

Technical University of Denmark



## The Smart Grid Network's recommendations

### Main Report

Vinther, Dorthe; Dreyer, Peter; Troi, Anders; Aagaard, Lars; Tang, John; Nielsen, Søren-Peter; Hjortkjær, Anna-Grethe; Balasiu, Andreea; Høyer, Hans J.; Abildgaard, Jørgen; Madsen, Claus; Jonsen, Bent Ole; Bendtsen, Maja Felicia; Grynderup, Pia; Jensen, Jens Hørup; Strøm, Sune; Andersen, Kim; Togsverd, Tom; Slente, Hans Peter; Østergaard, Jacob; Hauge, Birger; Stubberup, Maria Hillingsøe; Salamon, Martin; Poulsen, Ove; Schultz, Regnar

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DANISH MINISTRY OF  
CLIMATE, ENERGY AND BUILDING

# **MAIN REPORT**

## The Smart Grid Network's reccomendations

# Main Report

## Preface

The government aims for Denmark's greenhouse-gas emissions in 2020 to be reduced by 40 percent compared to 1990 levels. By 2050, our entire supply of energy must be provided by renewable sources. By 2035, our electricity and heating supply must be provided by renewable energy. Oil burners and coal must be phased out of Danish power plants no later than 2030, and half of Denmark's traditional electricity supply must come from wind power by 2020.

The government's goal will require an enormous phase-in of renewable energy, particularly from wind power. Along with the fact that the amount of electricity used for electric cars and heat pumps, for example, will also increase markedly, this presents a major challenge for the electric grid in the long term. If we want to avoid large investments in new cables, there must be a significant effort to promote a *Smart Grid*; that is, a smart electricity network. A Smart Grid is the key to the challenges facing the energy system because it can connect fluctuations in production to consumers' electricity usage.

Last year, the Minister for Climate, Energy and Building established the Smart Grid Network, which consists of a broad range of key players who were set the task of developing recommendations for future actions and initiatives. With these, it will be possible for the electric system to handle up to 50 percent of its electricity from wind power in 2020. The recommendations presented in this report are the results of the Network's efforts.

I see the Smart Grid as an important part of the energy system of the future, and the government supports a strategy for Smart Grid creation in Denmark. The Network's recommendations will provide major input into the development of this strategy.

As the newly appointed Minister, I look forward to further cooperation with all the players involved in developing a Smart Grid in Denmark. I owe a debt of gratitude to all the Network's members, and especially to the chairpersons of the Network's working groups for their particular efforts.

Martin Lidegaard

Minister for Climate, Energy and Building

## The Smart Grid Network's recommendations

With this report, the Smart Grid Network presents nine key recommendations and 35 specific part-recommendations, each of which will contribute to the realisation of a Smart Grid in Denmark by 2020 to be implemented using renewable energy in up to 50 percent of its electricity production. A more detailed review of the part-recommendations is presented in the Issue Papers from the individual working groups in the Network.<sup>1</sup>

An overview of the time prioritisation of the part-recommendations, along with which players have been considered to handle the responsibility for initiating these recommendations, is provided in Figure 1 below.

