MARKET MODEL 2.0

Final report

ENERGINET.DK

Electricity market of the future

Market-based solutions for an efficient, green transition

Denmark and Europe are working to create a green transition of their energysystems. Market-based solutions are an important step towards ensuring that the transition is as cost-effective as possible. Therefore, the framework for the electricity marked must be strengthened, so that we a prepared for a future with even more renewable energy while maintaining security of supply.

The electricity market needs new mechanisms

A well-functioning electricity market characterised by healthy competition helps ensure that the transition of the energy system to renewable energy happens as cost-effective as possible. Therefore, the market design must also be changed in step with the changing energy systems.

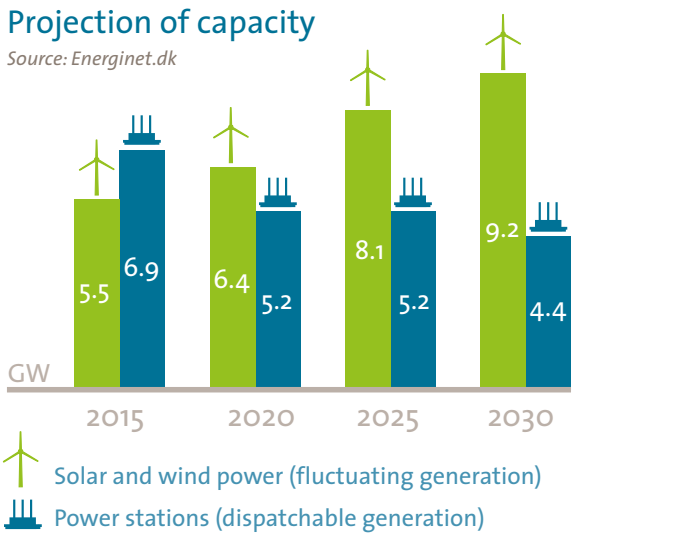
We can only find the best solutions if we work together. With EU's Energyunion and movements in neighbouring countries new possibilities emerge for even more cross border cooperation.

In close cooperation with its stakeholders, Energinet.dk intends to future-proof the electricity market frameworks. In many areas, new legislation and political decisions, agreement in the Nordic region or common EU rules may be required. In many areas, several parties must also move in the same direction to meet future challenges.

Three main issues and focus areas have been identified following the analysis and examination of rules, mechanisms and trends in the current electricity market conducted by the Market Model 2.0 project.

1. Capacity: A continued high level of security of supply requires action. If the current electricity market is maintained, there will be an increased risk of power shortages, ie the amount of electricity generated or imported will not be enough to cover the electricity consumption in Eastern Denmark in periods characterised by several failures. This means that from around 2025, Eastern Denmark could be in shortage of electricity for longer periods of time than Energinet.dk has established as acceptable. Therefore, the electricity market needs new mechanisms. Western Denmark is expected to be able to maintain Energinet.dk's security of supply target.
2. Flexibility: Wind and weather conditions change the electricity system
   The electricity market lacks the necessary incentives to drive a development that ensures increased consumption of electricity when it is cheap, and less in periods with no wind and electricity is expensive. There is a need for greater demand-side flexibility. Therefore, market rules need to be changed, while at the same time new business models are necessary in the market.
3. Critical properties: Who supplies when the power stations are not operating?
   Some of the properties that are critical to operating the electricity system are currently supplied by the power stations. But power stations are operating less and less. This entails the need to find new ways to obtain and remunerate for critical properties.

Background



A much greater share of the future electricity capacity is expected to come from solar and wind power rather than from CHP plants.

We are moving towards a new energy system

Not only Denmark, but all of Europe, is making efforts to transfer to more renewable energy – and it is not only a matter of greener kilojoules in new boilers. We are facing a paradigm shift.

We basically come from a time where, projections of the amount of electricity consumed by households and businesses tomorrow are made every day. Then the amount of energy matching the consumption is generated.

In the future, the vast majority of the electricity generated will not be generated by power stations, but rather as the "wind is blowing", or the "sun is shining". This means that generation – not consumption – will be the determining factor. In the future, consumers thus must use more electricity when there is plenty, and less when electricity generation is low. This requires new price signals, new services, new technology and also new ways to ensure our security of supply.

We are already seeing examples of the future development and challenges. Energinet.dk has recently issued a call for tenders for a strategic reserve in Eastern Denmark for the 2016-2018 period in order to maintain the current level of security of supply. In Germany, furthermore, efforts are being made to expand the transmission grid, so that more electricity can flow between the markets. For instance, there is currently a congestion in the North German grid, preventing large volumes of electricity to be transmitted back and forth. (See figure)

Market Model 2.0

More fluctuating electricity generation poses more challenges for the security of supply. In 2014, Energinet.dk therefore invited representatives from electricity generators, trade associations, governmental organisations, consumers etc. to participate in the Market Model 2.0 project. The objective was to identify challenges and find solutions for the future. The project was carried out with the assistance from the consultancies Quartz+Co and Copenhagen Economics. (See figure overleaf)

