FINAL REPORT

UPGRADING THE INTERNAL MARKET: THE POWER MARKET 2.0

Study on behalf of the
German Federal Ministry for Economic Affairs and Energy

29.06.2016

UPGRADING THE INTERNAL MARKET:
THE POWER MARKET 2.0

Study on behalf of the
German Federal Ministry for Economic Affairs and Energy

Final report,
29.06.2016

Connect Energy Economics GmbH

Gabriele-Tergit-Promenade 15
10963 Berlin
Germany

Contact: Dr. Marco Nicolosi
E-mail: contact@connect-ee.com

www.connect-ee.com

Content

Figures

Abbreviations

CHP	combined heat and power
EOM	Energy-Only Market
PV	solar photovoltaic
TSO	transmission system operator
VOLL	Value of Lost Load

UPRGRADING THE INTERNAL MARKET: THE POWER MARKET 2.0

Executive Summary

The European long-term objectives of decarbonisation, increasing renewables and energy efficiency, as well as completing the internal market require a transformation of the power system. The task is to upgrade the internal market to meet the objectives, particularly making the market fit for integrating renewables while guaranteeing security of supply. A flexible Energy-Only Market is a future-proof power market design that supports these objectives and the transformation process alike. It is also a cost-efficient answer for delivering security of supply in the internal market.

The strength of the Energy-Only Market is its high cost efficiency, low political risk and ability to adapt to changes and to stimulate innovation: It is well-suited to adapt dynamically to the transformation of the power market as it organises market adjustments competitively and unlocks high levels of flexibility. In the Energy-Only Market, the level and the variability of power prices indicate the required level and kind of investments. Based on these signals, the market finds the cost-efficient mix of power plants and flexibility optionsThe Energy-Only Market thus provides a combination of cost-efficiency and security of supply that could not be achieved via governmental intervention and regulation. Therefore, using the benefits of the Energy-Only Market is imperative for a successful transformation process that allows the smooth integration of renewables, new technologies, and innovative business cases.

To deliver on this, the Energy-Only Market needs to be upgraded by removing temporary imperfections and barriers for flexibility options as well as by strengthening the imbalance system. A safety net in terms of a capacity reserve could additionally safeguard supply security during the transformation process on top of the level that is delivered by the market. Notably, a well-designed capacity reserve leaves the internal market intact and does not interfere with the Energy-Only Market.

Currently, we observe market effects such as lower revenues for generators that stem from making progress towards reaching the objectives of the internal market

and decarbonisation: Additional low-carbon capacity entering the system in combination with reaping the benefits from the internal market can create temporary oversupply. These effects should not be confused with market failures. A low price level will induce the necessary market-based capacity adjustment to a new equilibrium. The Power Market 2.0 enables an efficient adjustment towards an economically sustainable capacity mix in the new equilibrium. The Power Market 2.0 will deliver on this, amongst others, by creating capacity remuneration elements: Hedging products such as long-term contracts contain such capacity remuneration elements and meet both the consumers' and the investors' need for stable cost and revenue streams. Notably, these are solutions tailor-made by the market itself and therefore better-suited and more cost-efficient than regulatory interventions.

It is important to note that the current situation of oversupply does not represent a market failure that jeopardises security of supply. In this context, capacity markets may appear as a seemingly easy solution, however for the wrong problem. Regulatory interventions, in particular capacity markets, rather tend to reinforce oversupply and the sub-optimal capacity mix. Capacity markets should be a measure of the very last resort since they come with significant risks and costs. Capacity markets rest on the assumption that the regulator knows best how the level and mix of capacities should be. Most likely, the outcome is not the one the market would choose. Instead, the mismatched capacities distort prices and trade in the internal market. This ultimately leads to distorted investments and may result in path dependency and market power. Additionally, political and business desires usually lead to higher costs while not necessarily supporting the original motivation of supply security. Continuous readjustments of the capacity market design to meet such desires increase the risks for investors compared to an Energy-Only Market. Also capacity markets can be designed to benefit selected baseload technologies instead of being technology-neutral. In consequence, they lock-in a fossil, base-load centred system and crowd out flexibility options, thereby increasing the costs of decarbonisation and securing supply.

To be in line with the European long-term objectives, the key criterion for capacity mechanisms should be reversibility in order to avoid such path dependencies. Since capacity markets are very difficult to remove, a phase-out strategy should already be an integral part of the concept at the time of introduction. In the end, the long-term objectives of a future-proof market design need to be completing the internal market and a creating a safe, competitive, environmental-friendly and flexible power market.

1 Introduction

A lively debate on the future power market design takes place in several member states as well as within the European Commission (COM 2015, 2016a and 2016b). Within this debate, in addition to the important focus on security of supply, it is imperative to highlight that a future-proof power market design should also support the European long-term objectives, such as completing the internal market, continuing decarbonisation, increases of renewables and energy efficiency.

Therefore, security of supply and future requirements regarding flexibility and continuous adjustments of the capacity mix should be integral parts of the solution. Currently, risks are high that short-term oriented solutions in form of capacity markets appear beneficial, but they come at the side effect of costly lock-in effects of incumbent technologies.[1] This path-dependency-effect necessarily leads to continuous adjustment needs of the capacity market design, which leads to increasing political risks and costs for all stakeholders.

This analysis explains the requirements of the transformation process and the effects that come with making progress towards the European objectives. Sometimes these effects such as lower revenue streams for generators are wrongly interpreted as market failures, while in reality they signal the demand for market-based capacity adjustments and do not jeopardise security of supply. We explain that an upgraded Energy-Only Market is able to provide supply security and does so at lowest cost, by removing temporary imperfections, barriers for flexibility and increasing the incentives of the imbalance systems.

In order to additionally safeguard security of supply during the transformation process, a capacity reserve outside the market can provide security on top of the level that is provided by the market. In this way, the efficiency and innovative strengths of the Energy-Only Market remain intact, while supply security is safeguarded via a safety net. We explain why this path is preferable to the introduction of capacity markets. Capacity markets usually come with significant risks and distortions, such as an increase in market power, path dependency and that political and business desires likely lead to a design that increases costs while not necessarily supporting supply security. If they are introduced nonetheless, they should include a phase-out strategy to increase the chances for completing the internal market and reach an environmental-friendly energy system.

[1] The analysis builds on the findings of the German debate, see e.g. Connect (2014), Connect (2015) and r2b (2014).

2 The transformation phase

FUTURE-PROOF

A future-proof market design supports the long-term EU targets by providing a stable, secure and future-oriented market environment, which stimulates innovation and competition.

The future power market design should be in line with the long-term objectives of the European energy policy, which mainly address decarbonisation, increasing energy efficiency and renewable shares as well as completing the internal market. The current market situation is a result of reaching these targets and should not be confused with market failures that undermine security of supply. On the road to reaching the long-term targets, the transition period should be managed by removing temporary market imperfections. This paves the way for the market to increase flexibility, which at the same time enables the market to safeguard supply security.

In order to find the right measures to manage the transformation process, it is important to understand the market reactions during this process. Considering the market reactions, the measures can be designed to support the transformation instead of threatening the achievement of the European long-term objectives by creating path dependencies. In this context, one needs to distinguish between market and policy design and their respective purposes. The market design allows the market to use its inherent efficiency and innovation potentials, while the policy design paves the way towards the European targets.

MARKET AND POLICY DESIGN

The market design sets the rules of the market place and provides security of supply by. Thereby, the market design takes a technology-neutral approach, by enabling market participants to identify the best and least-cost solutions based on their individual willingness to pay. The target of a market design cannot be to provide a risk-free environment for all investments. In particular, its purpose is not to finance a selected group of market participants, e.g. conventional power plants, at the expense of neglecting a level-playing field for all market participants and thus also at the expense of security of supply.

In order to manage a public good, e.g. the environment, policy designs can steer the system into the desired direction. Thereby, market and policy designs should be well linked, e.g. by integrating market-based elements into the policy. Such elements provide a market feedback to investors under consideration of the surrounding market developments and improve the interaction of market rules and policies. Examples are the Emissions Trading Scheme or the use of competitive auctions to find the adequate support level for renewables.

2.1 SECURITY OF SUPPLY AND FLEXIBILITY

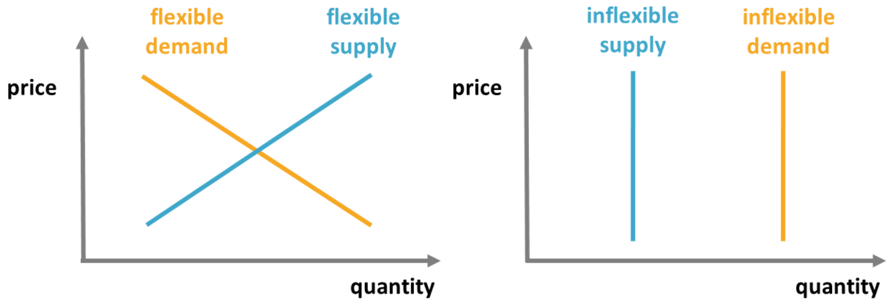
SUPPLY SECURITY

Security of supply requires that supply meets demand at all times. This requires flexibility in the market. A focus on insufficient funding for power plants falls too short.

