



Strategy Plan 2008

ENERGINET/DK



Strategy Plan 2008

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1. Summary

Current challenges

The energy and climate challenges are receiving increasing political attention and setting the agenda for Energinet.dk's future activities. The broad agreement on Danish energy policy, which was concluded on 21 February 2008, sets the course for Danish energy policy and gives Energinet.dk a number of new tasks. Similarly, the EU's coming climate and energy packages set a new agenda for Energinet.dk's international activities, including the collaboration with other TSOs.

Since Energinet.dk was established in 2005 and the first strategy plan was published in 2006, the merger and consolidation process has been completed, and Energinet.dk is assuming its responsibility of securing supply, facilitating competition within the energy markets and expanding the infrastructure for electricity and gas.

In the coming years, the most important challenges will be integrating renewable energy and ensuring the future supply of natural gas. Energinet.dk will work to solve these issues through holistic planning which is based on socio-economically viable solutions and which ensures that concerns for security of supply, the environment and an efficient energy market are properly addressed.

Energinet.dk also works to establish closer and more binding international cooperation. Even though Energinet.dk is a relatively small TSO, Energinet.dk and Denmark have a unique opportunity to ensure Danish influence on the international framework conditions in connection with the current restructuring and new ways of cooperating among European TSOs.

Integrating renewable energy

In the coming years, the share of renewable energy in the energy systems is to be increased significantly. In Energinet.dk's view, integrating intelligent electricity, heating, gas and transport systems is vital to ensure that renewable energy is utilised in a smooth and financially expedient way. The energy system of tomorrow must be efficient and flexible so that renewable energy can be used where it is most cost-effective.

It will be necessary to focus on energy-efficient solutions to achieve the objectives of fossil fuel independence. Electricity-based solutions are characterised by high efficiency, and in both the heating and transport sectors, electricity can be converted efficiently and flexibly. Integrating renewable energy into the electricity sector and using electricity in other sectors will thus be central in the coming years.

At the same time, it is important to focus on flexible solutions, as a high level of demand response offers optimum opportunities for using wind power. The challenge will be to optimise the interaction with the heating sector and utilise the potential of electric vehicles to bridge the gap between the electricity supply and the transport sector. Integrating electricity into the heating and transport sectors will become an important element in reducing CO₂ emissions in the sectors, which are not included in the EU's emission trading scheme and as such subject to fixed national reduction targets.

Furthermore, expansion of the infrastructure – both nationally and internationally – will also play a significant role in future. An internationally coherent, well-developed infrastructure and wellfunctioning international energy markets are essential to the integration of renewable energy.

Ensuring future natural gas supply

The biggest challenge within security of supply in the natural gas system is the accessibility of gas. In the near future, Denmark will no longer be self-sufficient in natural gas from the Danish part of the North Sea.

Despite investments in renewable energy, Energinet.dk expects that non-renewable energy sources will be in demand for many years to come.

Natural gas is an obvious fuel to supplement renewable energy as natural gas consumption emits significantly less CO₂ and fewer particles than coal and oil consumption. In addition, gas-fired units generally have better regulating properties and are thus more suitable for an electricity system with large wind power production.

Energinet.dk is therefore in the process of establishing a new infrastructure which will ensure continued access to natural gas. It will also contribute to supply diversity and market integration at European level as well as ensure utilisation of the large socio-economic investments which Denmark has made in the natural gas grid.

2. Introduction

Since Energinet.dk was established in 2005 and the first strategy plan was published in 2006¹, a number of significant changes have occurred in the world around us. The global climate challenge is larger than ever before, and climate and energy policies are high on the political agenda, both in Denmark, the EU and globally. Ambitious goals are being set up for reducing CO₂ emissions and for the increased use of renewable energy.

Strategy Plan 2008 thus focuses on the importance of the climate challenges for the energy policy and the resulting challenges. Energinet.dk plays an important role in relation to implementing the political objectives and contributes actively to creating holistic and robust solutions in order to develop the energy system. Energinet.dk ensures consistency between the political objectives, the company strategy and the continuous development of the electricity and gas systems, thereby ensuring that the objectives can be translated into specific solutions and implemented in due time.

The overall challenge for Energinet.dk in the coming years will be to further develop the electricity and gas infrastructure, taking into account the goals of having an even better market function, a high level of security of supply, the efficient integration of larger amounts of renewable energy, more environmental awareness and socio-economic viability.

The strategy plan highlights the future strategies for the following areas: security of supply, infrastructure and the market for electricity and gas. The environmental and climate concerns, including the ob-

jective of integrating increasing amounts of renewable energy, are an important and integral part of these areas. The Strategy Plan will be revised and updated continuously in relation to changes in the overall political objectives and as the technologies are developed and mature.

As regards electricity, the focus is on integrating renewable energy into the electricity system, including large amounts of wind power, and the future principles of establishing transmission lines in Denmark.

On the gas side, the focus is on ensuring new supply routes for natural gas and on the possibilities for phasing in biogas in the natural gas grid.

The strategy plan also includes examples of how the PSO- and tariff-financed research and development (R&D) programmes support the energy-political agreement.

Chapter 3 describes the central strategic climate and energy challenges that Denmark is facing. Chapter 4 emphasises the importance of intelligent energy systems and describes how a combination of different means could meet the challenges. Chapter 5 addresses specific strategies for electricity, and Chapter 6 describes specific strategies for gas.

2.1 Mission and vision

Energinet.dk is leading the way in finding solutions which can contribute to realising the ambitious climate and energy-political objectives. At the same time, the increased internationalisation

of the energy policy and the energy sector emphasises a need for these solutions to have an international platform.

This is now reflected in the company mission and vision in that they have been revised in relation to the formulations that were laid down in 2006.

Mission

The mission describes Energinet.dk's *raison d'être*.