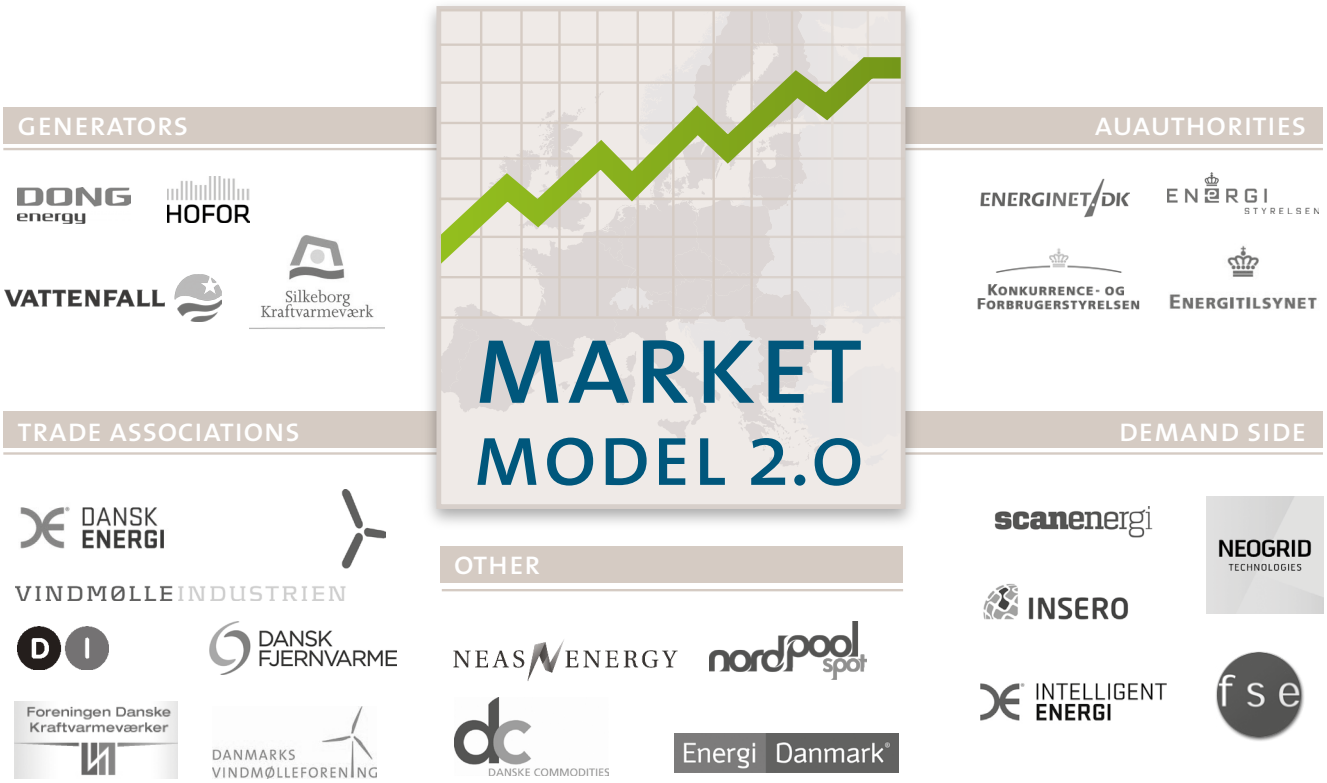
The Market Model 2.0 project assessed the challenges in the broad sense. The public debate usually focuses on whether we have sufficient capacity or not? Who is responsible for ensuring that households have electricity in the future? Nevertheless, there are also other market mechanisms of major importance to the development of the electricity market.

The Market Model 2.0 work has been monitored by an advisory board, with representatives from the electricity sector providing input and advice. The work has been performed by several working groups with representatives from the participating organisations through workshops and a study trip to Brussels etc.

The project ended in September 2015 with a technical background report, containing analyses of the current electricity market and the level of security of supply until 2030 etc., as well as proposing a number of solutions.

Denmark is linked to its neighbours

When identifying future solutions, wiping the Danish slate clean and starting from scratch is not an option. First of all, a large number of Danish, Nordic and European rules and frame-



Market Model 2.0 has been developed by Energinet.dk with assistance from Quartz+Co and Copenhagen Economics, as well as with ongoing input and feedback from generators, trade associations, the demand side and authorities.

works are governing the electricity market. Second of all, the market is becoming increasingly interconnected cross border, and we are highly dependent on the situation in our neighbouring countries and the direction in which the individual countries and the EU choose to go.

We need to take all of this into consideration when designing future market rules. We cannot search for only short-term and stop-gap solutions to current problems, nor can we focus exclusively on long-term solutions, such as the Danish Parliament's 2050 objective of making Denmark independent of fossil fuels.

We must ensure competition, innovation and security of supply – tomorrow and after 2030.

Energy Union and Europe in several directions

Denmark is an integral part of the European electricity market, and electricity is traded on the Nord Pool Spot exchange. Electricity flows across borders, and supply and demand determine electricity prices and trading between countries on an hour-by-hour basis.

In addition, many successful cooperations and common rules have been established, which have gradually made Europe's electricity markets more interconnected. Among other things, the countries ranging from Finland in the north to Portugal in the south have joined forces to create 'regional market coupling', through which physical barriers have been removed, thus making it easier to transmit electricity across borders and the regions into which the European electricity grid map is divided.

And there are indications that the European market will become even larger and more integrated. The aim of the European Commission proposal for an Energy Union is to take the internal energy market one step further through, eg, a more binding European and regional collaboration and better cross-border infrastructure, guaranteeing that more electricity can flow across the borders – wind and hydroelectric power from north to south, solar energy from south to north etc. The proposal also identifies the need for a new electricity market design aimed at supporting competition and an efficient transition to more renewable energy, involving consumers while also ensuring security of supply. Among other things, the European Commission believes that the countries should increasingly share backup capacity.

In fact, the question of backup – "What happens when power stations shut down and more electricity is generated by the wind?" – has prompted the launch of measures in a number of countries. Several countries are already in the process of implementing solutions. However, these solutions vary in terms of both objectives and the means of achieving them.

Germany is also making efforts to future-proof its electricity market. Germany is not only Denmark's neighbour to the south, but also a large-scale consumer, a major electricity generator and a European hub. Germany's decisions will have an impact on the Danish electricity market.

The German Federal Ministry for Economic Affairs and Energy has made specific proposals for:

- establishing a 'strategic reserve' to ensure sufficient capacity

- opening the balance market to include new market participants (demand-side flexibility, emergency power generators, producers of renewable energy, electric vehicles and batteries etc.) combined with initiatives to make it easier to trade flexibility
- developing the market to allow trading closer to the time of consumption
- removing restrictions on price formation in the electricity market together with stronger incentives to maintain balance between generation and consumption

Moreover, Germany has taken the initiative to issue a 'Joint Declaration for Regional Cooperation on Security of Electricity Supply in the Framework of the Internal Energy Market'. The declaration has been adopted by 12 countries, including Denmark, and promotes more open electricity borders and increased cooperation in periods when the systems in the individual countries are under pressure. The declaration also encourages regional rather than national assessment of security of supply.

Safeguarding electricity capacity

Do households also have electricity on calm winter days or when power stations are shut down for maintenance during the summer period? The question is becoming relevant as wind power is taking over to a greater extent. The emergence of new renewable energy sources results in the ejection of other energy sources, and some power stations and CHP plants will be out-competed, closed or converted into pure heating plants.