Continuing the path towards the internal market and increasing the share of renewables throughout Europe requires an integrated approach towards security of supply and flexibility. Flexibility options, such as demand response or back-up power stations, can improve supply security at low cost. Without understanding the interaction between security of supply and flexibility, we risk missing the European long-term objectives and increasing costs to consumers at the same time.

FLEXIBILITY AND ITS CONNECTION TO SECURITY OF SUPPLY

Guaranteeing security of supply requires that supply always meets demand. This implies that the demand and supply curves intersect and that the intersection determines the market price (see figure below). In simplified analyses, it is sometimes assumed that the demand side is not flexible (inelastic) and does not react to price signals. In reality however, demand reacts both in the long- and in the short term to the price signal. While the economic term elasticity is static and has no intertemporal information, flexibility is a more meaningful concept in the context of power markets, since it incorporates temporal attributes, such as a power plants' ability to ramp up and down in a given time.



As the figures show, a certain level of flexibility is necessary to enable supply and demand to meet and to form a price. Increasing a markets' flexibility therefore increases security of supply. The more flexibility options can contribute to security of supply, the lower are the costs.

Flexibility helps to meet the requirements of supply security and renewables integration, because it allows market participants to express their willingness to pay over a wide range of prices. Since flexibility addresses the price sensitivity of the supply and the demand curve, a logical next step is to revisit the connection to security of supply.

Security of Supply

Security of supply is important for private consumers and businesses alike. In order to provide security of supply, it is not necessary that the entire supply and demand curves are flexible. Only the relevant pieces of both curves, i.e. the pieces that determine the intersection of the supply and demand, require flexibility.

CLASSIFICATION OF SECURITY OF SUPPLY

The economic classification of a good depends on its properties. The classification helps to identify the degree to which the good's properties necessitate regulatory intervention and to which degree the organisation can take place in a competitive market environment. The two dimensions that determine the classification of a good are rivalry and exclusivity.

		Rivalrous?	
		No	Yes
Excludable?	No	public good	common pool resource
	Yes	club good	private good

Security of supply is sometimes wrongly conceived as a public good. With regard to the two dimensions, the good security of supply exhibits the following properties: In scarcity situations, rivalry shows via the willingness to pay for electricity. Excludability is present for consumers with real-time metering[2], since they always know their consumption and can reduce it in case they consume more than they purchased. If they do not reduce their excess consumption, they need to pay imbalance fees. Since both rivalry and exclusivity exist in power markets, security of supply is not a public good. For large consumers, who form the majority of overall consumption, supply security is a private good. Only for consumers who are not real-time metered, security of supply is currently a common pool resource. With further deployment of smart meters and the appearance of new supply contracts and tariff structures, it will become a private good for almost all consumers.

The role of demand response

The years following the start of the liberalisation process were characterised by overcapacities, which lead to sufficient flexibility from the supply side. During these times of conventional overcapacities, demand flexibility did not provide an additional value. This changes when overcapacities melt away. However, the flexibility potential of the demand side has not been newly assessed since pre-liberalisation

[2] According to COM (2016b) 72% of European consumers are expected to have smart electricity meters in 2020.

times when regulated, vertically integrated monopolies organised the power supply. Today, the question is whether costly conventional power plants need to cover the last MWh of demand, or whether utilizing the flexibility potential of the demand side leads to lower costs for consumers instead.

In order to better understand demand side flexibility, it is helpful to revisit the traditional concept that has been widely used to determine the value of security of supply and apply the underlying information to demand response. According to this concept, the economically efficient level of security of supply is measured by the *average willingness to pay for electricity* (opportunity costs) in case of an *involuntary* disconnection. In this context, the average value of power is called Value of Lost Load (VOLL) and is usually reported to be around 10.000 EUR/MWh.[3] Focusing on the average simply means that valuing electricity at the VOLL leads to gains for consumers with lower opportunity costs (lower willingness to pay), while consumers with higher opportunity costs realise a loss. This original concept can be adjusted to the perspective to the *individual* willingness to pay, thus applying the information to *voluntary* demand response. Here, we apply this approach to the analysis of the opportunity costs for large industrial consumers only. By using the same methodology as in the original concept, we identify the opportunity costs on an individual basis per industry and location and construct a so-called opportunity-cost merit order (see Figure 1).

SIGNIFICANT FLEXIBILITY POTENTIAL ON THE DEMAND SIDE ALLOWS A SUSTAINBALE MARKET OPERATION AND LOW COSTS FOR CONSUMERS

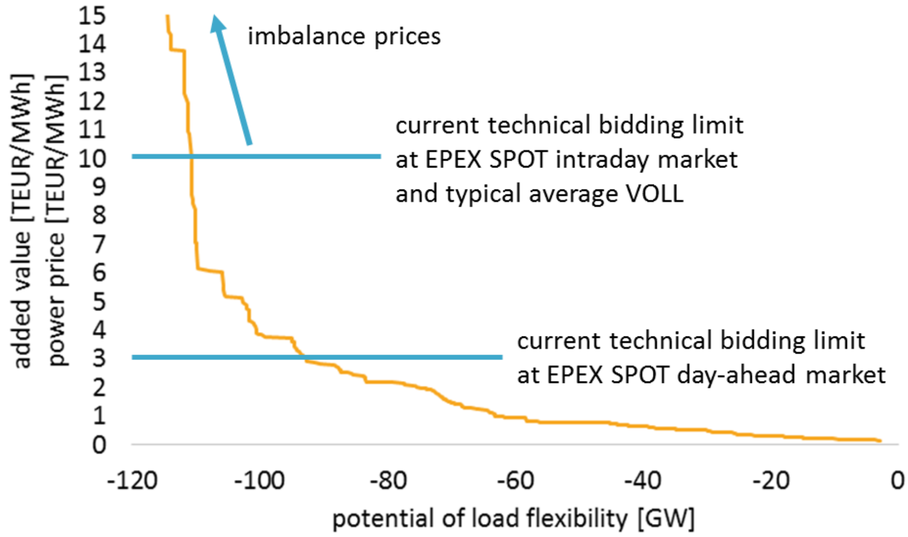


Figure 1: Opportunity-cost merit order of the industrial sector in the EU 27.
Source: Own calculation based on data from Eurostat (2015a, 2015b).

[3] VOLL is supposed to quantify the economic costs of a blackout. In reality, only brownouts exist. This means the disconnection affects either single large consumers or specific distribution grids.

The analysis shows that the European industrial sector alone has a demand response potential of roughly 110 GW below the VOLL. [4] These considerations can now be related to the original question whether conventional generation should cover the last MWh of demand. For consumers, it is economically profitable to voluntarily reduce consumption when prices exceed their willingness to pay. Not tapping this potential seems unnecessary costly. This especially holds true since consumers would have to pay for the capacity provided as an alternative to using demand response. The annuity costs of a conventional peaking plant is well above 50.000 EUR/MW. This translates into a power price of 50.000 EUR/MWh for the last consumed MWh. This is more than five times the typical average VOLL. Consumers would need to pay that much (e.g. via capacity prices), even if they would be willing to reduce their demand already at much lower power prices. It is also important to notice that, in order to reach a market equilibrium, only a fraction of the demand response potential described above is required (see discussion in section 2.3).

THE BUSINESS CASE OF DEMAND RESPONSE

Industrial consumers use electricity to produce a good, which they then sell with a profit margin (opportunity cost). If the power price reaches the opportunity cost of an industrial consumer, this consumer is indifferent whether he should consume electricity or not. Usually, industrial consumers purchase a significant share of their electricity in advance on the forward or futures market in order to hedge against price volatility. Therefore, if the power price exceeds the individual opportunity costs, the consumer can make a higher profit by selling the electricity back to the market rather than consuming it for producing a product with a lower profit margin.

While demand side flexibility has a significant potential, there are various other flexibility options, too. Back-up power systems and flexible heating- and cooling processes are already widely available today. The power market design also needs to integrate future applications, such as an increasing number of electric vehicles, storage applications, heat-pumps and other power-to-heat options, including heat storage. Figure 2 shows how the integration of flexibility options leads to an increasing system flexibility and therefore to security of supply.

[4] In addition to the industrial sector, the commercial and private sectors show significant demand response potentials, particularly with an increasing integration of information and communication technology.