In order to meet the future challenges, the mission's focus on the system operator tasks has been increased, and the task in relation to integrating renewable energy has been explicitly addressed. Energinet.dk's mission:

As the entity responsible for the electricity and natural gas systems we own the overall energy infrastructure, ensure reliable energy supply and create the framework for well-functioning energy markets and effective integration of renewable energy

Vision

The company vision describes 'Where are we going?'. The new vision reflects the fact that Energinet.dk is taking a leading role in relation to identifying and implementing solutions which can support Denmark's energy and climate policy objectives:

Using international and preferably market-based solutions, we will facilitate the increased use of renewable energy and help to solve the global energy and climate challenges

¹ Energinet.dk's first Strategy Plan 2006 focused on the strategic challenges in relation to ensuring a positive merger process and defining Energinet.dk's role in relation to the rest of the world. The merger and consolidation process has now been successfully completed.

3. Energy and climate

The increased focus on climate and energy matters and the fact that the energy sector is undergoing considerable changes – in Denmark as well as in the rest of Europe, have given Energinet.dk new strategic challenges. These challenges concern both the integration of renewable energy and the wish for more binding international cooperation and closer integration of the European electricity and gas markets.

3.1 Energy-political framework

The energy-political objectives increasingly focus on the climate challenges, including initiatives for reducing CO₂ emissions and increasing the use of renewable energy.

The broad agreement on Danish energy policy, which was concluded on 21 February 2008, sets the course for Danish energy policy and gives Energinet.dk a number of new tasks. Similarly, the EU's coming climate and energy packages, including the third liberalisation package, set an entirely new agenda for Energinet.dk's international activities, including the collaboration with other TSOs.

3.1.1 The EU – targets impacting Energinet.dk

The EU's coming climate package lays down binding targets for the share of renewable energy and a reduction in CO₂ emissions, among other things. These targets will be a significant indicator for

Energinet.dk's activities in the coming years and will have a major impact on the Danish energy system, both in the electricity, gas and heating sectors and in the transport sector.

By 2020, total CO₂ emissions in the EU must be reduced by 20 per cent compared with the level in 1990. In the EU, emissions must be reduced by 21 per cent in the sectors which are included in the EU's emission trading scheme and by 10 per cent in the sectors which are not included in the scheme. For Denmark, according to the suggested burden-sharing principles, this will mean a 20 per cent reduction in the sectors which are not included in the EU's emission trading scheme. The largest emissions come from the agricultural and transport sectors. It will therefore be obvious to focus on increasing the use of renewable energy in the transport sector and increasing the production of biogas to reduce agricultural methane emissions.

By 2020, the share of renewable energy in the EU must constitute 20 per cent of the final energy consumption², and the goal for Denmark is 30 per cent compared with 17 per cent in 2005.

With the EU's third liberalisation package, new and more binding cooperation will be established for the European TSOs. More specifically, the European Network of Transmission System Operators (ENTSO) will be created for electricity and gas, respectively. ENTSO must prepare common European rules and standards and thereby contribute to an

ever closer integration of the European electricity and gas markets.

Energinet.dk is contributing actively to the establishment of ENTSO (electricity) and will continue to play an active role once the organisation has been set up. Acting as an intermediary between two synchronous areas, the UCTE and Nordel, Energinet.dk will work to increase harmonisation in the new European association.

In November 2008, the European Commission presented its second strategic energy review which outlines the EU's energy prioritisations for the coming years. Overall, the report focuses on security of energy supply, and the Commission has identified five areas which will require additional efforts to secure energy supplies in future: 1) subsidies are needed to support the establishment of demanding energy infrastructure; 2) there is focus on the EU's international relations, including relations with supply and transit countries; 3) focus will be on mechanisms that can handle any disruptions of the electricity and gas supply; 4) speedier and more efficient efforts are required for improving energy efficiency in the EU; and 5) improved utilisation of the EU's own energy resources is required – including renewable energy sources and fossil fuels.

Six prioritised infrastructure actions have been proposed, two of which involve Denmark. For Denmark, it is of particular importance how the expansion of the infrastructure for wind turbines in the North Sea (the so-called North Sea

² The EU and Denmark use two different methods for calculating the share of renewable energy. The EU uses the final energy consumption whereas Denmark uses the gross energy consumption. In short, the difference between the two calculation methods is that the EU does not include the energy which is lost in the production of electricity and heat. The target of a 30 per cent reduction in the final energy consumption corresponds to a reduction of 26.8 per cent in the gross energy consumption.

Offshore Grid) is planned in collaboration with the other EU countries. Furthermore, it is important for Denmark how the plan for interconnecting the infrastructure in the Baltic Sea region (the Baltic Interconnection Plan) will influence future investments in the Danish transmission grids for electricity and gas. The Commission's aim is for a detailed plan to be prepared in 2009 and for the implementation process to start in 2010.

3.1.2 Denmark – objectives impacting Energinet.dk

The focus of the energy-political agreement of February 2008, which applies to the period 2008-2011, is that Denmark's fossil fuel dependency is to be reduced. As a consequence thereof, a goal has been set that 20 per cent of gross energy consumption will be covered by renewable energy in 2011.

In addition to increasing funding for land-based wind turbines, it has been decided to invite tenders for a new 400 MW offshore wind farm for commissioning in 2012. Energinet.dk recommends that a long-term plan for the siting of coming offshore wind farms be prepared. In this way, it will be easier to ensure that the energy-political objectives can be met in time and in a cost-efficient way.

The focus of the energy agreement is furthermore to increase the utilisation of the Danish biogas resources, and the subsidies for electricity production based on biogas have thus been increased. Biogas-based energy production is expected to increase from approximately 4 PJ a year to 12 PJ a year. Biogas has several applications. One of the options is to use biogas in CHP plants to replace natural gas. This could also create a demand for transporting the biogas over longer distances than is the case today, as local heating requirements can limit the demand for biogas. Energinet.dk is

working to enable the transport and sale of biogas via the gas transmission grid.

3.2 Current strategic challenges

Energinet.dk is facing a number of specific strategic challenges that stem from the increased political focus on climate and energy issues. In addition, there are strategic challenges of a more general nature which must be addressed by both Energinet.dk and businesses in other sectors.

