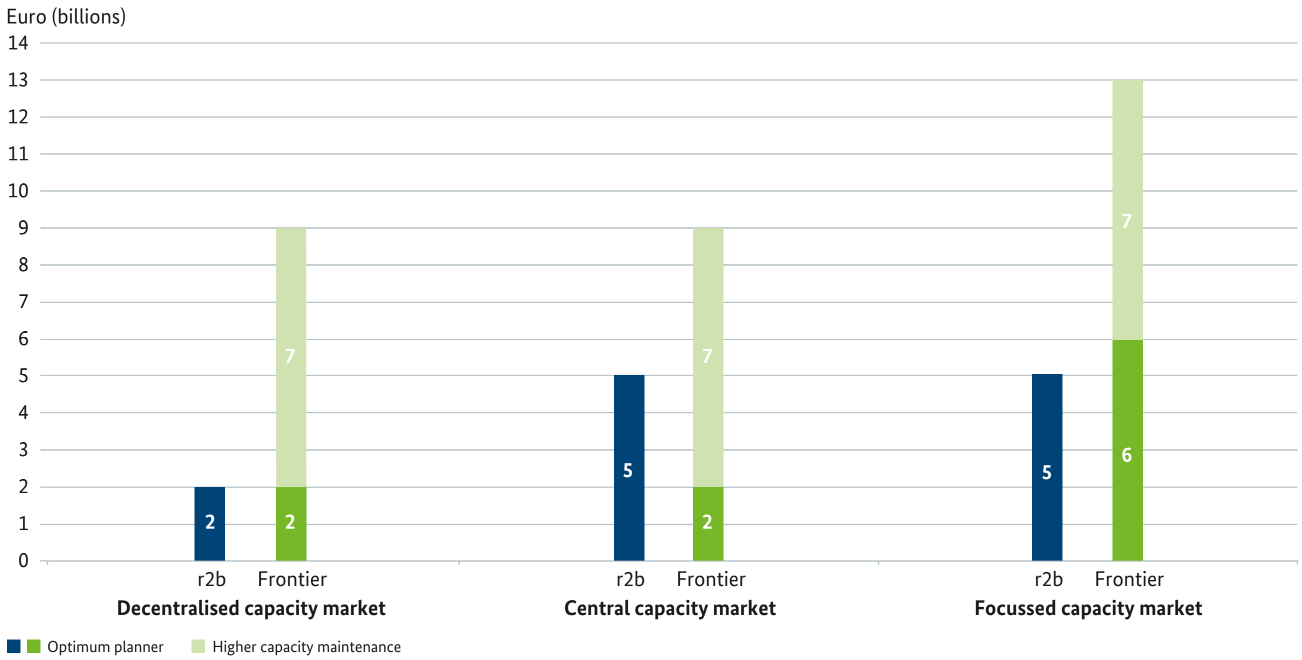
For producers, external effects are minor and avoidable, and do not have a relevant influence on security of supply. The reports studied the impact of external effects on security of supply. External effects for producers can arise if, in extreme situations, producers are unable to feed to the grid on account of system stability measures and therefore lose revenue. The reports come to the conclusion that these external effects cannot be ruled out entirely for producers given current practices. However, according to the reports they do not have a relevant bearing on the investment of generation facilities and therefore on security of supply. To avoid any influence on investment with all certainty, producers could also be fully compensated for any lost revenue, in a similar fashion to the rules governing redispatch and feed-in management, if TSOs curtail them as part of measures to maintain system stability when there is a high residual load.

Impact on system costs. Both reports created a model for the total costs of the various options. They conclude that the differences between the system costs (dark area) are moderate if a perfect, well-informed system planner is assumed in the simulations (Frontier Impact Assessment 2014, r2b 2014). However, there are considerable cost risks if the system planner makes mistakes and the settings for some parameters are less than optimum. If, for example, a higher capacity specification is incorrectly selected in a capacity market, this can partly drive up the system costs considerably. This is illustrated in the simulations performed by Frontier Economics (shaded section). The cost risks are higher the greater the intervention intensity of the mechanisms (as is the case in comprehensive capacity markets). The many parameters that must be defined in the various mechanisms constitute other central influencing factors that carry a cost risk.