The discussion should not be whether we are for or against more wind turbines in Denmark. Regardless of how and how fast Denmark will add more wind turbines, wind will become the dominant energy source in our electricity market. This is due to a major expansion of wind power in the region, in connection with which Denmark plays a minor role. Northern Germany already has three times the wind turbine capacity of Denmark, increasing to five times as much in 2020. Last year, Sweden surpassed Denmark in terms of total wind capacity. Other countries in the region are also strengthening their wind power capacity considerably. The large volumes of wind energy around us affect the Danish electricity market and the Danish electricity prices. (See figure overleaf)

Denmark has not experienced power cuts due to power shortage in recent years, but there are indications that, in the very short term, the five-minute objective may be difficult to meet in Eastern Denmark. Therefore, Energinet.dk has recently issued a call for tenders for a 200 MW strategic reserve in Eastern Denmark. The reserve will be available until the end of 2018, after which a new interconnection to Germany related to the future Kriegers Flak offshore wind farm will be commissioned, improving the capacity situation in Eastern Denmark.

What is security of supply?

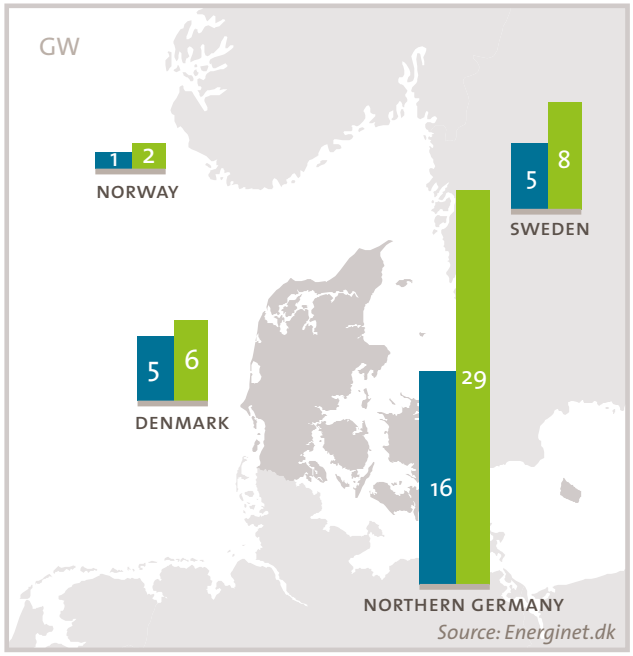
Denmark has one of the highest levels of security of supply in Europe. In 2014, electricity consumers had electricity 99.996% of the time.

Security of supply consists of two parts:

1. 'System adequacy' – whether enough electricity is generated or imported to cover the needs, also called capacity, and whether the infrastructure is sufficient to transmit electricity to the consumers.
2. 'System security' – whether the system has the necessary properties to handle failure, such as a short curcuit failure.

Denmark has not experienced power cuts due to power shortage in recent decades. All incidents of power cuts have been caused by storms, fallen trees, short circuit failures in transformers, lightning strikes, accidental damage to cables and submarine cables etc. It is Energinet.dk's ambition to ensure that electricity consumers continue to experience a high security of supply. This means that on average, calculated over a number of years, Danes must not be without electricity for more than 20 minutes per year thanks to capacity adequacy and system security in Energinet.dk's grid. Of this, power shortages should constitute no more than 5 minutes. The 5 minutes are an average estimate based on a number of years with no outages followed by one major breakdown with no electricity for a longer period of time, eg 60 minutes in parts of the country. The 5 minutes cover rare events, eg when there is no wind and the sun is not shining, when there is an outage on an interconnection, and when local areas or regions will have no electricity.

Installed wind capacity



2014
2020

Wind capacity in and around Denmark will increase rapidly until 2020

In the longer term, the Market Model 2.0 project conclusion is that Western Denmark can maintain the objective of the average consumer not experiencing more than a five-minute outage due to power shortage in an average year. The situation is different in Eastern Denmark, and developments indicate that the objective may come under pressure in approx. ten years' time. The difference between Western and Eastern Denmark is particularly a result of the fact that Western Denmark has a larger capacity in terms of interconnections, and it is connected to more neighbouring areas than Eastern Denmark. Therefore, you could say that Western Denmark has put its eggs in several different baskets as opposed to Eastern Denmark, and this development is being further reinforced by new interconnections to the Netherlands and potentially England.

Market Model 2.0 analyses show that, in Eastern Denmark, the level is expected to increase to approx. 7-14 minutes in 2030. The 7-14-minute range is a result of calculations of several scenarios, taking into account the various speeds at which the transition to more renewable energy is made, the development of electricity prices and the expansion of interconnections. In the event of more unexpected situations, eg that electricity prices are lower than expected, the number of minutes of outage could be almost doubled. Unexpected situations can, however, also result in a development that is better than expected. (See figure overleaf)

The development in minutes of outage reflects the major reduction in the central and decentralised thermal power plant capacity in both Eastern and Western Denmark up until 2030. Historically, Denmark has had a large generation capacity at