Energinet.dk is leading the way and proactively supports the environmental and energy-political objectives. Energinet.dk is therefore working in a targeted way to ensure that the different energy systems complement each other. In Energinet.dk's view, integrating electricity, heating, gas and transport systems is vital to ensuring the flexible and efficient utilisation of renewable energy. The future energy system must be efficient and flexible so that renewable energy can be used where it will be most cost-efficient.

Thus, Energinet.dk does not focus exclusively on the electricity and gas systems, but also assumes a level of responsibility, together with the relevant players, in relation to integrating renewable energy into the heating and transport systems. Not only does this fulfil the expectations of Energinet.dk from society at large, it also contributes significantly to meeting the specific challenges within the electricity and gas areas.

3.2.1 Integration of wind power

In combination with previous agreements, the energy-political agreement of February 2008 means that, before the end of 2012, approximately 1,300 MW of additional wind power capacity will have to

be installed in Denmark. This corresponds to a 40 per cent increase over a period of four years compared to current capacity.

This presents Energinet.dk with a number of challenges in relation to both the 'connection task' and the 'integration task'. In relation to grid connection, Energinet.dk plans to connect three offshore wind farms to the grid³. This translates into a considerable number of construction projects, not least in 2009 and 2010 when all three grid-connection projects are expected to be underway at the same time.

In relation to the technical and market integration of the new wind power production, the ambitious expansion also presents a number of challenges. No doubt an integration of the electricity, gas, heating and transport sectors is necessary to ensure security of supply and the market function at the same time as effective use of the large amounts of wind power. Energinet.dk's main challenge will be to optimise the interaction with the heating sector and to utilise the potential of electric vehicles to bridge the gap between electricity supply and the transport sector.

3.2.2 Carbon capture and storage

As part of the EU climate package, a CCS (Carbon Capture and Storage) draft directive is currently being considered. In the sector, there are general expectations that CCS will become a relevant technology for CO₂ reduction in the long term. Energinet.dk is therefore closely monitoring the extent to which this technology is used.

Energinet.dk is participating in the EU cooperation ERA-NET FENCO-ZEPP which completed a joint call for projects this spring regarding analyses and investigations to pave the way for the CCS. Priority has been given to a project in which

³ Including the two ongoing projects – Rødsand 2 and Horns Rev 2 – as well as the new 400 MW Anholt offshore wind farm which has been approved.



Risø DTU National Laboratory for Sustainable Energy and GEUS (Geological Survey of Denmark and Greenland) are participating. Other project participants include operators from the Netherlands, Germany and Norway, and the project is to examine the potential for storing CO₂ in Utsira in the North Sea. The project will start in 2009.

If there is a political desire to use CCS in Denmark, Energinet.dk will be able to assume a role in relation to transmission and possibly also storage. It would only be natural to use Energinet.dk's expertise from constructing and operating the natural gas grid as well as from handling regulated activities.

Energinet.dk is also monitoring the work performed in other EU forums in relation to Zero Emission Power Plant (ZEPP).

3.2.3 Increasing internationalisation

The challenges in relation to energy and climate policies are international, and the best solutions must to a great extent be developed in international collaboration. Whether the issue is integrating renewable energy, developing well-functioning markets or strengthening the security of supply within the electricity

and gas sectors, the solutions must increasingly be found in an international setting. This is attributable not least to the fact that the EU is also focusing intensely on climate and energy policies.

In relation to several of Energinet.dk's core tasks, it is vital that the company is able to influence international decision-making processes in a direction which ensures that Danish interests are safeguarded and which positions Energinet.dk in connection with the expected consolidation among European TSOs. Energinet.dk has therefore intensified its international cooperation within a number of areas.

Energinet.dk is also working to establish closer and more binding international cooperation. Even though Energinet.dk is a relatively small TSO, Energinet.dk and the Danish state have a unique opportunity to ensure Danish influence on the international framework conditions in connection with the current restructuring and new ways of cooperating among European TSOs.

3.2.4 Growth in the energy sector

The energy sector is generally experiencing growth. In its relatively short life,

Energinet.dk has also experienced considerable growth in its tasks, among other things through its acquisition of part of DONG Energy's 132 kV grid and its acquisition of the natural gas storage facility in Lille Torup. In addition, Energinet.dk has been assigned a number of administrative tasks and PSO tasks in connection with the energy-political agreements.

In the coming years, Energinet.dk expects to continue to manage an increasing number of tasks – both in the form of expansions within its existing activities, such as the construction or acquisition of more infrastructure within gas and electricity and in the form of new tasks, as was the case in connection with the acquisition of the natural gas storage facility.

Among Energinet.dk's customers, market players and other stakeholders, there are high expectations that Energinet.dk will work proactively to improve the infrastructure and market integration within the gas and electricity areas.

Energinet.dk is therefore continuing to focus on maintaining a scalable organisation to ensure that preparing for and taking on new tasks run as smoothly as possible.

4. Integrated planning of energy systems

The political objectives for the increased use of renewable energy place considerable demands on the development of the electricity and gas systems and on an integration of the energy systems:

- The handling and efficient utilisation of wind power will in future pose an even bigger challenge to Energinet.dk than is the case today. It is therefore important to focus on the potential for increased integration of wind power within the transport and heating sectors. It must be ensured that the increasing amounts of wind power can be integrated into the electricity system while maintaining security of supply and developing the market function.
- For many years to come, natural gas will continue to be a supplement to renewable energy, but the possibilities of transporting biogas in the natural gas system must also be explored. These issues are addressed in more detail in Chapter 6.

If the ambitious, long-term objectives for reducing greenhouse gases are to be realised, it will require a wide range of solutions within the energy sector. These solutions both include activities that have been focal points for many years, eg energy savings and increases in energy efficiency, but also areas that have become relevant in step with technological development, eg carbon capture and storage, demand response, electric vehicles' use of electricity in the transport sector, and use of heat pumps and electric boilers in the heating sector.