INCREASING FLEXIBILITY ON THE SUPPLY AND ON THE DEMAND SIDE LEADS TO AN INCREASE IN SECURITY OF SUPPLY

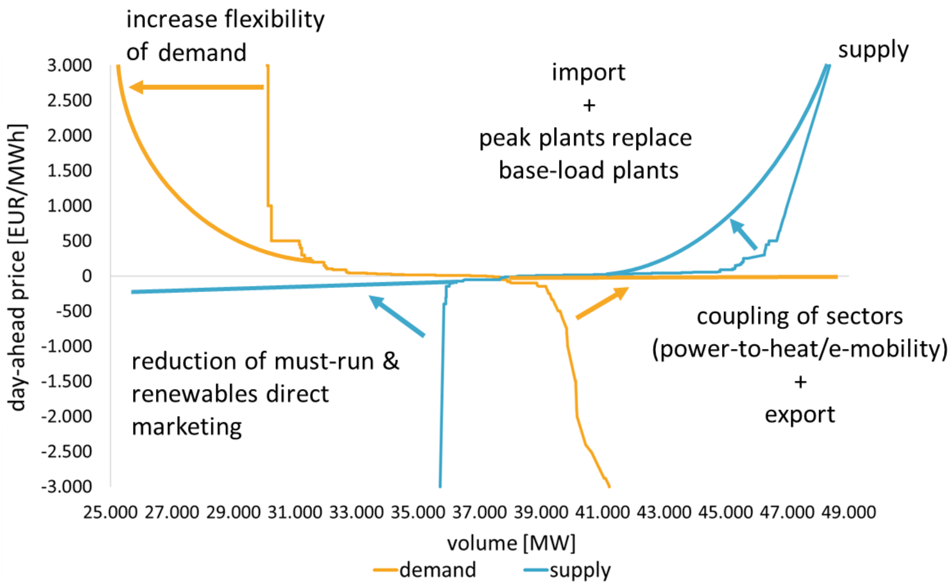


Figure 2: Impact of integrating flexibility options on supply and demand curves.
Source: Own illustration based on data from EPEX SPOT (2015).

Figure 2 demonstrates that higher flexibility on the supply and demand side, including possible imports, increases the areas in which both curves can intersect and thereby increases security of supply. Until the market is sufficiently flexible, we face a transformation process. The next section will discuss the role of the internal market for security of supply and the transformation process.

2.2 THE BENEFITS OF AN INTERNAL MARKET

AS INTENDED

The internal market reduces the required level of capacity, which, in conjunction with fuel cost savings, lowers the costs for consumers.

The progress towards improving the internal market is one of the core drivers of the current transition process. Comparable to the effects of an increase of renewables (which we discuss in the next section), the progress of market integration affects generation capacity. In this section, we discuss the effects of forming an internal market and elaborate on the consequences.

The internal market provides flexibility for all EU member states and therefore reduces the residual demand for flexibility. In the past, the main source of flexibility were power plants within their respective market zone. With the progress made in market coupling, these resources also provide flexibility to other market zones. One can distinguish between two related effects, the effects on market operation and the effect on investments.

Utilizing the different characteristics of the different market zones via exchange saves costs. The higher the difference in load patterns, renewable infeed, power plant mix and outages, the higher are the potential cost savings of cross-border trading. Accordingly, the continuous improvements in market integration over the last years have decreased fuel costs and have therefore led to lower prices for consumers.

In addition to the savings in fuel costs, imports can lead to lower utilisations of peak load technologies. This leads to the opportunity of reducing the fixed costs by lowering the overall required capacity and using flexibility options with low fixed costs to cover the rare peak loads. The potential capacity savings originate from the balancing effects of non-simultaneous peak loads and renewable infeed during scarcity times.

The continuous integration of the markets, together with the increasing renewable shares leads to a reduction of the required level of firm capacity. We can identify the potential saving opportunities with a simplified analysis. In this analysis, we assume that the internal market is complete and has no grid bottlenecks. The following figure breaks down the potential capacity savings from non-simultaneous peak loads and renewable infeed and the relative savings in required capacity.

THE INTERNAL MARKT HAS ALWAYS BENEFITED FROM BALANCING PEAK LOADS, BUT SAVINGS DUE TO RENEWABLES INCREASE SIGNIFICANTLY

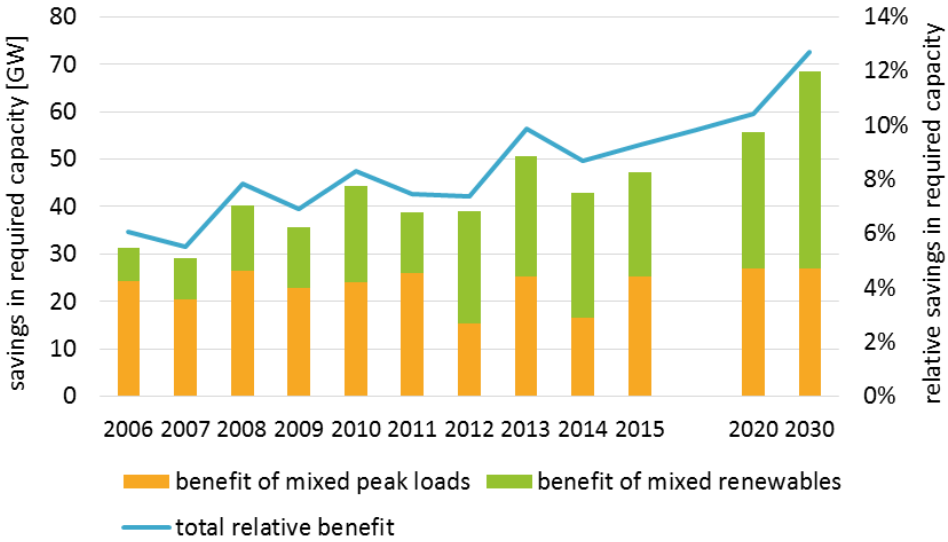


Figure 3: Potential capacity savings of mixed peak loads and mixed renewables. Source: Own calculation based on data from ENTSO-E (2015, 2016) and DWD (2016).

By forming an internal market a potential capacity saving opportunity of roughly 70 GW can be found until 2030. The benefits of mixed peak loads (orange area) remain relatively constant between 15 and 25 GW. In contrast, the potential capacity savings due to the non-simultaneous renewable infeed shows a clear upward trend. Ten years ago, the potential saving was only about 5 GW. In 2015, this increased to more than 20 GW. By 2020, we can expect roughly 30 GW and by 2030 more than 40 GW of potential capacity savings. Combining the effects from balancing peak loads and renewables, a potential of 13% relative capacity savings could be realised until 2030.

The analysis highlights three developments. First, the benefit of the internal market increases with a growing share of renewables. Second, during everyday market operation, the peak load technologies are less utilised in the future. In addition, the capacity mix needs to adjust to this dynamics. This aspect of the transformation process will be discussed in the next section. Third, a further increase of interconnection capacity is required to reap the benefits of the internal market. As a result, the internal market is a low cost, no-regret provider of flexibility, which leads to a lower demand for more expensive flexibility options and therefore to cost reductions for the consumer.

2.3 THE TRANSFORMATION PROCESS AND THE ROLE OF FLEXIBILITY OPTIONS

DYNAMIC MARKETS

Adjustments of the generation capacity mix and an increasing participation of flexibility options lead to a sustainable price level.

The European power market currently faces a transition period due to the continuing integration of the market places, the ongoing decarbonisation efforts, lower demand (partly due to energy efficiency) and the increasing share of renewable electricity. This section focuses on security supply and a sustainable price level during the adjustment process that is necessary to integrate the increasing shares of renewables efficiently. By understanding the requirements and possibilities of dynamic markets, market improvements and potential temporary measures to safeguard supply security can be aligned with the long-term objectives.

The transition process requires a continuous adaptation of the capacity mix. Figure 4 shows that a lower share of base load technologies and higher shares of mid and peak load technologies best complement a system with a high share of renewables.

THE CAPACITY MIX ADJUSTS ITSELF TO THE NEW REQUIREMENTS BY REDUCING BASELOAD AND INCREASING PEAK LOAD TECHNOLOGIES

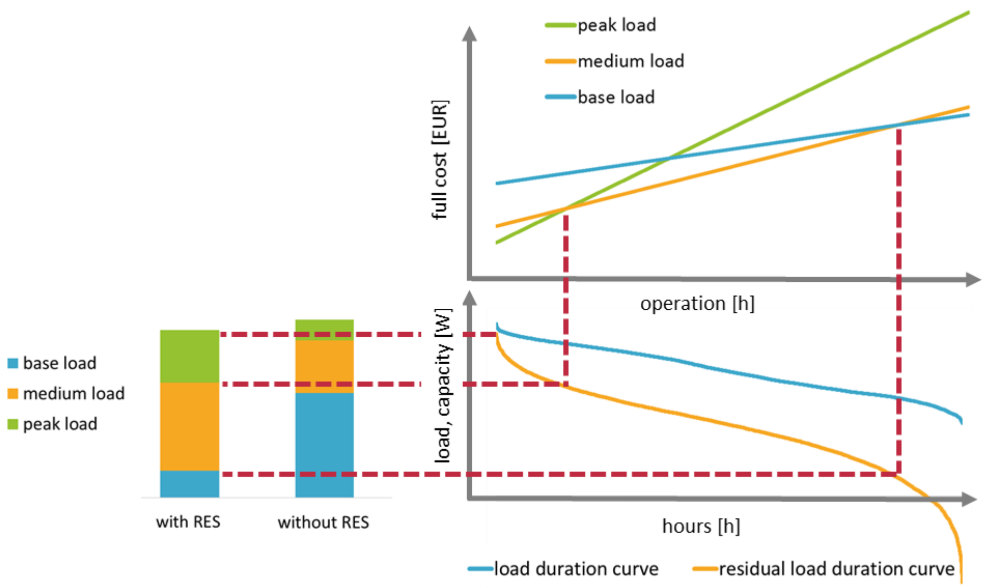


Figure 4: Adjustment of the conventional capacity mix.
Source: Own illustration.