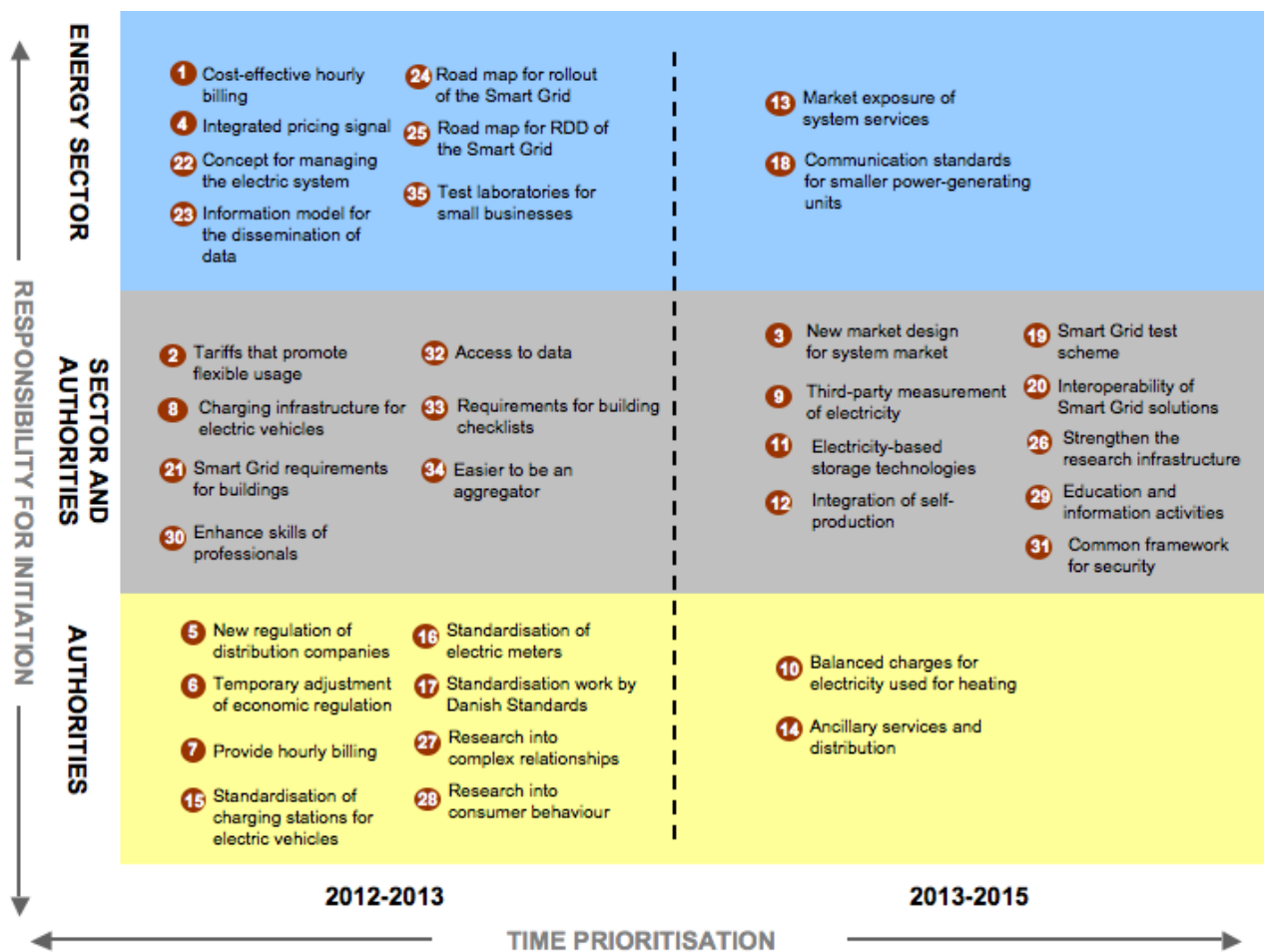


Figure 1. Time prioritization and responsibility for initiating the secondary recommendations

<sup>1</sup> Issue Papers (interim reports) from the individual working groups in the Smart Grid Network are available at [www.KEMIN.DK](http://www.KEMIN.DK)

## Key Recommendation 1: Pricing signals to customers that reflect the value of flexible usage

*Customers should be offered prices that reflect the current costs of electricity usage at a given time so that there is a financial incentive to shift electricity use to times of day when there is excess production and when the grid has spare capacity.*

Charging on an hourly basis is a key requirement if customers and other players in the sector are to realise the advantages for flexible consumption made possible by the Smart Grid.