Furthermore, expansion of the infrastructure – both in Denmark and internationally – will continue to play a significant role. An internationally coherent, well-developed infrastructure and

well-functioning international energy markets are essential to the integration of renewable energy.

Increased incentives for wind turbines to react to price signals and the geographic location of offshore wind farms will also constitute important supplements to the interconnections with a view to balancing the electricity system.

In the long term, Energinet.dk estimates that increased use of domestic means and integration with other sectors will be necessary to obtain a balanced electricity system. Energinet.dk is therefore taking a targeted approach to ensuring that the many different means can be brought into play on market terms.

4.1 Means of integrating wind power

Wind power potentials are high in Denmark. Utilising wind power production in other sectors is thus an important condition for making Denmark independent of fossil fuels in the long term. Energinet.dk is endeavouring to ensure that the means used to integrate wind into the electricity system also support the integration of electricity (which will be based increasingly on renewable energy) into the heating and transport sectors.

If the objectives for fossil fuel independence are to be met, it will be necessary to focus on energy-efficient solutions. Electricity-based solutions are characterised by high efficiency. In the heating and transport sectors, electricity can be converted efficiently and flexibly. Energinet.dk therefore believes that integrating renewable energy into the electricity sector and using electricity in other sectors will be central in the coming years.

At the same time, it is important to focus on flexible solutions as a high level of demand response offers optimum opportunities for using wind power.

The different means have different time horizons. This is illustrated in Figure 1 which also shows whether the primary purpose of the means is balancing the electricity system or integrating electricity in other sectors.

The many different means require a holistic strategy which can ensure interaction and flexibility between the different technologies. Thus, the total potential of the solutions for supporting the political objectives is utilised in the best possible way. Energinet.dk therefore prepares holistic means analyses that consider the mutual impact of the different technologies and the infrastructure. The main challenge will be to optimise the interaction with the heating sector and to utilise the potential of bridging the gap between electricity supply and the transport sector.

4.1.1 Electricity storage

In future, electricity storage can become highly significant as a method of balancing the electricity system, but it requires that the existing technologies are further developed – in particular with respect to efficiency and economy. Electricity storage ensures better wind power utilisation and increases security of supply. In the short term (seconds and minutes), electricity storage facilities can supply necessary ancillary services, whereas long-term storage (hours or days) also contributes to ensuring a well-functioning market; storage stabilises the price formation and reduces peak-load production requirements.

	Short term	Medium term	Long term
Primary focus on: Balancing the electricity system	<ul style="list-style-type: none"> • Expanding interconnections – cross-border trade in electricity • Reinforcing and expanding existing electricity grid • Downward regulation of production using negative spot price option 	<ul style="list-style-type: none"> • Geographic location of off-shore wind farms • Demand response • Flexible electricity production 	<ul style="list-style-type: none"> • Electricity storage in hydrogen • Compressed air energy storage • Electricity storage in batteries
Primary focus on: Integrating electricity into other sectors	<ul style="list-style-type: none"> • Heat pumps in CHP plants • Electric boilers in CHP plants 	<ul style="list-style-type: none"> • Heat pumps in private households • Plug-in hybrid cars • Electric vehicles 	<ul style="list-style-type: none"> • Use of (electrolysed) hydrogen in the transport sector • Use of (electrolysed) hydrogen in the gas grid

Figure 1 Means of integrating wind power.

As a result of the common Nordic electricity market and the well-developed interconnections, the Norwegian, but also the Swedish hydropower plants, function as storage facilities for the Danish electricity system. The interconnections can thus be compared to a storage facility in Denmark.

Different electricity storage technologies are also available. Some storage types are capable of long-term energy storage while others are primarily used for short-term storage. Many storage technologies also offer ancillary services necessary for the operation and balancing of the electricity system. In analysing future storage technologies, reducing the overall loss is an important issue.

Energinet.dk is involved in a number of development projects within electricity storage. The most relevant storage methods in Denmark are (in random order): the further expansion of the interconnections with Norwegian hydropower, CAES storage⁴, batteries as well as reversible fuel cell systems. Energinet.dk supports

R&D activities for developing and identifying possible storage technologies.

4.1.2 CO₂ reductions in sectors not included in the EU's trading scheme

The integration of electricity into the heating and transport sectors play a key role in reducing CO₂ emissions in the sectors which are not included in the EU's emission target scheme.

The technology for integrating electricity into the heating sector is well developed, and both electric boilers and heat pumps constitute commercial technologies. However, heat pumps are significantly more energy-efficient and flexible than boilers. Heat pumps used in small units which, for example, replace an oil burner, are financially attractive solutions today. Heat pumps in larger district heating systems are an energy-efficient and socio-economically attractive way of reducing society's dependence on fossil fuels for heating purposes.

There is a high CO₂ reduction potential associated with using heat pumps and, at the same time, it will offer demand response to a great extent, which in the long term will be more valuable in connection with balancing wind power in the electricity system. A greater extent of demand response will also yield a number of advantages in connection with utilising hydropower and wind power in the surrounding areas to which the interconnections provide access.

Expanding areas supplied with district heating offers the potential for replacing fossil fuels used in individual oil and natural gas burners. Converting district heating to renewable fuels will enable efficient utilisation of biomass resources, industrial surplus heat and biogas – either in the form of pure heat production or CHP. This could be combined beneficially with individual, electricity-based household heat pumps in areas where district heating, CHP and natural gas have not been profitable.

⁴ Compressed Air Energy Storage. The storage facility uses compressed air which is stored underground. The compressed air is used in conjunction with natural gas to run a gas turbine.

Electricity for transport offers considerable potential for superseding fossil fuels and thus CO₂ from a sector which is not included in the EU's emission trading scheme. Electric vehicles offer the greatest potential in the transport sector. The growth of electric vehicles is expected to follow several tracks; partly plug-in hybrid cars that both have a battery and a combustion engine and partly 100 per cent battery-powered electric vehicles.