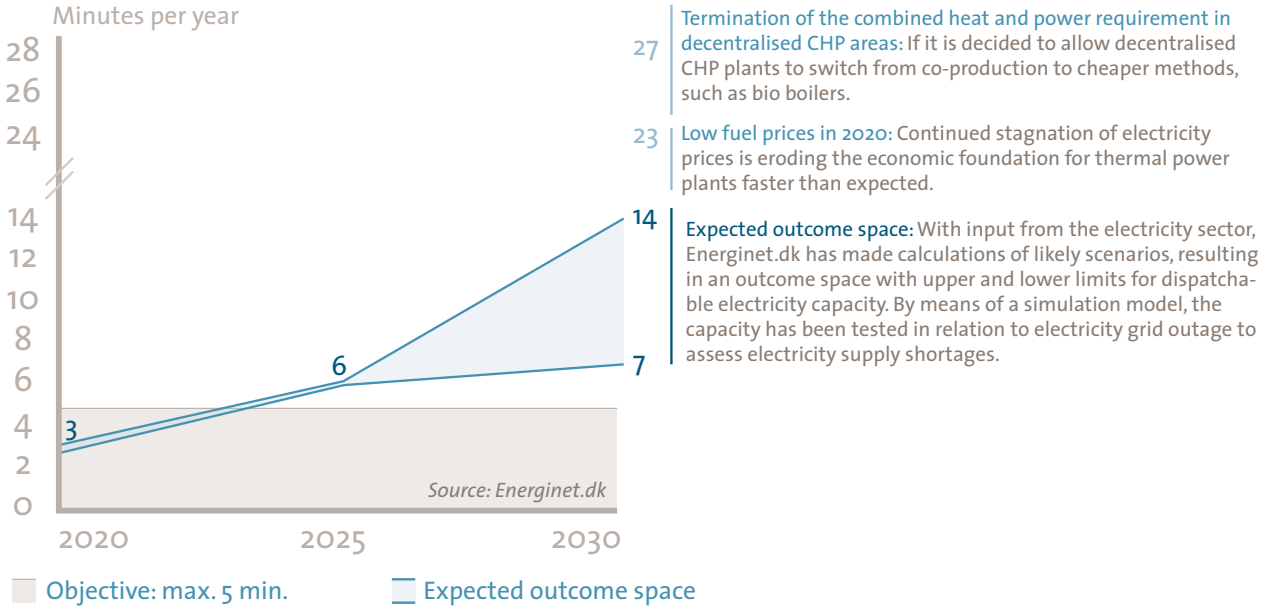
What is a strategic reserve?

A strategic reserve is held outside the market and is only activated when the market is unable to balance supply and demand. A strategic reserve can consist of power plants and demand side flexibility.

The strategic reserve is offered to the market at the the so-called "price cap". The current electricity market has a price cap, given that the demand side has traditionally been inflexible. The consumer has been 'blind' to the electricity price charged in the specific delivery hours and has therefore not reacted, which may have resulted in an 'extremely high price' without a price cap in situations where supply cannot meet demand.

In a strategic reserve, the TSO buys the lacking capacity. The strategic reserve should only be used when all commercial alternatives have been exhausted. Therefore, it has less impact on commercial transactions in the market.

Expected outage for an average consumer in Eastern Denmark



Expected development in Eastern Denmark. If the market model is not adjusted, the number of minutes with outages for the average consumer is expected to increase over the years.

central and decentralised CHP plants. Over the next 5-15 years, major investment decisions will have to be made in relation to whether plants should close or remain in operation.

The capacity of the central CHP plants is expected to drop from 3,800 MW to between 1,900 and 2,350 MW in 2030, depending on the scenario. Today, it is not worth the effort economically for market participants to build new CHP plants. Plants producing only electricity will not be able to make it in the electricity market. Prices are too low. The least profitable plants are expected to close. Other plants will carry out lifetime extension measures or convert fully to biomass. Many plants are expected to scale down the electricity capacity and go from being CHP plants to being primarily heat plants with electricity as a smaller bi-product.

The situation is similar with regard to decentralised CHP plants. Depending on the scenario, the capacity of decentralised CHP plants is expected to drop from 2,400 MW to between 1,550 and 1,700 MW. The figures include waste-to-energy plants etc. Only the biggest and most efficient plants are expected be able to gain from reinvesting in combined heat and power generation. Many plants are expected to supplement heat generation with a heat pump or the like, and thereby not reinvest in electricity generation. Others will close. The special financial support that most decentralised plants recieve - in the shape of a CHP subsidy - will expire after 2018. Other events could also have an impact on the development, such as the termination of combined heat and power requirements at decentralised CHP plants.

In the Market Model 2.0 project, various options have been assessed for maintaining the five-minute objective by establishing a strategic reserve or a capacity market.

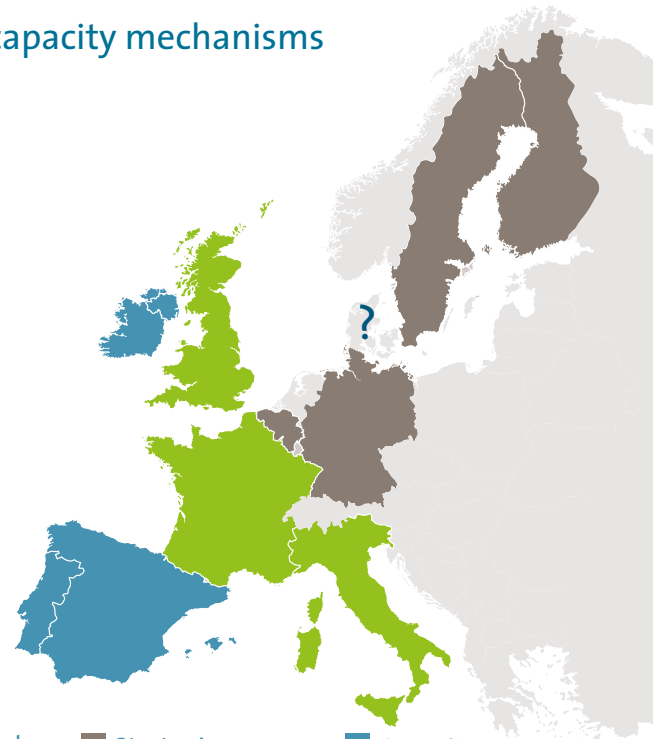
In Europe, different countries have made different choices. Sweden, Finland, Belgium and, most recently, Germany are pursuing a strategic reserve, while the UK, France and Italy have chosen a capacity market. (See figure overleaf)

The analyses in Market Model 2.0 indicate that a strategic reserve would be the best way of addressing the expected needs. A strategic reserve is a limited, targeted payment for maintaining capacity and is therefore a less extensive solution. It is also a flexible instrument which can be adjusted relatively quickly in response to changing needs. Introducing a capacity market will require substantial changes in the market. At the same time, a capacity market affects competition in neighbouring countries. Therefore, the European Commission recommends incorporating such a solution in a wider regional context. Given that Germany and Sweden are aiming for a strategic reserve, there is also due to this good reasoning in Demark not pursuing a capacity market in isolation.

Denmark distinguishes itself from the rest of Europe by having many CHP plants generating both heating and electricity. Therefore, the project has analysed a special type of strategic reserve allowing a CHP plant to continue to operate in the heating market, while also taking part in a strategic reserve. The analyses suggest that both the advantages and disadvantages of the model are highly dependent on on which power stations will offer themselves to a strategic reserve at the time of the

Established capacity mechanisms

Source: ENTSO-E



The European countries have different strategies. This affects Denmark's room for manoeuvre

What is a capacity market?