The reason behind this shift is that peak load technologies have lower fixed costs and higher variable costs compared to base load technologies and therefore require less operating hours to be economically viable. The current base load-heavy generation mix is therefore not well suited for a system with higher shares of renewables (for simplicity, here we focus only on generation capacity). Currently, we observe low power prices in many power markets throughout Europe. Figure 5 shows that an adjusted capacity mix is able to provide a sustainable price level, while the capacity mix without adjustment results in a non-sustainably low price level.

MARKET-DRIVEN DYNAMIC ADJUSTMENTS OF THE CAPACITY MIX LEAD TO A SUSTAINBLE PRICE LEVEL

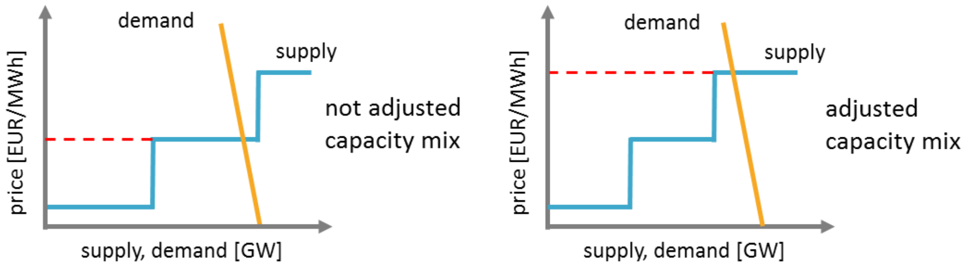


Figure 5: Effect of adjustments in the capacity mix on power prices.
Source: Own illustration.

Since a market-based adjustment of the mix leads to sustainable price levels, funding unprofitable power plants via regulatory measures, such as capacity payments, would lead to an inefficient delay of the transformation process. The question is which technologies best accompany the transition from the perspective of flexibility and security of supply. Following the logic implied by Figure 4, the technology should have very low fixed costs, relatively high variable costs, and - due to the uncertainty regarding peak load - should ideally not depend on income from the power market.

Thus, the ideal technologies provide spillover effects to the power market, whereas their original purpose lies outside the power markets. This is in fact the true nature of many flexibility options. Consumers with flexible demand have a main business model different from providing a service to the power market. However, if it is economically reasonable, they reduce their demand according to their own preferences. The same applies for back-up power systems. Their purpose is to protect facilities such as stadiums or hospitals against network failures. This is the only reason the investment took place. However, their value increases further if they can provide a service to the power market and make an additional profit. Similarly, the reason for electric vehicles does not lie in the power market, but in their transportation function. If providing flexibility enables them to get better electricity tariff, consumers may become interested in participating in the power market via flexible charging and maybe even discharging. All examples have in common that their main business function is different from the provision of flexibility and that they do not depend on income from the power market to cover their fixed costs. They simply provide a spillover service. Additionally, these technologies can be integrated quickly into the market compared to the construction time of a power plant. Usually, integration only requires minor technical adjustments and sometimes only a change in the supply contract. Both characteristics provide an increasing level of supply security at very low costs and in a very short time.

For many European markets, significant investments in conventional generation with high fixed costs are currently not required from a security of supply perspective. Instead, more flexibility options can provide supply security at very low costs.

THE ACTIVATION TIME OF FLEXIBILITY OPTIONS IS MUCH SHORTER THAN THE CONSTRUCTION TIME OF A CONVENTIONAL POWER PLANT

For a low-cost energy system, flexibility options should be used for the relatively rare peak loads due to their low fixed costs and the high variable costs. Building a conventional generation technology for just a handful operating hours per year is highly inefficient. If the flexibility options are deployed regularly, higher prices appear regularly, too, and the overall price level increases to a sustainable level. The regular occurrence of price spikes in combination with an overall higher price level triggers investments in generation capacities. The more flexibility options are in the market, the lower the price volatility. Smooth price movements also provide plannable income streams for conventional technologies. This transformation process can be complemented by additional instruments, which safeguard supply security, as will be discussed in section 4.4.

2.4 STRATEGY ON MANAGING SECURITY OF SUPPLY

NO MARKET FAILURE

Current market results can be explained as effects related to reaching European objectives. Temporary imperfections should be removed to enable the market to dynamically adjust itself and to provide supply security.

The previous sections showed that the currently unsustainably low price level signals the need for a market-based capacity adjustment. It is not a sign of a market failure and does not necessarily jeopardize security of supply. It is a sign of functioning market developments in line with the European objectives of reaching the internal market and forming an environmental-friendly power system.

Low price levels and a resulting lack of income do not jeopardise security of supply, as long as flexibility options are not blocked by regulatory or market barriers. In this context, technical price limits on power exchanges should not be confused with legal price caps, which indeed can lead to a market failure and should be removed accordingly.

As long as proper balancing responsibility is applied and flexibility options are able to enter the market, security of supply can be managed in a market-based, competitive manner (see discussion in the next chapter). Security of supply means that supply always meets demand and a power price results from this market clearing. Which technologies enable this market results is secondary from the perspective of supply security.

A static perspective on security of supply that only focuses on the level of conventional generation capacity, leads to narrow solutions that crowd out efficient and innovative technologies, hinder the internal market and increase costs for the consumers. These frictions could lead to path dependencies, which could even prohibit reaching the objectives or make the transition process more expensive.

It is important to change the perspective on the strengths of markets, particularly the dynamic adjustment possibilities of the power market, which leads to sustainable price levels and an increase of flexibility and innovation. A competitive market allows market participants to identify the required solutions by utilising innovative technologies and business cases. If supply security is a concern, the transformation process can be managed with reversible measures. In this way, the long-term objectives of an efficient and environment-friendly power system can be reached at lower costs without risking costly and unsustainable path dependencies.

The next chapter explains the core elements of a future-proof market design. The third chapter builds on that and discusses the role of temporary measure to allow securing the transformation process.

3 Power market design

The previous chapter discussed the market effects that result from making progress towards the long-term policy objectives. In this chapter, we discuss how the market design should accompany this by efficiently providing security of supply and improving flexibility. One of the key criteria of a future-proof market design is the ability to integrate innovations, such as electric vehicles and informed flexible consumers, as soon as they appear. After all, the future market design should satisfy the needs ahead of us and utilize the upcoming potentials rather than relying solely on currently established technological solutions.

3.1 THE ENERGY-ONLY MARKET

ADVANTAGEOUS EOM

The EOM is characterised by low political risks as well as by high cost efficiency and innovation potential. It organises dynamic market adjustments competitively and leads to high levels of flexibility.

The future market should incorporate as many flexibility options as possible in order to provide a competitive, secure and stable market environment. The Energy-Only Market Design (EOM) consists of a limited set of core rules, which are already sufficient to meet these requirements. Since the current debate on market design shows some misunderstandings concerning the EOM, we provide a brief overview of some fundamental characteristics that explain why the market is able to adjust itself dynamically and thereby is able to provide security of supply. Later, we discuss future opportunities to improve the current versions of the EOM, which allow for a better integration of flexibility options and innovations.

Capacity remuneration in an Energy-Only Market

In the EOM, the main explicitly traded product is energy (MWh). Capacity (MW) is either implicitly traded as part of the physical delivery requirement of the energy product or as hedging product against price volatility. Additionally, ancillary service markets, e.g. reserve power markets, can also incorporate explicit capacity products.

In the spot market, fixed costs are sunk costs and are not part of the bidding process. Therefore, the bids include only short-term marginal costs. It is important to notice that opportunity costs are a vital part of these marginal costs. A common misunderstanding is that only fuel and CO_2-certificate costs are part of the bidding price. However, the inclusion of opportunity costs in the short-term marginal costs is an important detail when it comes to the implicit remuneration of capacity.

In normal market operation, opportunity costs are a negligible part of the marginal costs. Therefore, when the last deployed unit sets the price, only plants with lower marginal costs earn a rent to recover their fixed costs. When the market becomes scarce however, opportunity costs play a crucial role. This occurs on the demand side and on the supply side.

The demand side bids the opportunity costs of the alternative energy use into the market. If an industrial consumer produces a good by consuming energy, the profit lost by not producing this good or producing it later equals the opportunity costs. If the potential profit was lower than the power price, the industrial consumer would lose money if he continued production. Bidding the opportunity costs into the market is therefore rational behaviour.