Impact on national CO_2 emissions. As part of the impact analysis, the report presented by r2b energy consulting analysed the effect of the various options for action on national CO_2 emissions. It comes to the conclusion that with the market organised at optimum cost, both decentralised and central comprehensive or focussed capacity markets could result in a slight increase in CO_2 emissions in Germany compared with an optimised electricity market (r2b 2014).

Conclusions from the reports: The acceptance of price peaks on the wholesale market is a decisive factor. At its core, the initial question as to whether the electricity market in its current form ensures sufficient capacity or whether a capacity market is also needed essentially seeks to determine whether the occurrence of occasional price peaks on the electricity market is acceptable. Both options can guarantee security of electricity supply to consumers. With capacity markets or reserves, it is possible to hold a higher level of capacity available than would result from the electricity market. Capacity markets can also reduce price peaks in the spot market. However, capacity markets give rise to a new cost element which must be redistributed to the power consumers (capacity surcharge).

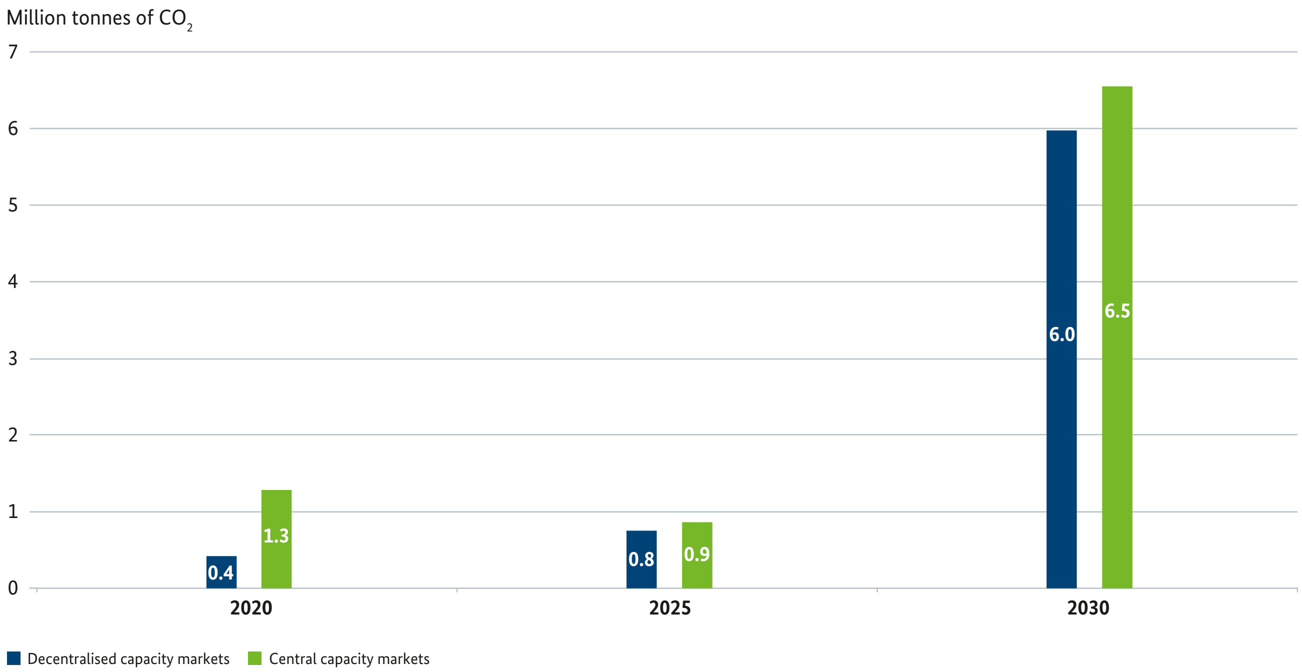
Figure 4: Additional system costs of capacity mechanisms compared with the electricity market 2.01



1) The graphic illustrates the cash equivalent of system costs in the r2b model period spanning 2014 – 2030, and the 2015 – 2039 model period for Frontier. In each case the difference is illustrated compared against the optimised electricity market.