The capacity market is where the total amount of capacity needed is secured and remunerated. Market participants submit bids in a capacity auction and get the price set by the market.

Market participants are paid to make capacity available. The market participants receive payment for capacity meeting the requirements in addition to their regular earnings in other electricity markets, such as the day-ahead market.

This differs from a strategic reserve in that the market participant continues to operate normally in the electricity market, selling the electricity it generates in addition to its earnings in the capacity market.

tender. It is therefore recommended to take a look at the model if the need to establish a strategic reserve arises again.

The Market Model 2.0 analyses suggest that the payments from consumers to generators in a capacity market could amount to approx. EUR 100 million per year – and more than three times as much if foreign capacity is to receive Danish capacity payments. The reason is that Denmark would thus have to pay for the capacity which is made available today to interconnections via the electricity market. A strategic reserve in Eastern Denmark is expected to result in payments of up to EUR 8 million from consumers to generators, increasing to EUR 13,5 million per year if developments prove more negative than expected. The payments do not reflect socioeconomic costs, which are expected to be lower.

Energinet.dk recommends:

- A strategic reserve should be the starting point for solving problems relating to lack of capacity in Eastern Denmark after 2025. When the need arises, the solution must be held up against other alternatives, such as a new interconnection between Western and Eastern Denmark, a new type of strategic reserve allowing CHP plants to participate in a strategic reserve while also participating in the heating market etc.
- Energinet.dk is closely monitoring the situation in Denmark and abroad, especially in Germany and the Nordic countries, and elaborating on it in the annual statement on security of supply, in order to assess whether the solution chosen is still appropriate.

Demand-side flexibility

Market is rigid and lacks flexibility

For the green transition to more renewable energy to succeed, electricity must be used more widely and displace fuels such as oil and coal. For this to happen efficiently, demand-side flexibility must play a bigger role. We need efficient markets with lower barriers to entry and sustainable business models – rather than schemes subsidising demand-side flexibility.

In private households, heat pumps should run when there is plenty of wind and electricity prices are low, and the recharging of our electric vehicles should be paused if the wind dies down, forcing the power stations to ramp up to full capacity leading to high electricity prices. It must be easier for businesses to gain financially from supplying anything between a few minutes to several hours of flexibility, for example through the flexible operation of electric melting furnaces; further, hospitals and institutions with their own emergency power units must gain from using their back-up power supplies at times when this also benefits the electricity system as a whole.

In fact, a lot of research and development has already been carried out in the field of demand-side flexibility, and in recent years the electricity system has taken major technological steps in the direction of greater flexibility. Other elements include the installation of hourly metering for small consumers, a DataHub for gathering all data about our electricity consumption, and a so-called wholesale model, which is building another level to the foundation, creating the potential for more competition and innovative business models.

Expectations are that the electricity supply sector will gradually undergo developments on a par with the dramatic changes seen in, eg, the telecom sector. New products and types of subscription will come to change our perception of what it means to be an electricity customer – perhaps freezers will in the future be sold inclusive of the electricity required to run them, or consumers may be able to take out a subscription tailored exactly to their level and pattern of electricity consumption.

All in all, the Market Model 2.0 project estimates that 300-450 MW of flexibility can be brought into play in the near term. This figure covers only emergency power units, buildings and electricity-intensive industrial plants.

In this way, a significant contribution could be made to addressing the expected deterioration in the level of security of supply in Eastern Denmark.

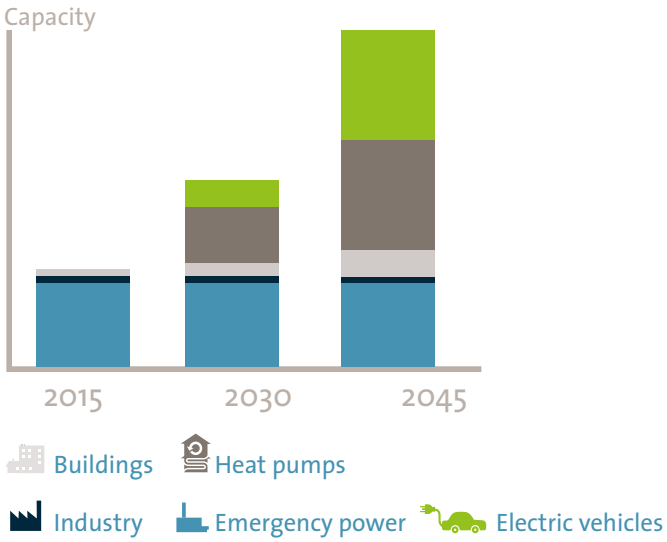
Heading towards 2030, where electric vehicles, heat pumps etc. as well as many other new intelligent appliances are expected to play a far greater role, the potential is believed to grow. Electric vehicles and heat pumps alone are expected to be able to contribute 700-900 MW. (See figure overleaf)

New role must pool flexibility

One of the most important barriers identified by Market Model 2.0 is the lack of market participants that can and will aggregate and coordinate demand side flexibility from private households, institutions and businesses.

Demand-side flexibility

Source: Energinet.dk



There is a need for a new role in the electricity market, a so-called 'third-party aggregator'. The concept covers a specialist function which can create new business opportunities, in that the aggregator knows about the performance of all the various batteries for electric vehicles, and equally well how the same heat pump would perform in either a standard 1970s single-family house or a house from the 1930s. A brand-new market participant or an existing one, which on the one hand can offer new special products to individual customers, and which on the other hand can pool the flexibility from many customers and offer this to the market as a way of helping to meet the need for flexibility in the electricity system.

However, a number of existing rules – both Danish and European – do not accommodate the need for such a new role. The problem is twofold. Firstly, the barriers to entry are too high, among other things because the new third-party aggregator initially will have to negotiate agreements with a total of around 15 different companies acting as the balance-responsible parties for the aggregator's potential customers. Secondly, the running costs are too high relative to the earnings potential, and the cost of metering the demand side flexibility of individual customers and for individual appliances is a subject for discussion. Today, most electricity consumers have only one main meter, but it may be necessary to install an additional meter to provide the data needed to settle demand side flexibility.