In order to ensure an economic incentive to adjust electricity usage to times with excess production and spare capacity in the electric grid, it is essential that customers are offered pricing signals that reflect the actual costs of electricity usage at a given time. By offering customers the opportunity to adjust their usage according to actual pricing signals, the capacity of the electric system could be utilized more effectively while at the same time passing on the financial benefits to customers, by optimising the use of electricity in accordance with price variations throughout the day.

Figure 5 shows the typical daily variation in existing usage, marked by the gray area. If the actual pricing signals are not delivered to customers – or directly to appliances – it is expected that much of the new electricity usage resulting from the general electrification of energy consumption will exceed the present so-called “boiling point” in electricity usage. This will create a need for large investments to expand the electric system’s capacity. The idea of offering customers time-differentiated prices is to give them an incentive to adjust their flexible usage – e.g. for heating and recharging electric cars – to times of relatively high renewable-energy production and available capacity in the grid.

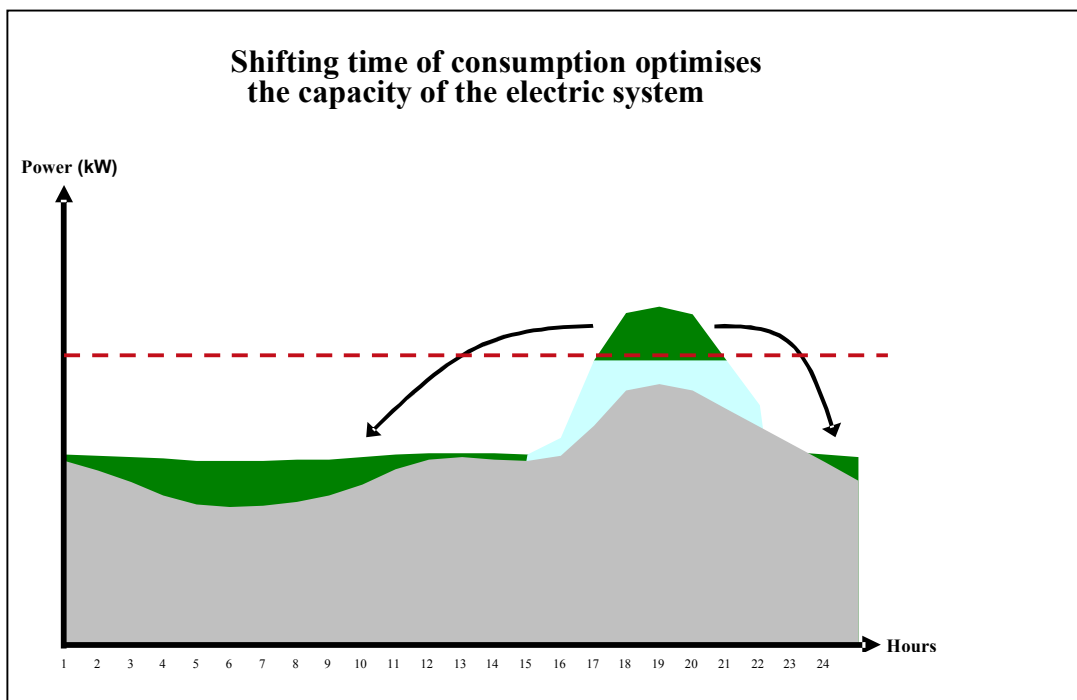


Figure 2. Shifting time of consumption optimises the capacity of the electric system

To accomplish this, all existing as well as future customers with the potential for flexible usage should, at a minimum – and to the extent that this is possible – be charged on an hourly basis. Only then will it be possible for customers as well as other players in the sector to reap the benefits of Smart Grid’s flexible usage. In addition to the customers who are currently being billed hourly (i.e. customers with an annual usage of more than 100,000 kWh), it is expected that small- and medium-sized processing businesses in particular, as well as customers with electric cars and/or heat pumps, will be able to utilise flexible pricing.