On the supply side, the opportunity cost results from the fact that the electricity generated can only be marketed once. As soon as there are multiple selling opportunities, opportunity costs of the generating capacity play a role in the bidding process. Imagine a power plant owner who expects a scarcity situation. When he thinks about bidding into the day-ahead market, he also thinks about potential alternatives. If for instance he expects an increase in scarcity towards the intraday timeframe, it may become lucrative to sell on the intraday-market instead. With this expectation, he will only sell into the day-ahead market, if the profit he can make is at least as high as the profit he expects from the intraday market. Therefore, he includes the opportunity costs of the expected intraday profits into the bid for the day-ahead market. Although the variable costs are identical in normal situations and in scarcity situations, the opportunity costs as part of the marginal costs increase in scarcity situations.

This bidding behaviour should not be confused with the exercise of market power. It is a normal, rational, economically viable behaviour in markets with non-storable goods. Usually, we observe this so-called Peak Load Pricing in service markets, such as air travel or hotels. During vacation time, prices for air travel and hotels increase, compared to off-seasons. The economic logic behind this observation is identical to the one applied in the bidding process in power markets. The chances that another customer is willing to pay the increased price is higher in vacation periods (scarcity times) compared to off-seasons.

A LOW PRICE LEVEL IS NO MARKET FAILURE, BUT AN EFFICIENT MARKET SIGNAL FOR OVERCAPACITIES

During the last years, we observed very few scarcity situations. This is due to the overcapacities in most parts of Europe (see discussion in section 2.1). Therefore, the currently low price level should not be misinterpreted as a market imperfection, much less a market failure. On the contrary, it is a clear market signal indicating the absence of scarcity in this timeframe. This in turn is a sign that the market reflects the fundamental situation correctly. As soon as scarcity appears, the price levels on all markets (spot and long-term markets) will increase due to the inclusion of opportunity costs. This again will signal demand for generation capacity. Producers can then decide to stay in the market and/or invest in new capacity.

Risk characteristics of an Energy-Only Market

Some people argue that the risk in the EOM is too high for investors and consumers. The question in this argument is to which benchmark we compare the risk level.

Compared to the past, when regulated monopolies built new power plants and socialised the costs to all consumers, the risk is higher for investors today. This higher risk simply stems from the different risk allocation. In the past, the consumer had to bear all the risk of an investment decision, without an opportunity to choose a different supplier. This is for good reasons no longer valid in liberalised markets.

A very similar result comes from the comparison with a capacity market design, which includes explicit capacity remuneration. The discussion of capacity markets takes place in the next chapter. However, it should already be mentioned at this point that the risk of political intervention in capacity markets increases the overall risk for investors as well as for consumers. The complex product design in capacity markets provides many opportunities for all stakeholders to present their wish list and to skew the capacity market design into the direction they desire, thus increasing costs.

When we compare the risk to that of other industries, we find no specific additional risk that originates in the power market itself. Many industries require long-lasting and capital-intense investments in order to produce goods and provide the services they sell. In fact, we might be able learn from the risk management behaviour of other industries.

Risk management in an Energy-Only Market

Earlier, we already mentioned that the economic characteristics in some other service industries are similar to those of the power market. Buying airplanes and building hotels also requires significant investments. Therefore, a comparison to the travel industry does not seem far-fetched. When planning a vacation, consumers have the choice to either go to the airport on short notice and risk paying a high price, or to plan ahead. Most consumers do not risk high prices, but book their desired vacation many months in advance instead. From the consumer's perspective, buying long-term is a risk hedge against short-term high prices. From the supplier's perspective, the early knowledge of the number of expected visitors or passengers allows more reliable income stream calculations and preparations for potential short-term adjustments of variable and recoverable fixed costs. Additionally, insurance products emerged that allow travellers to step back from their long-term commitment under certain circumstances.

Some customers prefer last minute booking in hope of a discount in case the demand for this particular vacation is low. In other words, there might be temporary overcapacities for some vacations. This example of last-minute booking is comparable to the behaviour on many European power markets in the past years. Many consumers expected low short-term prices due to overcapacities and decided to buy short-term. However, as soon as the risk of scarcity situations increases, the demand for long-term contracts will increase and their prices will rise. Consequently, in average market situations, most consumers will purchase long-term contracts. Aside from consuming the purchased power, these consumers have the possibility to sell it back to the spot market to make an extra profit.

NEW BUSINESS OPPORTUNITIES AND PRODUCTS WILL EMERGE, WHICH REDUCE RISKS FOR MARKET PARTICIPANTS

There is a chance that consumers might miss the first few opportunities to make these extra profits. However, if these chances appear on a regular basis, rational businesses will adjust their processes to make use of these opportunities. As a bonus, an increasingly flexible demand side is also a meaningful hedge against potential market power.

Power plant owners can expect a higher price of long-term contracts as soon as overcapacities disappear. With a growing share of renewables, the price volatility will increase and market participants will request additional trading products for hedging purposes. Usually in markets with increasing volatility, option products gain in popularity (see e.g. option products from EEX). This trend opens another market opportunity for secured capacity and flexibility options.

In order to allow an efficient and secure transformation phase in which the market signals scarcity early on, barriers for flexibility options need to be removed and incentives for hedging should be strengthened (see the next section). Additionally, the transformation process can be safeguarded by complementing temporary measures that provide supply security during the learning phase, such as capacity reserves (see section 4.4). The EOM design requires relatively few core rules, which reduces the risks for political intervention significantly. A stable and competitive market environment provides the best foundation for the required investments and allows innovations to materialise during the process.

3.2 TEMPORARY BARRIERS AND IMPERFECTIONS

COST EFFICIENT PATH

Removing barriers and imperfections allows reaping the efficiency and innovative potentials of many flexibility options.

The future market design needs to be able to integrate all kinds of flexibility options and innovations. Although no structural market failures can be found in the power market, different kinds of imperfections prevent the integration of some options. These barriers need to be identified and continuously removed in order to create a cost-efficient, secure and flexible power market. In addition, a lack of market-based incentives can form a barrier to flexibility and innovation. Therefore, the role of market-based incentives will be discussed in the next section.

Barriers can stem from regulatory or market imperfections. One possible indicator for inflexibilities is price volatility. Generally, very high and very low prices signal demand for flexibility. In the dispatch that comes with positive or negative price spikes, one usually finds some imperfections that could be resolved. Figure 6 shows some potential must-run and must-demand reasons that can lead to positive or negative price spikes.

ARTIFICIALLY BLOCKING FLEXIBILITY OPTIONS LEADS TO UNNECESSARY HIGH AND LOW PRICE PEAKS

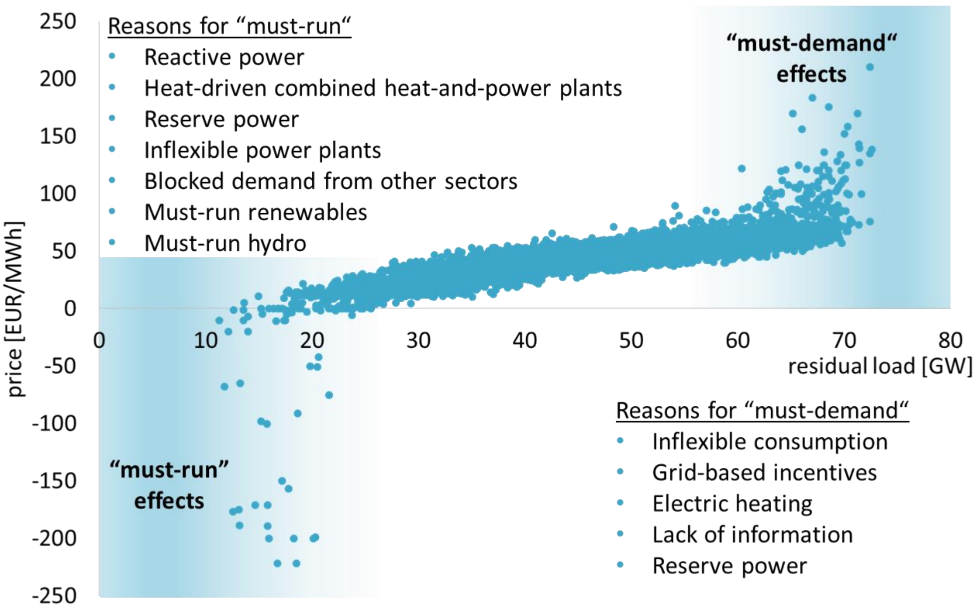


Figure 6: Must-run and must-demand reasons for price spikes.
Source: Own illustration based on data from EPEX SPOT (2015).

In addition to the potential barriers listed in Figure 6, product definitions in the power market and price caps can keep flexibility options from entering the market. Barriers can take many forms. Some are explicit, such as prequalification criteria in reserve power markets. Some are implicit, such as an arbitrarily long delivery time associated with a product that prevents unconventional flexibility options from participating in some markets. Here, we provide a brief, non-exclusive overview of some potential barriers.

Legal price caps: If legal price caps are present in a market, the so-called Missing Money Problem can occur. Missing money should not be confused with insufficient earnings (see section 2.3 on required adaptation of many currently existing capacity fleets). Another misunderstanding in the context of price caps concerns technical bidding limits at power exchanges. As long as bidding limits can be adjusted when the observed price levels suggest doing so, they are simply a technical requirement that enables the algorithm of the power exchanges to work properly and helps to prevent typing errors. If legal price caps exist, the underlying reason is often insufficient competition on the supply and the demand side. In this case, the underlying challenge should be addressed and price caps should be phased out as soon as competition increases.