Energinet.dk proposes:

- That Energinet.dk, in a dialogue with the electricity sector, continues its efforts to establish a regulatory framework for a third-party aggregator and promote its realisation. For instance by reducing the barriers to entry and the running costs for the aggregation. Experience from the UK and other countries will be included in the assessment. Energinet.dk can then adapt its regulations to accommodate third-party aggregators. The changes must be approved by the Danish Energy Regulatory Authority.
- That Energinet.dk works internationally to change the rules and remove the existing barriers to demand-side flexibility. It is important that any initiatives be coordinated with the efforts being undertaken in our neighbouring countries.
- That Energinet.dk offers its support for initiatives in the electricity sector which are aimed at increasing flexibility. Such initiatives may take the form of theme days, courses, visits to relevant market participants etc. with a view to building knowledge about demand-side flexibility among consumers, businesses, building owners, electricity suppliers etc.

Higher price caps

Many consumers have no incentive to be more flexible in the way in which they consume electricity. There is no 'what's in it for me?', when the potential savings for a family amount to only a few tens of euro a year. The difference between boiling water, washing your clothes etc. when electricity prices are low, as opposed to when they are high, is too little.

A raised price cap – the maximum price paid for one kWh in the day-ahead market – would be one way of providing a greater incentive for electricity consumers to adapt their consumption to how much they are willing to pay. The current price cap is EUR 3,000 per MWh.

Flexibility is expected to increase if there is a greater difference between cheap and expensive hours. In addition, a higher price cap will, to a greater extent, leave it to the market to distribute the electricity in situations where Energinet.dk would otherwise be forced to randomly disconnect electricity consumers in order to maintain grid voltage, the so-called brown-outs. Today, brown-outs would otherwise have to be made without any regard being given to what individual consumers are prepared to pay. A raised price cap will also contribute to ensuring sufficient capacity by paying electricity generators more for making capacity available in strained capacity situations.

For the consumer, the higher payments during periods of capacity scarcity will to some extent be offset by the lower cost for Energinet.dk of procuring strategic reserves, as the demand for a strategic reserve would fall due to a higher price cap. Consumers insure themselves against price fluctuations by entering into contracts with suppliers, eg via fixed-price contracts or price-dependent bids.

Energinet.dk proposes:

- That Energinet.dk works towards raising the price cap from EUR 3,000 per MWh to a level which more accurately reflects the real value of electricity to consumers. Further work will be needed to determine which price cap to propose. Denmark cannot raise the price cap single-handedly; it must be done in cooperation with the countries in the price-coupled area, but in several countries, eg in Germany and France, developments are already pointing in that direction.

Market flexibility

Changes are also needed when it comes to those parts of the electricity market which ordinary consumers rarely, perhaps never, think about. Various markets and platforms have been developed over the years with a view to encouraging competition and ensuring that electricity can be traded across borders and between generators and consumers. Today, the electricity market consists, among other things, of:

The day-ahead market
The electricity consumed by most Danes is traded on the joint Nordic power exchange, Nord Pool Spot, which is an integrated part of the market coupling system. In the day-ahead market, generators announce how much electricity they want to sell in the next 24 hours. The electricity suppliers and generators submit their bids by 12 o'clock noon. Supply and demand then determines the spot price on an hour-by-hour basis.

The intraday market
All market participants must have a balance-responsible party which ensures a balance between the generation and consumption schedules submitted. In the intraday market balance-responsible parties can trade to correct unforeseen imbalances up to 45 minutes before the delivery hour. After this time, Energinet.dk assumes responsibility for balance management and settlement.

Regulating power and balance market
There is also a regulating power market, where generators and consumers sell capacity to Energinet.dk if a need to regulate up or down arises during the actual delivery hour so as to maintain the balance.

Moreover, Energinet.dk purchases automatic reserves so as to be able to maintain security of supply at the moment of delivery, and so as to even out even the tiniest imbalances in consumption or production, and counter any outages of, eg, power stations, offshore wind farms or interconnectors. The electricity market comprises a number of other platforms, auctions etc., including auctions of transmission rights on the interconnections between Denmark and Germany.

More market, less TSO

Market Model 2.0 has examined a number of rules and mechanisms which – despite their original intention of promoting competition and ensuring security of supply – no longer seem appropriate. More often than not, it does not make sense to look at any single mechanism in isolation, or to address one particular problem as any changes introduced will invariably impact other parts of the system.

'More market, less TSO' could be said to sum up the line of thinking advocated by Market Model 2.0 when it comes to redesigning the rules for the balance market of the future. A number of examples are given below of mechanisms which need modifying, changing or removing.

Better access to trading closer to the delivery hour

In step with the integration of more and more wind power, unpredictability will come to play an ever more pronounced role in the electricity system in the future. Consequently, the market participants will need to be able to trade closer to the delivery hour. Today, the intraday market only allows trading up

until one hour before the delivery hour. Then the market closes, and Energinet.dk assumes responsibility.

Analyses show that significant forecasting errors can be made one hour before the delivery hour. Only about half of the erroneous estimates made 24 hours before the delivery hour can be rectified through the possibility of trading until 60 minutes before the delivery hour. There is therefore a need for the market participants to be able to trade closer to the delivery hour, ie once they know more about their final position in the market. This can contribute to balancing the electricity system as a whole. Trading closer to the delivery hour is also in line with the development towards a quarter-hour market in the regulating power market.

However, shorter deadlines lead to challenges and worries elsewhere in the system. The closer you are trading to the delivery hour, the less time is allowed for the responsible control room to respond to imbalances and thereby avoid power cuts. The solutions devised must therefore take account, on the one hand, of the fact that the necessary balance should basically be created by the market and not the TSO, while on the other hand, also making the necessary tools available to the TSOs. Other countries, including the Netherlands and Belgium, currently have a market which allows trading closer to the delivery hour, and the EU is likely to introduce network codes pulling in the same direction.

Energinet.dk recommends:

- That Energinet.dk and the Nordic TSOs work towards introducing trading closer to the hour of operation. This is in line with the network codes which are currently being prepared in the EU.

'Balance before day of operation' rule must be changed

Another rule which should be changed is the 'balance before day of operation' rule. It was introduced at a time when it was necessary for the TSO to plan ahead, but must be deemed outdated in its current form: What the rule basically says is that 'there must be no imbalance', but given the increasing share of fluctuating electricity generation, a rule stipulating that balance must be ensured a whole 24 hours prior to the day of operation is contrary to the inherent characteristics of the new market.