Customers who are not charged on an hourly basis have no individual incentive to utilise flexible pricing, since individual customers do not experience any financial effect from changing their consumption habits, i.e. by adjusting their usage to relatively cheap hours. This is currently the case for approximately 2.7 million so-called “template customers” who are charged according to an average-usage template over a 24-hour period. The individual template customer sees no financial benefits from adjusting his or her consumption habits, as any gains in an actual customer’s change in usage is divided among the entire template-customer group. An individual price incentive could technically be achieved by charging all customers according to the principles applied to customers with usage over 100,000 kWh/year. However, charging customers with lower electricity usage in this way would entail high additional expenses for customers and other players in the sector, as specific requirements for the quality of data and particular deadlines for data dissemination apply to customers charged by the hour.

Transmission System Operator (TSO) in collaboration with the Danish Energy Association have been working on the possibility of establishing a new independent billing group for customers with usage metered by the hour (known as the “third billing group”<sup>2</sup>). For this group, adjusted requirements for validation and deadlines could reduce the additional expenses of hourly billing for existing template customers to a level that makes it worthwhile for customers with lower flexible usage to use electricity according to daily variations in prices and tariffs. Furthermore, this would indemnify customers who have limited or no potential for flexible usage.

***Part-recommendation 1 – Establish cost-effective hourly billing for existing template customers with the potential for flexible usage***

Electricity-market regulations should specify a new and independent billing group (“third billing group”) for hourly-rated customers who consume less than 100,000 kWh/year, thus making it possible to charge these customers according to their individual usage profiles. The DataHub ought meanwhile to be updated immediately after its launch to include the new billing group.

The limitations of this kind of billing group mean that a customer’s individual usage profile cannot directly play a part in procurement decisions in the wholesale market nor in balancing the electricity system. Customers can be billed according to their individual usage profiles, but cannot participate directly in the wholesale and regulation market. However, work should be done to ensure that the majority of players in the sector – including customers in the third

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<sup>2</sup> The report “Encouraging price-flexible electricity usage in small- and mid-sized customers” can be downloaded from the websites of both TSO and the Danish Energy Association.

billing group – have a cost-effective way to participate in the regulation market.

*Time prioritisation for part-recommendation: 2012–2013*

*Responsibility for implementation of part-recommendation: The industry specifies the third billing group in the electricity-market regulations, and offers smaller customers (template customers) the opportunity to switch to the new billing group with a real-cost payment.*

Traditionally, the electric grid has been expanded to meet customer demand. The grid has been designed according to its maximum load, and the need for grid expansion is determined by the hour of the year with the largest load. As an alternative, and to the extent that demand for electricity is flexible, the adjustment of usage to time periods with spare capacity contributes to a more effective utilisation of grid capacity; again, see Figure 5.

Offering an integrated pricing signal that indicates the scarcity of production as well as grid capacity could provide substantial economic value to society by promoting flexible electricity usage, whilst providing customers with a financial incentive for using electricity at times with excess capacity in the grid and a high production of renewable energy production.

Tariff legislation, however, does not give distribution companies licence to use time-dependent, long-term cost bases to tariff network services. There is a need for legislative clarification to ensure that distribution companies can organize network tariffs that support flexible electricity usage and meet the basic requirements for objective, transparent and non-discriminatory criteria.

***Part-recommendation 2 – Establish a framework for tariffs that ensures efficient use of customers' flexible consumption in the power grid***

It is recommended that the legislation specifies the possibility to differentiate network tariffs in relation to the expenses customers create in the grid over the long term – for example, by differentiating network tariffs according to capacity. This can help to direct usage away from periods of limited capacity in the grid.

Because future grid planning is dependent on customers' responses to pricing signals, the power companies may face an increased risk in relation to grid planning. In addition to a "basic product," it has been suggested that more specific services should be developed for customers with particular consumption habits. These products should be offered at attractive rates to customer groups in order to accommodate, for example, the potential for interruption, downward regulation, use of electricity at certain times of day, etc.

Finally, it should be possible to unite individual customers and decentralised producers upon individually agreed, transparent and objective terms (e.g. on regulation/ interruption), as far as capacity ratio in specific parts of the grid allows.