Energinet.dk is working to ensure an open and robust system in Denmark which can support many electric vehicle models and several development tracks. This requires developing the infrastructure in the form of the electricity system, a communications system and a market-based settlement system. The communications system must ensure the intelligent use of electric vehicles to make them a significant means of balancing wind power and reducing CO₂ emissions. Energinet.dk is actively involved in several electric vehicle projects and supports a targeted Danish effort in this area through R&D funding.

When analysing the means, it is thus important to focus both on integrating wind power into the electricity system and integrating electricity into other sectors. Both means must be put into play in realising the overall goal of fossil fuel independence. For Energinet.dk it is therefore not a question of either focusing on means the primary purpose of which is to ensure balance in the electricity system, or means the primary purpose of which is to integrate electricity into other sectors. The future will require that many means each contribute to meeting the climate targets.

The development and the spread of technologies that support the above-mentioned means must be realised through market-based solutions. A vital element in this connection will therefore be listing the framework conditions which will promote the development of the market-based solutions.



4.2 Control and regulation

With large amounts of renewable energy in the electricity system and new consumption types, there will be an increasing need for measurement, regulation and control which will ensure efficient utilisation of the electricity system resources, in relation to both market and operation.

The headline for the electricity system of the future is SmartGrids. The vision for SmartGrids is to ensure an electricity system which is perfectly balanced in terms of the environment, market service and security of supply. This means integrating renewable energy through demand response and new technologies. To realise this vision, the electricity system must be developed with communications and IT systems. In the EU, the USA, Canada and Australia, the electricity system is being developed so that it can utilise all connected resources in an intelligent, robust and optimum way. This applies to both small and large resources on the production and the consumption side.

The SmartGrids work is based on different national perspectives. A number of countries use SmartGrids to ensure better balancing between consumption and production to prevent breakdowns.

In Denmark, however, it is the possibility of integrating large amounts of wind power as well as ensuring efficient operation of the electricity system that spur the interest.

Energinet.dk works with SmartGrids under the auspices of the EU. Energinet.dk participates in a number of working relationships and heads the EcoGrid Europe project. In Denmark, the SmartGrids work is conducted in the form of the Cell project and the future vision of 'Electricity System 2025'.

Energinet.dk therefore intends to develop concepts for intelligent control, regulation and monitoring of the electricity system which enable optimum integration of 50 per cent renewable energy. The concept must be a future-proof solution which ensures that the highest possible proportion of electricity producing and consuming units as well as relevant grid components actively contribute to solving operational tasks. This applies from the individual operational second and up to active participation in current and future markets.

In order to strengthen the development of intelligent control and regulation of the electricity system and associated communications and IT technology, consumption and production must automatically be able to react to market signals. Whereas other countries focus on preventing electricity system breakdowns through remote control, the challenge of the Danish electricity system lies in integrating more renewable electricity and being able to react to price signals.

Energinet.dk therefore collaborates with the various players in the electricity sector to develop open-standard solutions and free market participation for both producers and customers. Furthermore, the R&D programme ForskEL has increased the level of focus on developing the technologies which are necessary in order to control, regulate and measure the electricity system in future.

5. Electricity

Energinet.dk is helping to make Denmark less dependent on fossil fuels by ensuring the necessary expansion of the electricity system to enable the integration of large amounts of renewable energy. Denmark functions as a market hub between the Nordic and the European electricity production systems. Energinet.dk will use its position to improve the framework so that, in 2025, the market will support the integration of 50 per cent renewable energy into the electricity system. At the same time, Energinet.dk will ensure a continued high level of security of supply for Danish electricity consumers.

5.1 Security of supply

5.1.1 Security of supply – short term

Energinet.dk works in a targeted way to increase the availability of the existing electricity transmission system. This is done by analysing the components that are particularly critical to the operation of the electricity system with a view to purchasing spare components for these and by optimising the processes for operation and maintenance as well as operational planning.

At least three primary power stations must be in operation today to ensure the stability of the electricity system. Energinet.dk is currently developing new market-based operations strategies that match an electricity system with a significantly increased share of local CHP and wind power production. The goal is to ensure a larger provision of ancillary services and to improve competition among the suppliers. As part of this work, methods are being developed for

utilising the coming Great Belt Power Link for exchanging ancillary services.

5.1.2 Security of supply – long term

Since the liberalisation of the electricity sector, no investments have been made in new, large conventional electricity-generating facilities in Denmark on standard market terms. Uncertainty about the operating pattern in the wake of an expected large-scale wind power expansion is considered to be the main reason for this. However, Energinet.dk believes that the market mechanisms will ensure that investments will be made in the necessary electricity-generating capacity as required. With transparent and long-term framework conditions for the electricity market, which are known by all market players, prices will gradually reach a level at which it will become profitable to invest in new capacity and/or which will lead to initiatives on the consumption side that will ensure balance between production and consumption.

There are several development tracks which will ensure security of supply in the long term:

- Increased capacity abroad and in more countries will give access to resources.
- The life of a number of Danish primary power stations will be extended. Some could have CCS installed which will ensure operation for many years.
- Many of the local CHP plants become active in the market.
- New thermal facilities will be established. This could also happen within the biomass and biogas sectors.
- Via the balance responsible parties, more production and consumption

resources will enter the regulating power and reserve capacity markets.

- More renewable electricity production will be introduced, primarily wind power, but also wave power, photovoltaic cells, etc.

As regards facilities, which can ensure the necessary capacity for upward and downward regulation, 225 MW of new peak-load capacity have been commissioned over the last three years. Furthermore, a number of existing local power plants are making their capacity available for upward and downward regulation as Energinet.dk, via the reserve capacity market, pays an availability fee to ensure the necessary operational reserves.

As it is responsible for the security of electricity supply, Energinet.dk continuously assesses the balance between consumption and production and whether there is sufficient reserve capacity.

5.2 Infrastructure

Energinet.dk's ambition to develop the electricity infrastructure is to design a transmission and distribution system that will meet the future supply and transport requirements. This is based on the expectation that 50 per cent of the electricity consumption will come from renewable energy sources in 2025.