Source: Own graphic based on data provided by r2b and Frontier

Figure 5: Increase in national CO_2 emissions in electricity production compared to electricity market 2.0 (reference scenario)



Source: r2b energy consulting

Chapter 10: Collaboration with neighbouring countries

Germany is working with its neighbours on a joint strategy for security of supply. Seeing security of supply from a broader, European perspective offers major advantages, as the peak need for capacity occurs at different times in different countries. Therefore, when security of supply is considered in a European context less capacity must be held available nationally: this, in turn, increases security of supply and drives down cost. Since July 2014, the Federal Ministry for Economic Affairs and Energy has been holding talks with Germany's neighbours on the topic of security of supply (common definition and joint monitoring of security of supply, cf. chapter 7).

Germany will make its fundamental policy decision for an optimised electricity market or the additional introduction of a capacity market in dialogue with our European partners and the European Commission. The maintenance of adequate capacity is a topic of debate in many countries in Europe. Some European countries, such as the Netherlands, Austria, Norway, Sweden and Finland have opted for an optimised electricity market. Finland and Sweden have a reserve to safeguard the electricity market, with Belgium and Denmark also recently choosing to do the same. Other countries have opted for a capacity market or payments to specific capacities. For example, France is currently implementing a decentralised capacity market and Great Britain will shortly be launching its first bid invitation for its central capacity market. Germany intends to coordinate its decision in favour of an optimised electricity market or an additional capacity market closely with other European Member States and the European Commission. Interaction between the individual models, as well as ways to improve coordination efforts, will play a central role here.

The European Commission has defined strict rules for the introduction of a capacity market. In legal terms, the European Commission categories capacity markets as a form of state aid, as they involve considerable regulatory intervention. The European Commission holds that such regulatory invention measures should only be taken if the structure of the electricity market is such that too little capacity is held available and milder intervention does not suffice. In this context, the European Commission distinguishes between temporary problems in the transitional phase and structural problems. In its recent guidelines on state aid for environmental protection and energy, the European Commission demands evidence proving that the market cannot provide sufficient capacity in the absence of state intervention (EU Commission 2014). The European Commission expresses particular concerns with regard to uncoordinated national capacity markets as they distort the level playing field sought with the internal market packages and could reduce the efficiency gains of the European internal market.

Independent national approaches could reduce the effectiveness of a capacity market and give rise to inefficiency in the internal market. Given that the electricity markets between Germany and its neighbours are coupled, additional capacity that a capacity market in Germany would encourage could substitute capacity in other countries to some extent (see box, chapter 9). If capacity markets were introduced in several countries in an uncoordinated manner, considerable overcapacity could result.