*Time prioritisation for part-recommendation: 2012–2013*

*Responsibility for implementation of part-recommendation: Clarification of legislation by*

*authorities. The sector develops new tariff products for its customers.*

In addition to time-dependent pricing signals from the electricity market and from the grid, pricing signals from regulation markets – i.e. from the markets that ensure a balance between production and usage close to and during hours of consumption– further strengthen price incentives promoting flexible usage. Individual customers, however, cannot directly participate in these markets under the present rules for regulating electricity, which are coordinated at the Nordic level. It is unrealistic that Denmark alone should expand the rules to include the opportunity for individual customers who are already billed hourly to directly participate in these markets, despite the existence of a proposal regarding how this could be done. The proposed model suggests that customers who are billed hourly in the existing system could use an online pricing signal from the regulation market (so-called “self-regulation”) to activate and use their potential for flexible usage directly in the regulation market.

***Part-recommendation 3 – Develop a market design that makes it possible for customers to actively participate in system markets***

Together with the Ministry for Climate, Energy and Building, TSO should continue to prioritise the potential for self-regulation in the Nordic electricity-market cooperative and in the Nordic Council of Ministers, including the immediate implementation of Nordic-level trials on self-regulation in line with the proposed model. Trials should be undertaken with regard to determining what kind of challenges would be created by self-regulation for the energy systems (especially in regard to industrial customers’ consumption habits).

It is also recommended that TSO, in collaboration with other players in the market, work actively on developing models that encourage all customers eligible for flexible usage to realise their market potential.

*Time prioritisation for part-recommendation: 2013–2015*

*Responsibility for implementation of part-recommendation: The energy sector work with authorities to prioritise the potential for self-regulation in the Nordic electricity-market cooperative.*

A standardized dissemination of pricing signals should be initiated concurrently, in order for customers, suppliers and service providers to have easy access to data, thus establishing a clear relationship between customer segments, and relevant prices and tariffs.

***Part-recommendation 4 – Provide an integrated, transparent pricing signal to all market players***

The creation of an industry-organized data portal with electricity-market data and other relevant information to ensure a standardized dissemination of pricing signals to customers, suppliers and service providers.

*Time prioritisation for part-recommendation: 2012–2013*



*Responsibility for implementation of part-recommendation: The sector collaborates with the relevant players to establish a data portal.*

## **Key Recommendation 2: New economic regulation of distribution companies' Smart Grid activities**

*A new, modern regulation of distribution companies should be designed, with an emphasis on establishing balanced and positive investment incentives for the rollout of Smart Grid solutions in the distribution system.*

The expected increase in the use of heat pumps and electricity-driven cars in particular creates a need to expand capacity in the grid, so distribution companies will have to make significant investments to provide the necessary distribution capacity for electricity usage in the future. As shown in Figures 6 and 7, a Smart Grid expansion of the grid actually entails two major changes in development strategy. The first change occurs when distribution companies substitute investments in traditional network facilities with investments in new technologies that encourage the optimisation and utilisation of grid capacity, for example through improved metering, monitoring and automation. The second change occurs when flexible usage is activated as a resource in the optimisation of grid capacity; see above, part-recommendations 1–4.