On a normal day, Energinet.dk has at its disposal both fast and slow reserve capacity which can be used to address imbalances. With more fast reserve capacity, Energinet.dk can intervene more efficiently, thereby allowing the market to operate closer to the hour of operation.

Energinet.dk recommends:

- Energinet.dk works to change the market regulation prescribing 'balance before the day of operation' because it goes against the principles of allowing trading closer to the hour of operation. In reality, the rule has already been relaxed in recent years so that this is no longer a duty, but a service.

Imbalances must be settled in the same way

It is difficult to accurately forecast electricity generation from wind turbines and solar panels. And it is not necessarily a bad thing that there is a difference between the volumes of elec-

tricity which market participants expect to generate and the actual volumes generated as long as a real and transparent market exists which will incentivize the affected market participants to restore the system balance through trading. However, today there are rules which do not encourage flexibility and which detract from the incentives due to the different prices and sanctions at work.

Today, imbalances are settled differently for consumption and production units. The difference depends on whether the imbalance in question 'helps' to restore system balance – eg through the market participants generating less electricity than expected during an hour of surplus production – or whether it 'exacerbates' the imbalance, eg through additional generation during an hour of general surplus generation. For production units, the so-called two-price model is used, which means that the price paid to a market participant whose imbalance makes the situation worse is lower than the price paid if the imbalance for which the market participants is responsible helps to redress the system imbalance. Consumption units, on the other hand, are paid the same settlement price, regardless of whether their imbalance helps to restore system balance or the opposite. The dissimilar payment principles for consumption and production units are an incentive for sub-optimisation.

Energinet.dk recommends:

- That Energinet.dk, in cooperation with the Nordics TSO work on harmonising the imbalance settlement model. The price paid for any imbalances should basically reflect the marginal costs associated with handling such imbalances. Energinet.dk will work for a single-price model. The settlement of imbalances must be seen in the context of Energinet.dk's purchasing and use of reserve capacity, including the pricing of the reserves in the markets, as well as the scale of the imbalances. The work must take account of the other market design changes and be aligned with the network codes which are being developed by the EU.

Power imbalances are settled only in the west

Some of the balance-market rules are very complex and hard to understand. For example, some settlement rules apply only in Western Denmark and apply only to large production units (power stations and offshore wind farms). For historical reasons, the same rules do not apply in Eastern Denmark.

A well-functioning market needs transparent and harmonised rules.

Energinet.dk recommends:

- That Energinet.dk works to simplify and change the power imbalance settlement rules, to make it easier for market participants to react to the price signal. The changes to the power imbalance settlement rules must be coordinated with the work that is already being done in the Nordic region to develop the market for automatic reserves.

More transparent settlement of special regulation

A rule on special regulation exists in the Nordic region which is designed to ensure that grid faults, interconnection outages etc. do not have any negative effects for the market participants and their bidding in the regulating power market. The rule also comes into play at times when a high level of electrici-

ty generation in Northern Germany – during windy weather – is pushed northwards because it cannot be sent south because of congestion in the German electricity grid. In such situations, Germany has problems balancing the system; firstly, it regulates down production at its own power stations, and then they ask whether any of the Danish market participants are in a position to supply special regulation, ie reduce power station or wind farm generation.

'Special regulation' is currently a source of confusion and frustration as the market participants are paid differently, depending on whether they are activated under the special regulation rule or in the regulating power market.

Energinet.dk recommends:

- That the special regulation principles and method be made more transparent for the market participants– this work is already under way.
- That Energinet.dk awaits the results of a Danish-German pilot project on closer coupling of the regulating power markets. In the longer term, this may reduce some of the need for special regulation.
- That Energinet.dk instigates an assessment of the special regulation rule together with the Nordic TSOs, possibly with a view of removing it. Any changes must be aligned with the concurrent work on EU's network codes.

In addition, the Market Model 2.0 project has identified several other market mechanisms and rules which, in Energinet.dk's opinion, should be adjusted or changed.

Critical properties

The general understanding of security of supply is probably that, as long as there is coal or biomass enough to fire the power stations or wind enough to keep the wind turbines rotating, security of supply will not be a problem.

However, security of supply is not just about firing enough coal or biomass or increasing the flow of natural gas. Sufficient capacity is only one part of the equation when it comes to ensuring that power is readily available to consumers. The second part of the equation, 'system security', concerns the fact that the system itself must be sufficiently stable. So stable that the outage of a power station or an interconnection will not push the system out of balance. Such a situation may arise, eg, due to short-circuiting, due to a defective component or because stormy weather blows down trees and power lines. System security relies on the so-called 'properties required to maintain power system stability', which are currently supplied by power stations, DC connections or synchronous compensators.

Several of the 30 or 40 different technical properties in question are supplied by power stations. The technical properties are built into the power stations, which are currently obliged to make them available to the electricity system. In some cases, compensation is offered for the cost of activating these properties, while in other cases they are made available free of charge.

However, as more and more power stations are decommissioned or operating for fewer and fewer hours, these properties will be in short supply. In other words, it may be that the electricity system is entitled to receive these services free of charge, but if nobody is there to supply them, then we all have a serious problem. And we should also discuss whether it would not be fair for the market participants to be compensated directly for the technical properties which they make available, and whether an element of competition could be introduced to the delivery of the services.

Defining products which can be traded and paid for encourages competition, thereby making room for new market participants, eg wind turbines. Thus, the idea is not that the changes should make life easier for the power stations. It is a question of ensuring that the electricity system will also have access to the necessary, critical properties in the future.

Working on a new ancillary services strategy, Energinet.dk has started addressing these challenges, including among other the role of the TSO today and its ownership of facilities which can supply critical properties required to maintain power system stability.

Energinet.dk recommends:

- That Energinet.dk conducts an analysis to identify the exact technical, critical properties and functionalities which will be needed in the future system and on which level. Based on the analysis, the aim is for these needs to be procured in the market and paid for, or to still be provided free of charge. The proposed solutions should be aligned with the common European network codes.