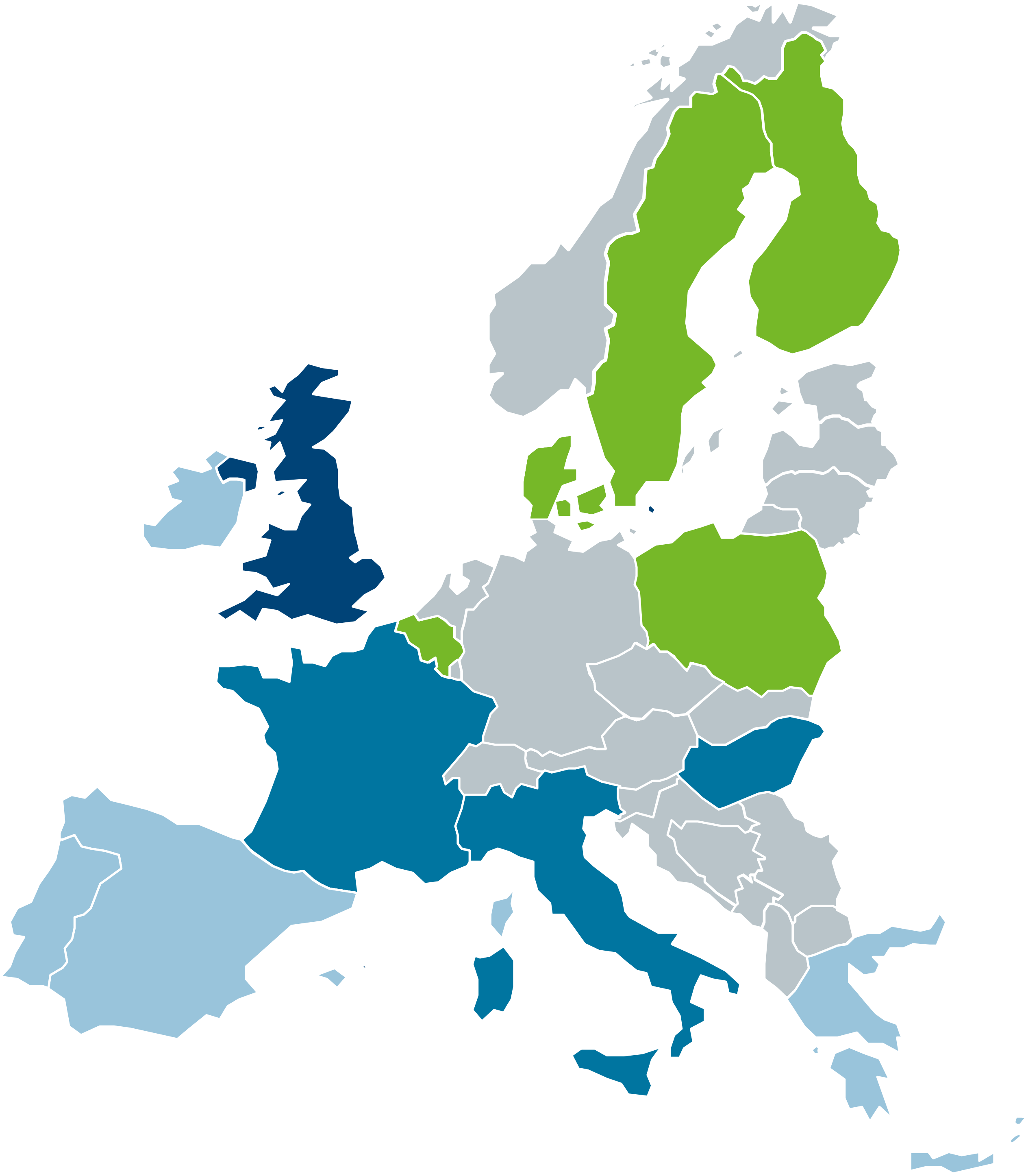
Capacity markets must be coordinated among European Member States at least. A coordinated approach requires a common understanding of security of supply among the neighbouring countries and the European Commission. Ideally, security of supply should be defined jointly with our neighbours. Further to this, supply adequacy should be monitored regionally (see above and chapter 7). Building on this, the overall capacity that should be held available in the region should be coordinated among the states so that goals can be attained as efficiently as possible. Finally, there is a need for a joint decision on how foreign capacity is factored into national mechanisms and can participate in these mechanisms.

Next steps

- The Federal Ministry for Economic Affairs and Energy will continue the security of supply initiative with neighbouring countries. After the first meeting in July 2014, a follow-up meeting will be held in November 2014. The initiative seeks to: establish a common definition of security of supply (uniform methodology and indicator), draw up a joint adequacy report with intercountry monitoring and, potentially, establish a joint guarantee of security of supply to the extent that such a guarantee is feasible and desired.

- The work of the Pentalateral Energy Forum (DE, FR, AT, BENELUX, CH) will be incorporated into the process.

Figure 6: Capacity markets and capacity reserves in Europe



■ Capacity market ■ Capacity market being implemented ■ Capacity payments ■ Capacity reserve

Source: Graphic based on data supplied by CEPS (2014), DIW (2013) and Frontier (2014)

Chapter 11: Capacity reserve as a safeguard

The electricity market will undergo a period of transition in the coming years. By the mid 2020s the electricity market will have changed considerably. The primary challenges during this transitional period include the continued internal market integration, the phase-out of nuclear power by 2022 and the transition to an efficient power system overall where flexible generators and consumers as well as storage systems respond to the intermittent supply of wind and solar energy (cf. section 2.1). These changes can produce uncertainties for investors in the years ahead. This can also delay investment in an electricity market that functions in principle. To safeguard the transition, an additional instrument is needed. This is true both if the electricity market is optimised but retains its current basic structure, or if a capacity market is introduced.