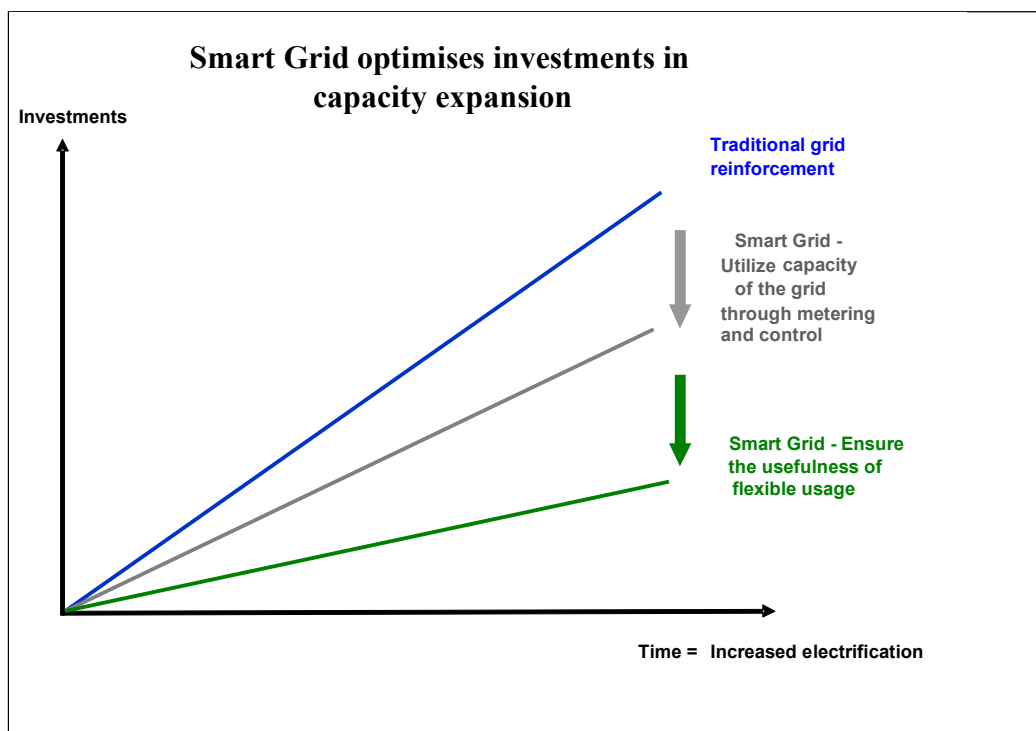


Figure 3. Smart Grid optimises investments in capacity expansion

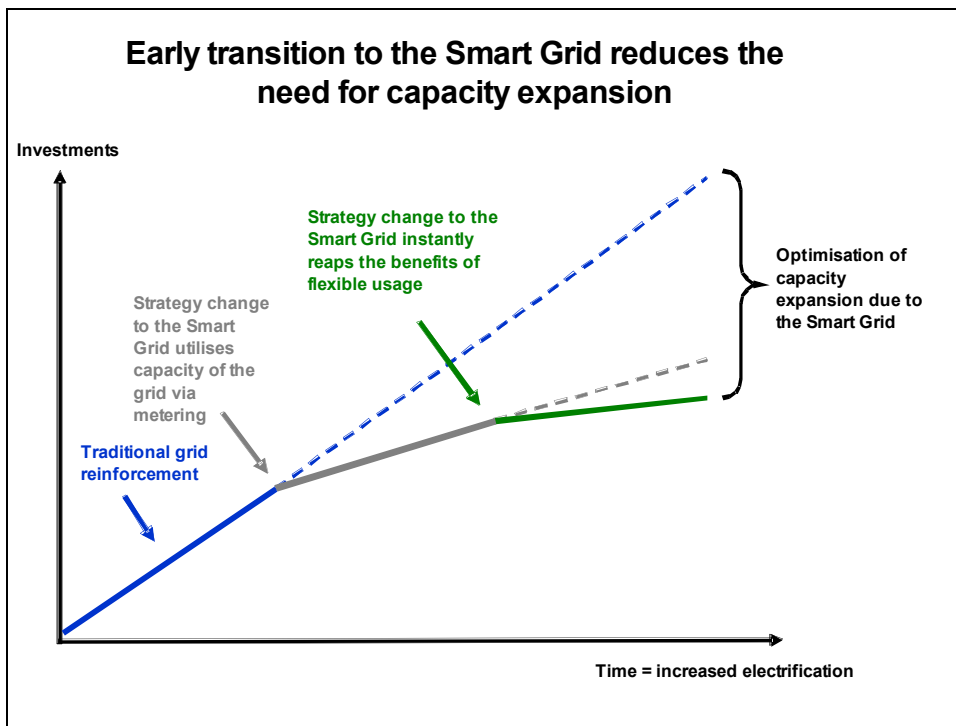


Figure 4. Early transition to the Smart Grid reduces the need for capacity expansion