Summary

The market design must create a framework for market-based solutions which will pave the way for an effective, green transition and support the increased internationalisation of the energy markets. The overall conclusion of the Market Model 2.0 project is that the existing market design is largely tailored to the existing electricity system and not to the system of the future. In the future system, the market must be able to do even more. More renewable energy means more fluctuating production, and consumers must go from primarily being passive recipients to being active participants providing the necessary demand-side flexibility. There is therefore a need both for minor adjustments and changes and for more fundamental changes.

Energinet.dk has already made some of these changes and adjustments, or we are in the process of implementing them. In several areas, new legislation and political decisions may be needed, or agreement will have to be reached among the Nordic countries or in the EU.

Conversely, there are areas where it makes sense to wait and see and monitor the work which is being done in the EU and in our neighbouring countries. We need to see which direction they take. Their decisions will affect the Danish electricity market.

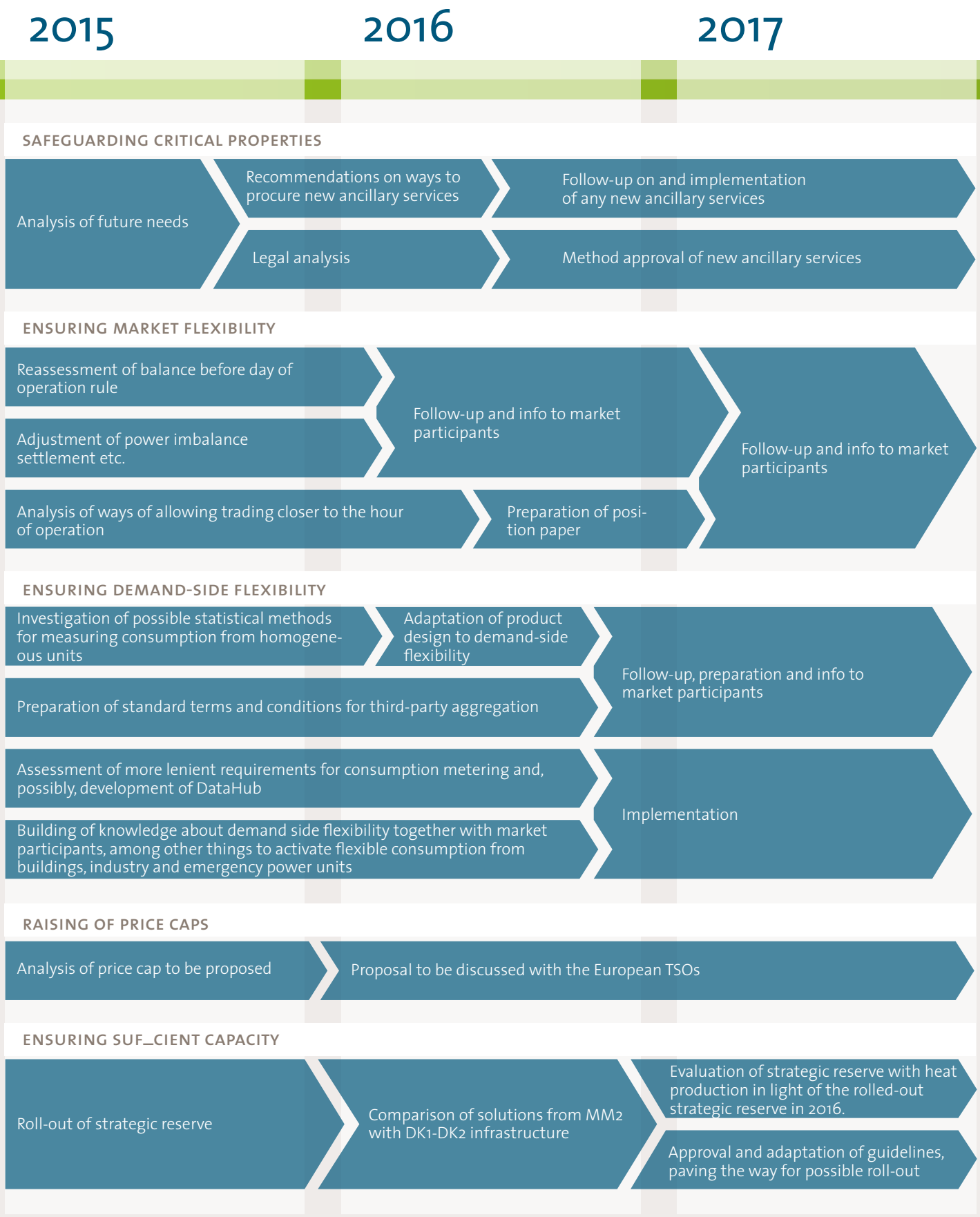
Among other things, there is time to monitor the capacity situation more closely before ultimately making a decision concerning a possible strategic reserve or capacity market in Eastern Denmark. The European Commission is currently looking at the capacity mechanisms in connection with a thorough investigation of the state aid rules, and any decisions made in our neighbouring countries may also have a knock-on effect in Denmark. Moreover, it will be a number of years before the challenges materialise, and there will be time to respond and take the necessary steps – even if developments happen faster than expected. Energinet.dk will be monitoring the situation closely.

(See figure overleaf) The Market Model 2.0 project has identified 24 activities. In the coming weeks and months, Energinet.dk, in cooperation with the rest of the electricity sector and the authorities, will continue working on the proposals, among other things looking at specific cooperation models which may be most conducive to realising the initiatives. The proposed changes are generally expected to be able to resolve the challenges which the existing market design is likely to face. It has only been possible to calculate the economic consequences of the capacity-related: initiatives. Further analyses of, for example, the critical properties – functionalities – will reveal the economic consequences in other areas.

The Market Model 2.0 project has focused on the 2020-2030 period. However, even though a number of changes and initiatives have been presented for the 2015-2017 period which will to some extent decide the direction of developments in the next 10-15 years, the recommended activities cannot solve all the challenges outlined. Today, wind power accounts for 40% of our electricity generation; in 2020, it will account for more than 50% , and in 2030, for even more. Things are changing all the time, new challenges and problems will emerge, and new solutions will be needed. Consequently, developments must be closely monitored and assessed to ensure that our future electricity market is one characterised by competition, innovation and security of supply.

NEXT STEP

THE MARKET MODEL 2.0 PROCESS WILL RESULT IN 24 ACTIVITIES



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