Spot market products and gate-closure times: Sometimes, the product definitions of spot markets restrict the participation of flexibility options or prevent a meaningful representation of fundamental market requirements. For instance, solar photovoltaic (PV) shows steep ramps. Taking only the average solar infeed over one hour into account does not necessarily fulfil the requirements of balancing a portfolio since the first and the last quarter of an hour show significant deviations from the hourly average. Therefore, shorter products (e.g. 15 minutes) help to provide a better picture of the market situation. At the same time, some flexibility options, such as flexible consumers, are better able to offer 15-minute services rather than one-hour services. At the same time, gate closure times should be as short as possible. In this way, the last available forecast information on portfolio imbalances can be used to adjust trade rather than to rely on balancing markets to resolve the imbalance.

Reserve power product design: The reason for the existence of balancing markets is to safeguard system stability. There is a fine line between fulfilling this responsibility and creating unnecessary explicit and implicit barriers. Prequalification criteria can form explicit barriers, even if some excluded technologies could provide the required services. Implicit barriers can stem from either unnecessarily long delivery or procurement timeframes. If the product is defined over a delivery period that is too long, flexibility options, such as storage or flexible consumers might have limitations to offer the requested service. They could easily provide the product for shorter timeframes and free-up conventional generation capacity in scarcity situations. The same applies for unnecessarily long procurement lead times. If a product is auctioned e.g. one week ahead, prognoses for demand and some renewable generation technologies might be too uncertain to bid into this market. If the product would be procured e.g. day-ahead, these flexibility options had a better chance to offer their services to the market. The high and low prices in Figure 6 might stem from the fact that the reserve power market design keeps flexibility options from providing efficient services. In periods of high prices, conventional generation capacities are bound in positive reserve products and cannot offer more energy, because they are required to run in part load mode. During periods of low prices, conventional plants that offer negative reserve power are forced to feed-in energy due to minimum-run constraints. Instead, positive and negative reserve power could also be provided by flexibility options in these situations. This would enable conventional generation capacity to play a more efficient role in the market.

Implicit incentives in tariff structures: Industrial and private consumers can face incentives imposed by grid tariffs structures that distort their market behaviour in scarcity situations. If for instance the level of the grid tariff changes during the day for some consumers (e.g. for electric heating), this sets an incentive to shift consumption to hours with lower tariffs. In a purely conventional system this may be sensible, since demand is lower during the night and additional consumption in the night-time helps the system. In systems with higher renewables shares, the residual demand does not follow this pattern. Linking grid tariffs to specific times then sets an incentive for a demand increase in the wrong market situations. A similar effect can result from grid tariffs for industrial consumers, if their grid fees are linked to a certain behaviour. The fee structure can set incentives for consumption patterns that might not be efficiently aligned to the market situation. In these cases, must-demand characteristics occur, which could increase the peak load.

Support schemes for renewables and combined heat and power (CHP): Support schemes can increase the infeed in market situations with low prices. Then a scarcity in flexibility entails either reducing infeed or increasing demand. In the case of renewables, direct marketing with premium tariffs should lead to market-based curtailment, if the power price drops below the negative premium value. For heat-based must-run, either heating storage or power-to-heat technologies can reduce the conventional infeed of heat-driven CHP plants.

Must-not-demand: If potential power demand from other sectors is blocked from entering the power market by unsynchronised taxation and fee structures, inefficiently low power demand can be a reason for very low or negative prices. Especially in situations with high renewable infeed, electricity could be used for heating and transportation, instead of using fossil fuels. Aligning the relevant opportunity costs between sectors increases the flexibility and supports the transformation process.

The brief overview of potential barriers can serve as a starting point for analysing the many rules forming the market environment. In the absence of market or regulatory barriers, market participants need the right market-based incentives to balance their portfolios and activate the efficient amount of flexibility options.

3.3 MARKET-BASED INCENTIVES

RESPONSIBILITY
Clear balancing responsibility leads to a market-driven demand for flexibility and an increase in security of supply.

Market participants will use flexibility options when balancing incentives are clear and strong. In section 2.3 we discussed many flexibility options, which can quickly be activated when the demand from market participants increases and thereby support risk management for all market participants.

The demand for flexibility options is currently relatively low for two potential reasons. First, some markets might have significant overcapacities. These markets do not demand activating new flexibility options. Second, it could sometimes be cheaper to pay imbalance prices than to balance the portfolio with flexibility.

While the first reason is just temporary until the market phases out overcapacities, the second reason needs to be fixed by regulators before the market shows the first signs of scarcity. Only when scarcity signals reach the responsible market participant, there is a clear economic motivation to activate flexibility options.

Basically, balancing responsibility means that if suppliers and consumers enter a contract, this contract must be fulfilled. The supplier should supply the amount he committed to and the consumer should consume the amount of energy he purchased. If one of the parties deviates from the agreed amounts, imbalance payments need to be paid, since the deviation needs to be settled by the transmission system operators (TSO) via reserve power. This is done constantly during everyday market and grid operation. Having these rules in place in scarcity situations is crucial for security of supply. Imbalance costs need to provide the incentive to balance the portfolio, especially in scarcity situations. If the proper rules are in place, all market participants need to understand that imbalance costs can be very high. Then, they have an incentive to improve their prognosis for demand as well as for generation and to acquire sufficient flexibility as back-up. This back-up flexibility can then be used when a deviation from the prognosis occurs or a power plant fails and is cheaper than paying imbalance prices.

In order to safeguard security of supply, the incentives that arise from imbalance prices should be designed such that the market participants acquire sufficient flexibility options. Sometimes, this simply means renegotiating a contract and including flexibility options, based on the consumers' willingness to pay.

4 The role of capacity mechanisms

No real-world power market is completely free of imperfections. At the same time, the majority of European power markets does not show structural market failures that cannot be cured by the previously discussed removals of barriers and incentive adjustments. Therefore, before completely changing a market design at the risk of undermining the internal market, it is important to consider the more efficient alternatives. These should include removing barriers and adjusting incentives, a detailed regional security of supply monitoring and, if necessary, temporary security measures. The introduction of capacity mechanisms should not lead to a sacrifice of the long-term objectives of the internal market and a flexible, environment-friendly power system. Therefore, reversibility is a key criterion when choosing adequate measures. Without reversibility, the management of temporary challenges comes at the expense of the European long-term goals.

4.1 OVERVIEW OF CAPACITY MECHANISMS

MAIN QUESTION

Capacity Mechanisms can attract investments inside the market or outside the market. If capacity markets incentivise capacities inside the market, the administratively set capacity demand and product design are responsible for attracting the right investments at the right time. Thus, political risks increase for all stakeholders.

All capacity mechanisms have more or less repercussions on the power market, and they should only be introduced if alternative measures were more harmful. The intermediate report of the sector inquiry (COM, 2016a and 2016b) suggests a differentiation of capacity mechanisms into market-wide and targeted designs. We believe that the necessary step before this classification is the decision whether the EOM should be the primary driver for the investments or whether capacity mechanisms with their administratively organised product designs should be the driver instead.

While typical capacity markets incentivise investments into the power market, capacity reserves keep the regulated capacity outside the power market.[5] The capacity reserve has the sole purpose of providing additional supply security as a safety net. The capacity reserve does not affect the selection of technologies within the EOM, as reserve capacities are fully outside the market. Therefore, the efficiency and innovation potential of the EOM is not compromised.

[5] Outside the market means that repercussions on the power market should be avoided. This can be achieved by ensuring that the capacity is not marketed at the power market and that no implicit price cap is introduced through a trigger price. Furthermore, in order to avoid negative effects on new investments, capacities that enter the reserve must never return to the market (no-way-back rule).

In capacity markets, the capacity allocation process relies on the regulated product design. The question is whether regulators are able to choose the right design options to attract the right, future-proof investments at the right time and at minimal costs. Since security of supply should be the primary reason for a capacity mechanism, we can exclude some design options from the further discussion.[6] A lack of funding for some market participants (e.g. generation capacity) is not a meaningful reason to introduce capacity markets, since it crowds out alternative technologies (e.g. flexibility options) that could provide supply security at lower costs.

AS SOON AS CAPACITY MECHANISMS ATTRACT INVESTMENTS WITHIN THE POWER MARKET, THE POWER MARKET LOSES ITS EFFICIENCY AND INNOVATION PO-

Price-based mechanisms are per se not effective in reaching a targeted level of security of supply. Since the quantity of secured capacity depends on the price level, missing or overshooting the desired security level is very likely.

Targeted mechanisms, which only add certain technologies to the market, are also not effective regarding security of supply. These mechanisms might crowd other technologies out of the market, since the supported technologies affect the power price and therefore the profitability of other technologies in the market. These other technologies might then require funding too, which would again influence prices and profitability, and so forth (slippery slope effect of regulation). Therefore, targeted mechanisms may not increase net capacity and the level of supply security may remain the same.