The long-term objective for the Danish electricity grid is to keep it as invisible as possible. Energinet.dk is therefore preparing a plan for a long-term grid structure based on the new political framework for expanding the electricity infrastructure which was laid down in November 2008 on the basis of the Electricity Infrastructure Report from spring 2008.



It was decided that the infrastructure from now on must be expanded in compliance with 'Principle C' of the Electricity Infrastructure Report, which as a general rule means that new 400 kV connections are to be established underground. At the same time, the 400 kV grid's vital backbone down through Jutland will be reinforced by using a tower of a more up-to-date design. This means that the existing row of towers between the Jutland-German border and Tjele will be removed and replaced by a new double-circuit line (two 400 kV systems on the same towers).

The existing 400 kV overhead lines will remain as they are, but the principle opens up for the implementation of projects to improve their visual appearance, involving the replacement of old towers with new types of tower, re-routing and partial undergrounding just as today, giving landscape values as much consideration as possible.

Based on a preliminary nationwide analysis of the environmental impact from existing electricity transmission grids in Denmark, Energinet.dk has identified possible sites in the 400 kV grid where projects to improve the visual appearance could become relevant.

Energinet.dk aims to have two such projects approved by the planning authorities by 2011. As a follow-up on the Electricity Infrastructure Report, Energinet.dk and the regional transmission companies are preparing an overall cable action plan for the 132 kV and the 150 kV grids. Following political approval, the plan will form the basis of detailed planning of the undergrounding process at these voltage levels.

5.2.1 Forthcoming infrastructure projects

The most important planned new constructions and conversions in the electricity transmission grid include the expansion of the Jutland-Norway, Jutland-Germany capacities and the 400 kV Kassø-Tjele line. To this must be added the connection of the coming Anholt offshore wind farm. The Great Belt Power Link, which was approved by the Minister for Transport and Energy in April 2007, is under construction and expected to be commissioned in September 2010.

In May and June 2008, respectively, Energinet.dk's and Statnett's supervisory boards decided to obtain permission

from the authorities to expand the Skagerrak interconnection with a fourth pole for commissioning in 2014. The Skagerrak 4 link will have a transmission capacity of approximately 600 MW and will be connected in Tjele in Denmark and in Kristiansand in Norway.

In February 2008, Energinet.dk and E.ON Netz concluded an agreement on increasing the trading capacity between Jutland and Germany to 1,500 MW and 2,000 MW in the north- and southbound direction, respectively, from 2012. The intention is to upgrade further to at least 2,500 MW in both directions from 2017.

The conversion of the 400 kV Kassø-Tjele power line is scheduled for 2012-2014 by replacing the existing row of towers with a double-circuit tower of a more up-to-date design as described in Principle C of the Electricity Infrastructure Report.

The expansions towards Norway and Germany and the expansions in Jutland will improve the international trading options and reduce congestion between the Nordic countries and the Continent. This will furthermore improve the market function and the sales opportunities for Danish wind power.

In addition to the planned infrastructure projects, a number of other potential projects are being examined. The most important projects include a link to the Netherlands, an interconnection between Denmark, Sweden and Germany in connection with the connection of offshore wind turbines at Kriegers Flak and a 400 kV cable link between Asnæs Power Station and Kyndby Power Station.

Energinet.dk and the Dutch TenneT are examining the possibility of establishing a 600-700 MW DC connection between Jutland and the Netherlands. The connection carries the working title COBRA Cable. A decision to move ahead with an actual construction project is expected by mid-2009.

Energinet.dk, Svenska Kraftnät and Vattenfall Europe Transmission are examining the possibilities of establishing a joint facility connecting offshore wind farms at Kriegers Flak to the grid with an interconnection between the three countries. It is possible that Kriegers Flak could become relevant as a location for the next Danish offshore wind farm after Anholt.

5.3 Market

A significant success factor for Energinet.dk is to ensure a well-run and efficient electricity market. Effective competition is a prerequisite for efficient electricity supply to consumers. The electricity market is characterised by relatively few players on the supply side, which could impede competition, in particular in relation to the supply of ancillary services. Moreover, wind turbines are not active participants in the market. Finally, the demand in the market only depends on the development in prices to a limited extent, which may prove to be a problem for the market function in the long term.

From an international perspective, the Danish electricity market is highly integrated with the markets in our neigh-

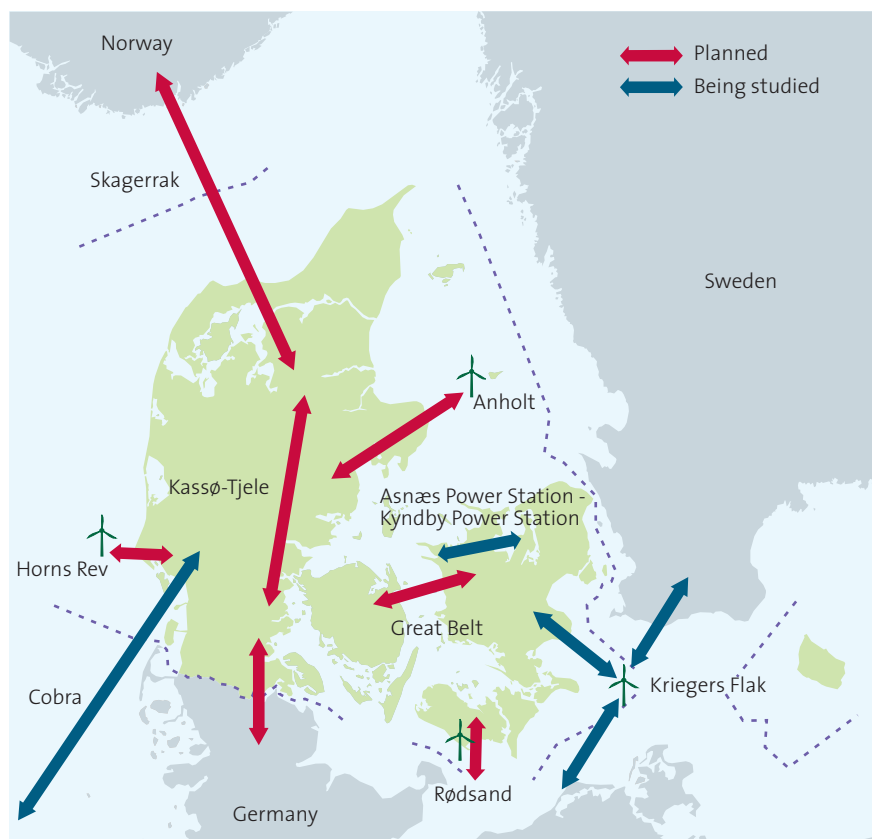


Figure 2 Electricity infrastructure projects – planned and potential projects.