The aim of a capacity reserve is to safeguard power supply in addition to the generation facilities active on the electricity markets. It must be designed in such a way that it can reliably perform this task (Frontier/Consentec 2014 and r2b 2014). Similar concepts for safeguarding supply have been proposed by the German Association of Energy and Water Industries, *BDEW* (introduction of an interim instrument until the decentralised capacity market has been implemented), the German Association of Local Utilities, *VKU* (parallel introduction of a safety reserve to safeguard the capacity market) and a joint paper submitted by associations and the academic community (BDEW/BEE/VKU among others, 2013). International experience shows that the process of creating capacity markets can take several years, from the fundamental policy decision to the point where a fully functioning market is established. Therefore, it is certainly advisable to include a safety net in the form of a capacity reserve during the transition phase.

The capacity reserve should not negatively impact investment security on the electricity market. The capacity reserve is procured by the transmission system operators in a competitive process and is dispatched exclusively by the TSOs. If a facility is contracted for the capacity reserve, power plant operators may no longer use it on the electricity market. This ensures that market activity remains unaffected by the reserve. The capacity reserve may only be dispatched if the electricity market is unable to balance supply and demand. This makes it different from the network reserve, which provides capacity for redispatch regardless in order to overcome bottlenecks in the grid. Therefore the use of the capacity reserve is comparable to balancing capacity: similar to the solution proposed by the Federal Network Agency and the 2013 E-Bridge Study for TenneT (E-Bridge 2013), it is used as a ancillary service only once all market transactions have been concluded. In this way, it does not affect pricing or competition, and does not influence investment decisions of participants in the electricity market. Balance responsible parties who cannot meet their delivery obligations and cause the reserve to be deployed, must bear all the costs, including the costs of reserve maintenance, on a "causer pays principle". The mechanism can be implemented quickly, is micro-invasive and is compatible with the European internal market.

A capacity reserve could also address grid congestion in southern Germany. The grid situation in the south of the country is expected to remain tense even after 2020 (cf. chapter 5). Therefore, an instrument like the network reserve is needed as a transitional instrument for this period. The capacity reserve could also contain a regional component and therefore assume the function of the network reserve.

Next step

The Federal Ministry for Economic Affairs and Energy will implement a capacity reserve while taking the existing network reserve into account.

Chapter 12: Further procedure

The Federal Ministry for Economic Affairs and Energy is opening a public consultation with this Green Paper. As part of this consultation, the public may submit comments on the Green Paper. Comments on the Green Paper are invited at the following address until 1 March 2015: gruenbuch-strommarkt@bmwi.bund.de. With the consent of the sender, all comments will be published on the website of the Federal Ministry for Economic Affairs and Energy.

The Federal Ministry for Economic Affairs and Energy will discuss the Green Paper with parliamentary groups in the German Bundestag, the *Länder* and stakeholders.

At the same time, the Federal Ministry for Economic Affairs and Energy will continue discussions in the Electricity Market Platform. The Electricity Market Platform commenced work on preparing for this Green Paper in summer 2014. It comprises four working groups assigned to specific subject areas and a plenum. Additional information is available to the public on the website of the Federal Ministry for Economic Affairs and Energy (http://bmwi.de/DE/Themen/Energie/Strommarkt-der-Zukunft/plattform-strommarkt.html).

The Federal Ministry for Economic Affairs and Energy will also discuss the Green Paper in the course of dialogue with neighbouring countries and the European Commission, as joint solutions in the context of the European internal market offer significant cost advantages. Dialogue with neighbouring states commenced at the Federal Ministry for Economic Affairs and Energy in summer 2014 in a high-level working group led by the competent state secretary. So far, the working group has primarily dealt with issues surrounding security of supply and the promotion of renewable energy (cf. chapter 7 and 10). The Federal Ministry for Economic Affairs and Energy will continue and further intensify the dialogue.

The Federal Ministry for Economic Affairs and Energy will develop a regulatory proposal, giving due consideration to the comments and opinions on the Green Paper submitted in the course of the consultation, the discussions mentioned above and the dialogue with neighbouring countries. This proposal will contain the key parameters for the future design of the electricity market and will be published in the form of a White Paper. Following further consultation, a legislative proposal will be put forward on this basis.

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