The main decision is whether investments should be attracted inside or outside the market. As soon as investments inside the market are attracted, the power market loses its purpose to allocate capacity in general and flexibility options in particular, and thus loses its efficiency and innovation potential, too. The power market will only organise the dispatch decision, while all investment decisions rely on the administratively set product design of the capacity market.

[6] A network reserve can play a temporary role to bridge the timeframe until critical grid constructions are finished. Since the present analysis focuses on capacity mechanisms with the objective to increase the overall security of supply level in a market zone, we do not discuss intra-zonal measures with a locational/grid focus any further.

4.2 DISTORTING EFFECTS OF CAPACITY MARKETS

UNAVOIDABLE DISTORTIONS

Capacity markets distort the capacity level and mix, power prices and trade in the internal market due to the administratively set capacity demand and product designs.

All capacity markets that aim at increasing the level of firm capacity within the power market have distorting effects on different levels. They affect the level and the mix of capacity within the respective market zone as well as in neighbouring market zones. They also influence the corresponding power price levels, thus affecting trade in the internal market.

Selecting the right level and mix of investments is one of the core strengths of the EOM. Market participants chose an investment under consideration of the power price, which incorporates all relevant market information and implicitly remunerates capacity in times of scarcity (see section 3.1). Since capacity markets provide explicit capacity payments on top of the power price, the price formation on the power market changes and the power price signal is distorted.

The purpose of a capacity market is to increase the level of firm capacity compared to the level an EOM would attract. Regulators decide on the adequacy target, either directly through capacity demand or indirectly via penalty payments, instead of consumers, as it is common in liberalised markets. The administratively increased level of firm capacity also distorts power prices, since it has the same effect on power prices as overcapacities, i.e. an unsustainably low power price level. The resulting gap in revenues is supposed to be bridged by the capacity price.

An additional distorting effect originates from the capacity product design. Product designs are usually geared towards existing capacities and technologies. Thus, they result in increased lifetime of existing plants and crowd out new investments and innovations, particularly low cost flexibility options. Due to the separation between power prices and capacity prices, the attracted investments need to fit to the administrated capacity product design in order to acquire sufficient funding. However, the investments do not necessarily need to fit to the fundamental demands of the power market. Therefore, the separation of the investment signal from the power price most likely results in increasing costs.

As already indicated, the power price level is lower with a capacity market compared to the power price level without a capacity market due to the effects on the level and the mix of capacity. r2b (2014) calculates an average price difference between an EOM a central capacity market. In 2030, it amounts to

- 10.4 EUR/MWh in peak hours and
- 3.0 EUR/MWh on average.

A lower power price level does not mean that consumers face lower costs, since they have to pay the capacity price on top of the power price. The effects of an increased capacity demand and a product design that excludes low cost solutions lead most certainly to higher total costs for consumers. According to r2b (2014), the net present value of the additional costs for German consumers between 2014 and 2030 reaches

- 13.8 to 15.3 billion EUR in a central capacity market and
- 6.1 to 6.8 billion EUR in a decentral capacity market,

depending on the level of demand response participation.

In addition to the distorting effects on capacities and prices within the corresponding market zone, these effects spill over to the internal market. It is still unclear how cross-border participation in capacity markets can be organised best. However, there is no way to avoid distortions in the internal market as long as the capacity market is effective. A capacity market is effective, if it leads to more firm capacity in the respective market zone compared to the situation without a capacity market.

The distortions related to the internal market can be separated into short- and long-term effects:

Short term: Trade within the internal market is distorted between market zones with capacity markets and market zones without capacity markets due to the previously explained price effects. Since power prices in market zones with capacity markets are suppressed, the exports from these market zones increase. For a scenario with a central capacity market in Germany, the calculations of r2b (2014) show an increase in exports of 16.5 TWh in 2030. This affects the power plant utilisation and thus the profitability in neighbouring markets.

Long term: Since an increase in firm capacity is a key objective of a capacity market, the capacity level should be higher in the respective market zone. Since markets try to establish an equilibrium, this leads to lower investments in coupled markets without capacity markets. Thus, regional investments in the internal market are distorted.

These distortions take place in all markets with a capacity market. The degree of the distortion varies with the level of the capacity market's effectiveness. However, it is not possible to eliminate the distortions completely.

4.3 RISKS OF CAPACITY MARKETS

SLIPPERY SLOPE OF REGULATION

Capacity markets have a high political risk, which usually leads to suboptimal investments and higher costs. Continuous readjustments are likely, which increase the risk for investors and the costs for consumers.

Capacity markets should only be introduced as a last resort, if all other options for upgrading the EOM by removing flexibility barriers have not been effective to solve a problem with security of supply. In any case, the nature of the underlying security of supply problem should first be specified through careful analysis before deciding on a capacity market. Reversibility is a key criterion for all capacity mechanisms, particularly since the current market imperfections can be solved over time and the capacity mechanism should not create a lock-in.

This section provides an overview of various risks that can result from the introduction of capacity markets. Due to these risks, capacity markets should only be a measure of last resort.

(Almost) irreversible: One of the main problems of capacity markets regarding the transformation process is that it is very challenging to phase them out. Once market participants receive money for capacity, they expect funding for new investments in the future as well (rent-seeking behaviour). It is therefore very likely that, after an attempted phase-out of the capacity market, new investments fall behind expectations, because investors wait for regulators to step in again and fund the new investments.

Funding capacity instead of fixing imperfections: Capacity markets can be a seemingly easy solution for the wrong problem, whereas improving the market design to enable a well-functioning power system can be challenging. In comparison to these improvements, accepting the imperfections and providing funding for capacity is politically much easier. Nonetheless, solving the underlying imperfection should be the target, since this is crucial for reaching the European long-term objectives and cost efficiency.

No level-playing field: Due to the heterogeneity of flexibility options (particularly demand response), a capacity market product design cannot provide a level playing field. Product requirements and auction or procurement timeframes crowd out some technologies, either explicitly or implicitly. For instance, procuring the required capacity one year ahead has advantages for existing plants, but is not an option for new investments. Procuring the capacity five to seven years ahead of the delivery period allows for new investments, but increases the risk for older plants and poses an unmanageable risk for flexible consumers. By definition, all capacity product designs (including their penalty systems) prohibit a level-playing field, usually at the expense of flexibility options and particularly at the expense of innovation. The lack of a level-playing field typically leads to higher costs and less flexibility, and patronises existing technologies and market participants at the cost of innovative technologies and business cases.

Product segmentation: The above-mentioned lack of a level-playing field in combination with a politically desired outcome regarding specific technologies could lead to a segmentation of the procurement process. In this case, technology-specific product definitions are introduced. For example, the products may differ for new plants, old plants and demand response. This segmentation requires extensive administrative planning. Regulators have to decide on the amounts procured per technology and on the timing of the procurement. By trend, this leads to higher costs and to continuously stronger political interventions due to the diminished role of competitive elements.

Blocking the adjustment process: The majority of the capacity market participants are existing power plants. Capacity markets usually lead to an increased lifetime of these plants. In section 2.3, we discussed the importance of adjusting the current capacity mix to enable the market to find a sustainable price level and attract flexibility options. Capacity markets can lead to a lock-in of the not-adjusted capacity mix by simply funding the lack of income via capacity prices. In this case, the adjustment process is blocked by the capacity market. The power market will not find a sustainable price level, flexibility options are crowded out and consumers pay the extra costs.

Increasing the costs for renewable integration: The unsustainably low price level on the power market caused by the lock-in effect of the capacity market leads to lower income streams for renewables. Just like with any other subsidy for conventional technologies and fossil fuels, the market value of renewables suffers. Reaching the renewable targets will require higher support costs, due to the additional income for conventional plants from the capacity market. This is a step back from reaching a level-playing field and consequently the path towards the long-term targets becomes more costly.

Market power, price volatility and risks for investors: Capacity markets are prone to market power abuse due to the concentration on generation capacity and the difficulty to include foreign capacities. In addition, the difference in fixed costs between existing plants and new investments leads to a significant jump in the supply curve of the capacity market. In markets with high market power, the capacity price level is most likely always at a sufficient level for new investments, leading to overcompensation at the expense of the consumers. In markets with low market power, the capacity price shows a high volatility between times when old plants set the capacity price and times when new investments set the capacity price. This leads to income risks comparable to those in an EOM, in addition to the regulatory risk of constantly readjusting the products to match political desires. At the same time, the notorious lack of a level-playing field typically leads to a less flexible and more expensive system.

Prone to political and business desires: Capacity market discussions in many countries show that the capacity market product design is prone to political and business desires at the expense of supply security and costs to the consumers. Typical political desires are a focus on low carbon intensity and high flexibility. Also, the construction of a local power plant can appear beneficial compared to building grids. Typical business desires are often reflected in suggestions for product designs that favour incumbent and local technologies. If these desires find ways into capacity market product designs, chances are high that costs increase while supply security is sacrificed. Cramton and Ockenfels (2011) also acknowledge this dilemma: *"[...] there is a long history of flawed capacity market designs, resulting in large inefficiencies and costs. These flaws are well-understood theoretically, so policy makers and administrators can avoid them, but often policy makers and administrators appear guided by political forces that are vulnerable to the adoption of flawed approaches.*" (page 2 et seq.).