bouring areas. However, there are still a number of interconnections which cannot be handled ideally from a market point of view. This is primarily due to infrastructural limitations, including the relocation of internal bottlenecks to the borders.

With a view to expanding the Nordic market model to the rest of Europe, Energinet.dk is working under the auspices of Nordel to improve the integration of the Nordic electricity market with the surrounding markets even further. In order to harmonise the rules and facilitate a European electricity market where processes and systems flow freely across the borders, Energinet.dk is also focusing on strengthening the planning and operational collaboration with the TSOs in Northern Europe. Energinet.dk is also working to facilitate the establishment of a common Nordic retail market for elec-

tricity, which is an important element in connection with, for example, the ability of households to react to price signals.

In order to develop the market design to be able to integrate increased amounts of renewable energy into the electricity system while maintaining security of supply and a well-functioning market, Energinet.dk is working to promote the active participation of wind turbines and electricity consumers in the spot, intraday and regulating power markets. At the same time, the establishment of several price areas and the creation of a North-European market for ancillary services for the electricity system will be important elements in future. Finally, power station sites for potential investors in new electricity-generating capacity must be made available.



6. Gas

The biggest challenge concerning security of supply in the natural gas system is the accessibility of gas. In the near future, Denmark will no longer be self-sufficient in natural gas from the Danish part of the North Sea.

Despite investments in renewable energy, Energinet.dk expects that non-renewable energy sources will be required for many years to come.

Natural gas is an obvious fuel as a supplement to renewable energy as natural gas consumption emits significantly less CO₂ and fewer particles than coal and oil consumption. Furthermore, natural gas could potentially be used in the transport sector where it can help supersede oil. Finally, gas-fired units generally have better regulating properties and are thus more suitable for an electricity system with large wind power production.

Energinet.dk is therefore in the process of establishing a new infrastructure which will ensure continued access to natural gas. This will at the same time help to ensure a diversity of supply and market integration at European level.

6.1 Infrastructure and security of supply

Danish North Sea production currently supplies Denmark, Sweden, Germany and the Netherlands with natural gas. In the near future, ie around 2015, Denmark will no longer be self-sufficient in natural gas from the Danish part of the North Sea.

Currently, over 300,000 consumption sites in Denmark depend on natural gas, one of the reasons being political agreements. Energinet.dk is thus working to establish a new infrastructure which

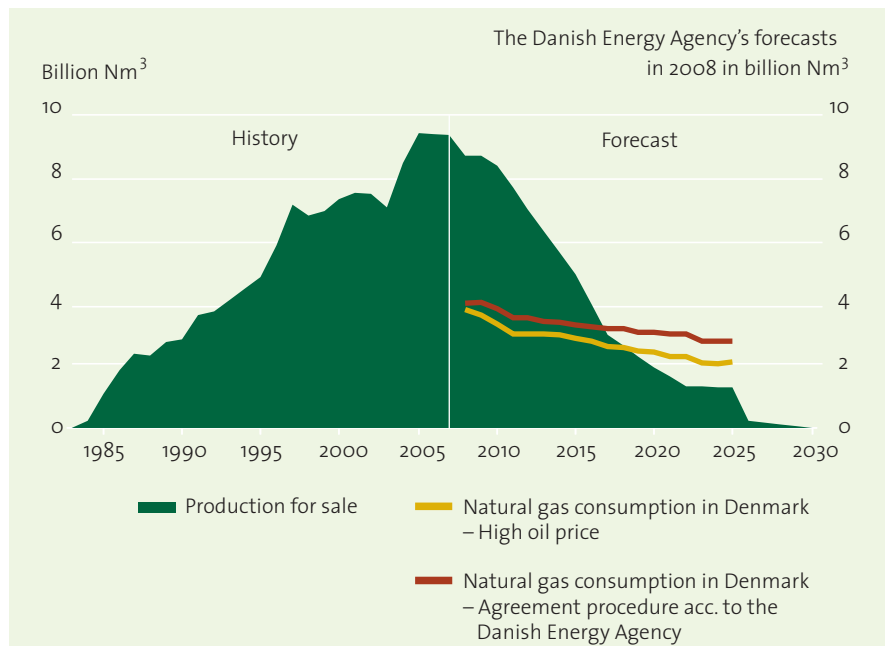


Figure 3 Forecast for natural gas from the Danish fields in the North Sea.
Source: Danish Energy Agency 2008.

will ensure continued access to natural gas – also after 2015. Denmark could thus optimise how it utilises the investments already made in the gas system (transmission, distribution and storage facilities) and at consumers.

New gas pipelines could also contribute to maintaining transit income as a replacement for the current income from gas transport to primarily Germany which is expected to decrease considerably in the coming years. Energinet.dk will examine the market's investment signals through an Open Season process (see below) to determine whether investments should be made to ensure security of supply and supply diversity.

Depending on the level of investment, the Danish gas infrastructure could be on the way within seven years to

becoming a central and integral part of the North-West European gas infrastructure. The Danish security of supply and the competition in the gas market could thus be improved compared to the current situation with only one physical source of supply.

6.2 Coming infrastructure projects

New gas pipelines to Norway and Poland and an expansion of the connections to Germany and Sweden could contribute to the security of supply and support the development of the Danish gas market considerably. This must be seen in the light of the fact that for many years Denmark will continue to be dependent on fossil fuels.