While there are many potential reasons why capacity markets may appear beneficial, capacity markets are often introduced without a proper analysis of the underlying challenge. Given the high risks that accompany the introduction and the likely need for a continuous redesign of capacity markets, their implementation should be a measure of last resort. In this case, the phase-out strategy should already be an integral part of the introduction, since capacity markets are very difficult to phase out. Instead of introducing capacity markets in the first place, a more sustainable, internal market-friendly and less costly way is to correct the current market and regulatory imperfections and to safeguard the transformation process with easily reversible measures.

4.4 A SAFETY NET FOR THE TRANSITION PERIOD

ADDITIONAL SECURITY

Until temporary imperfections are solved, the EOM can be safeguarded by a reversible capacity reserve. The reserve also protects against overhasty political reactions in case of unforeseeable scarcity events.

The transition period until the market is sufficiently flexible might require a temporary safety net. Market imperfections can create barriers for an increase in flexibility and therefore might weaken supply security. In order to be in line with the long-term objectives, the key criterion for capacity mechanisms is reversibility, since it avoids harmful path dependencies. The main focus should be to improve market and regulatory rules by reducing barriers and making sure that the market-based incentives work properly.

The sector inquiry states that spot markets cannot be implemented over night (COM, 2016). The same is true for capacity markets. Also, improving power market rules requires time, and the reaction of market participants to the adjustments could come with a time lag, too. In all these cases, supply security benefits from a temporary capacity reserve that safeguards the transformation process.[7] Since the reserve is an additional safety net outside the power market, it does not interfere with the market, while providing *additional* supply security on top of the level that is already achieved by the market itself. The introduction of a capacity reserve provides all stakeholders with the time necessary to improve the underlying imperfections in a sustainable manner and in line with the European long-term objectives.

Besides the imperfections and barriers to flexibility, which should be resolved over time, some unexpected developments could appear during the transformation towards the internal market with high shares of renewables. If these events occur, regulators might be forced to find an instant solution. There is a significant risk that these solutions would not be in line with the long-term objectives and form new barriers. As a protection against these potential developments, a capacity reserve could also be introduced ahead of the challenges. This allows a proper handling of the challenges when they occur while leaving the functioning of the power market otherwise intact.

The main requirement on the reserve is that it should have minimal repercussions on the power market. For instance, it should not introduce an implicit price cap by binding its deployment to a certain market price. The reserve should also have a no-way-back rule to avoid increasing market risks for the capacities that remain in the market. The capacity reserve avoids entering the slippery slope of regulation, especially compared to capacity markets. Investments within the market take place solely on the basis of the power price signals, which allows reaping the efficiency and innovation benefits of the EOM.

[7] A network reserve can also bridge the time, until the grid construction is finished. However, intra-zonal challenges are not a focus of this analysis.

4.5 STEPS OF MARKET IMPROVEMENTS AND INTERVENTIONS

FOCUS ON NO-REGRETS

Reducing barriers and strengthening incentives are no-regrets. Reversible capacity reserves can safeguard the transition period. Capacity markets should be the last resort.

The European power markets are currently in a process of transformation towards the long-term objectives. This transformation may come with some temporary challenges. Some of these challenges will sort themselves out by market processes, whereas other challenges stem from temporary imperfections and require improvement processes. In order to continue the path towards a secure, competitive and environment-friendly power market, the measures to encompass the transformation process should be coordinated and ideally aligned.

To improve the markets with least possible distortions, the following steps should be part of the process and come before the introduction of capacity markets.

The first step should be to form a positive vision of the desired market, in term of its technology mix, its role in the internal market and its flexibility characteristics. This analysis should include the identification of market imperfections and a roadmap to correct the imperfections by removing barriers and by strengthening the market-based incentives.

Second, a regional security of supply monitoring based on a set of advanced probabilistic metrics (see e.g. Pentalateral Energy Forum, 2015 and Consentec/r2b, 2015), should be used to identify the priorities in improving market functioning and removal of barriers from a supply security perspective. It should also assess the potential necessity to introduce additional measures to safeguard supply security such as a capacity reserve. The findings of the market improvement roadmap should be shared within the regional forum to align market improvements, to identify best practices and to potentially coordinate additional measures.

Third, if necessary, the introduction of a temporary capacity reserve to secure supply should take place with regional coordination. It is crucial to strive for the least market-distorting design (see section 4.2).

Fourth, the measure of last resort. If the removal of market imperfections is prohibitively time-consuming and a strong market intervention is required, a least-distortive capacity market could be introduced. The introduction should in any case be accompanied by an exit strategy in form of a phase-out roadmap to facilitate reversibility. This roadmap should include the measures planned to correct market imperfections and a clear plan when and how the capacity market will be phased-out to increase the chances of getting back on track to the European long-term objectives of a competitive, integrated and environment-friendly power market.

5 Conclusion

A future-proof power market design should support the European long-term objectives, such as completing the internal market, continuing decarbonisation, increasing the share of renewables and enhancing energy efficiency. Security of supply and flexibility are best delivered by a competitive, market-based design: An upgraded, flexible Energy-Only Market delivers security of supply cost-efficiently and is in line with the European objectives. Capacity markets on the other side have a high risk of blocking these developments by creating lock-in effects of fossil, base-load technologies while entailing higher costs to reach security of supply.

The current market situation with its relatively low prices is a result of making progress towards the European tong-term targets and a sign of necessary market-based capacity adjustments that will then lead to a sustainable price level. There are no signs of structural market failures. Instead, we observe temporary market imperfections with side effects such as oversupply. These imperfections can be resolved by removing barriers for flexibility, for example through improving spot and reserve power markets, and by creating clear and strong incentives within imbalance systems. The Energy-Only Market is also likely to develop implicit and/or explicit capacity remuneration elements, e.g. in long-term contracts, however on a decentralized market-basis and not by regulation. By upgrading the Energy-Only Market, it can provide security of supply in a competitive manner and enable a cost-efficient adjustment towards a new equilibrium

Already today, there is a magnitude of flexibility options that can provide supply security based on the individual willingness to pay. This abundance allows a competitive market-based selection of the best-suited options. In this way, it is possible to use the cost efficiency potential of the market and to facilitate innovative technologies and business cases.

The key criterion for selecting measures to safeguard security of supply during the transformation phase is reversibility. If reversibility is neglected, measures for supply security, in particular capacity markets, have a high risk of creating costly lock-in effects of incumbent technologies. Therefore, if capacity markets are introduced, a phase-out strategy should be integral part of the measure. A capacity reserve, however, can provide an additional safety net outside the market to provide sufficient time for the transformation process, while leaving the efficiency and innovation advantages of the Energy-Only Market intact.

Taking all of these findings into account, the long-term objectives of a future-proof market design need to be the completion of the internal market and a creating a safe, competitive, environment-friendly and flexible power market.

Literature

Connect (2014): Leitstudie Strommarkt – Arbeitspaket Optimierung des Strommarkt-designs. Connect Energy Economics GmbH, July 2014.

Connect (2015): Leitstudie Strommarkt 2015. Connect Energy Economics GmbH with contributions from Consentec GmbH, r2b energy consulting GmbH, Fraunhofer-Institut für System- und Innovationsforschung, May 2015.

Consentec/r2b (2015): Versorgungssicherheit in Deutschland und seinen Nachbarländern: länderübergreifendes Monitoring und Bewertung. Consentec GmbH, r2b energy consulting GmbH, March 2015.

Cramton, P., Ockenfels, A. (2011): Economics and design of capacity markets for the power sector. 30 May 2011.

COM (2015): Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Launching the public consultation process on a new energy market design. European Commission, 15 July 2015.

COM (2016a): Report from the Commission – Interim Report of the Sector Inquiry on Capacity Mechanisms. European Commission, 2016.

COM (2016b): Commission Staff Working Document Accompanying the Document "Report from the Commission – Interim Report of the Sector Inquiry on Capacity Mechanisms". European Commission, 13 April 2016.

DWD (2016): Data from COSMO-EU model. Deutscher Wetterdienst, 2016.

ENTSO-E (2015): TYNDP 2016 Scenario Development Report. European Network of Transmission System Operators for Electricity, 3 November 2015.

ENTSO-E (2016): Country Data Packages. European Network of Transmission System Operators for Electricity, 2016.

EPEX SPOT (2015): Market data for the German market zone. EPEX SPOT SE, provided by EEX AG, 2015.

Eurostat (2015a): Supply, transformation and consumption of electricity - annual data. Eurostat, 2015.

Eurostat (2015b): National Accounts aggregates by industry. Eurostat, 2015.

Pentalateral Energy Forum (2015): Generation Adequacy Assessment. Pentalateral Energy Forum, Support Group 2, 5 March 2015.

r2b (2014): Endbericht Leitstudie Strommarkt – Arbeitspaket Funktionsfähigkeit EOM & Impact-Analyse Kapazitätsmechanismen. r2b energy consulting GmbH, 30 July 2014.