Figure 4 Ongoing project development.

The plans of different market players to transport gas through Denmark (from Germany and/or Norway to Sweden and/or Poland) offer Energinet.dk a current window of opportunity in relation to a number of different expansion projects, including the projects Skanled, Baltic Pipe and the expansion of DEUDAN. Common to all of these projects is that an investment decision must be made in 2009.

6.2.1 Open Season

In order to ensure that the necessary investments are made and to limit the risk of erroneous investments, the European Regulators' Group for Electricity and Gas (ERGEG) has pointed to a market-based mechanism which is intended to ensure the necessary infrastructure expansion. This mechanism is called Open Season. Open Season is based on the commer-

cial market players giving investment signals in an open process by entering into long-term capacity agreements. This ensures that the transmission companies provide the appropriate future infrastructure and that the risk of erroneous investments is limited.

The Open Season process in Denmark will run through 2009 in parallel with similar processes in Norway, Sweden, Poland and Germany. The results of the process in Denmark and the processes in the – potential – neighbouring gas transport systems will thus have a decisive influence on the ongoing development projects. It is expected that long-term transport agreements can be concluded with the shippers in December 2009.

6.2.2 Ongoing project development

Since January 2007, Energinet.dk has been part of the Skanled project – a pipeline running from Kårstø via Rafnes in Norway to Sweden and Northern Jutland. Skanled will also necessitate the establishment of a pipeline from the landing in Northern Jutland to Lille Torup and onwards to Egtved. Skanled is expected to be ready for commissioning in December 2012.

Concurrently with the Skanled project, Energinet.dk is collaborating with the Polish gas TSO, Gaz System, on a pipeline between Denmark and Poland. The so-called Baltic Pipe project will integrate the Baltic areas with the Nordic market. Baltic Pipe will contribute to capacity increase requirements in the Danish transmission system from Egtved to Dragør. The West-East capacity expansion will be carried out by establishing compressor stations in Egtved and Langeskov. In addition, Energinet.dk must establish a compressor station in Avedøre by the Baltic Pipe landing.

Baltic Pipe could be ready for commissioning in 2013-2014 if the Polish PGNiG and other market players can provide an adequate investment signal in both Gaz System's and Energinet.dk's Open Seasons on Baltic Pipe and the resulting necessary expansions of the Danish system, respectively. A Baltic Pipe will be capable of transporting gas to and from Denmark and thereby contribute to supply diversity in both Poland and Denmark.

Finally, Energinet.dk is continuing its dialogue with the owners of the North-German grid (DEUDAN) about the possibilities of supplies from Germany to Denmark. If Denmark is to be capable of importing large quantities of gas from Germany, compression capacity will have to be constructed on either the German or the Danish side of the border. For larger quantities, additional measures are also required in Germany as is a doubling of the section between Ellund and Egtved.

6.3 Market

The gas market continued to undergo significant developments in 2008 which resulted in an improved competitive situation and a number of projects which will improve security of supply.

More than half of total Danish gas consumption is traded in the bilateral trading facility GTF (Gas Transfer Facility). This is a large increase relative to 2007. Since the partially Energinet.dk-owned gas exchange opened in March 2008, it has only offered daily contracts. Trading in daily contracts has been limited but is a good start to the development process which the exchange and the players must undergo before the exchange with a wider product palette can assume a more central role in the Danish gas trade.

There continues to be a lack of firm capacity at the Ellund border point where the capacity in Denmark and Germany is traded according to different principles. Energinet.dk is working to provide an improved mix of capacity products at the border point and to implement an auction model for day-ahead capacity which has been developed together with ERGEG and the Danish Energy Regulatory Authority.

In relation to the gas exchange, Energinet.dk supports its product development. Possible new initiatives include the introduction of long-term products, capacity sales etc.

Finally, Energinet.dk will continue to limit the considerable and low-cost imbalance options in relation to the Danish gas market, which the market players have been offered since 2004 due to the lack of trading options. Energinet.dk is thus in the process of limiting the imbalance options offered thus far to prevent commercial use of these options from wrecking the system. The commercial players must increasingly trade their own imbalances to balance on the gas exchange and thus support the total balance in the system and a transparent price formation.



6.3.1 Biogas

Since the introduction of natural gas from the North Sea, the Danish gas system has enjoyed natural gas of a stable quality. The introduction of biogas or other gases in the gas grid presents a number of challenges as a result of the larger gas quality variations.

Energinet.dk supports R&D within hydrogen, synthetic natural gas, gas from biogasification etc. It will take some time before the above-mentioned technologies can supply gas for large-quantity sales. Biogas, however, is already a technology which, in 2008, supplies 4 PJ of energy in the form of electricity and heat.

The energy agreement of February 2008 has increased the settlement price for biogas used for electricity and CHP production. A threefold increase in biogas production in Denmark towards 2020 is therefore expected. However, the total biogas potential is much higher – up to 40 PJ or approximately 22 per cent of Danish gas consumption. If more of the potential is to be utilised, it is a precondition that the biogas can be sold through the natural gas grid.

The increased quantities of biogas have several applications. Use in CHP plants is an obvious application as power plants could have the option of switching from natural gas to biogas. The gas could also be used in the transport sector as is the case in Sweden, Germany and Switzerland. Finally, the gas could be sold on the gas market. If biogas is to be metered, transported and used in the natural gas system, the biogas must be upgraded. Several players have shown an interest in transporting upgraded biogas in the natural gas system.

Energinet.dk supports R&D in the area via the ForskNG programme. In collaboration with the EUDP of the Danish Energy Agency and the Danish Biogas Association, a review has been initiated with a view to presenting a Danish strategy in spring 2009 for the use of biogas and any R&D requirements identified.

Energinet.dk is working to ensure that the gas system and the market model support the use of biogas in Denmark and international trade via the existing gas system (distribution and possibly transmission). Energinet.dk is working towards making it possible to transport biogas in the gas system in 2010.

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