New regulations should allow and encourage distribution companies to introduce new technologies for the optimisation, utilisation and expansion of grid capacity, including engaging in research, development and demonstration activities that promote Smart Grid solutions. Distribution companies should also be encouraged to balance effectively physical network construction solutions with operational solutions, which entail the active involvement of other sector players on commercial terms. The new regulations should also ensure that distribution companies maintain a normal return on activities, which will attract the necessary capital for Smart Grid investments.

Furthermore, the regulations should ensure that customers without the potential for demand response do not pay more to finance other customers' utilisation of their potential for flexibility.

***Part-recommendation 5 – Develop new regulations to encourage distribution companies to undertake the necessary investments and activities to ensure quality delivery and maximum utilisation of grid capacity in the future***

New regulations should allow and encourage distribution companies to:

- introduce new technologies for the optimisation and utilisation of grid capacity (improved metering and monitoring as well as automation), including engagement in research, development and demonstration activities that promote Smart Grid solutions
- produce an effective balance between engineering solutions and operation solutions that actively involves the stakeholders on commercial terms
- support flexible usage through time-differentiated billing of customers who have the potential for flexible usage
- receive a normal return on activities

*Time prioritisation of Part-recommendation: 2012–2013*

*Responsibility for implementation of Part-recommendation: Authorities conduct studies together with key players in the energy sector.*

Until the new legislative measures are in place, the potential to adjust administrative regulations, etc. within the existing legislative framework should be investigated to ensure that, at the very least, Smart Grid activities operate within the same framework as traditional grid activities.

***Part-recommendation 6 – Introduce temporary administrative initiatives to ensure maximum utilisation of grid capacity within the boundaries of existing legislation***

The definition of so-called “necessary new investments” in regulations that cap revenue should be adapted along with the handling of Smart Grid activities when benchmarking distribution companies. In the short term this would ensure that, at the very least, Smart Grid activities be implemented within the same regulatory framework as traditional grid activities.

*Time prioritisation of part-recommendation: 2012*

*Responsibility for implementation of part-recommendation: Authorities in close cooperation with the electric industry.*

It is the responsibility of distribution companies to meter consumption and to make the relevant data available to electricity customers and other sector players. Before long – expected at the end of 2012 – data dissemination will take place via the DataHub.

Introducing hourly billing to more small customers (so-called “template customers,” who are included in a new third billing group; see part-recommendation 1) will mean increased expenses for the metering and dissemination of consumption data, though to a much lesser extent than the traditional hourly billing of larger customers. It is important then that distribution companies have the potential to recuperate increased meter-data expenses through tariffs offered to customers charged on an hourly basis.

Due to economies of scale, the total cost of creating the new billing group is dependent on the initial number of customers it comprises. It may appear that the focus should be on minimising extra costs per customer, and thereby introducing the new billing form – including the necessary remotely-read meters – to all customers. However, a complete rollout of hourly-based metering and billing would mean increased costs for all customers, while only those customers with the potential for demand response would benefit from the switch.

The question of whether hourly billing should apply to all customers, or only to customers with the potential for flexible usage is one for political consideration, taking into account the costs and benefits for each customer group.

**Part-recommendation 7 – Provide hourly billing of flexible electricity usage below the current obligatory limit**

Clarification is required as to the extent of the introduction of hourly billing for smaller customers (so-called “template customers”) with the potential for flexible usage, as well as how it will be financed.

*Time prioritisation of part-recommendation: 2012–2013*

*Responsibility for implementation of part-recommendation: Authorities adapt legislation that affords distribution companies the potential to recuperate increased metering costs incurred by facilitating hourly billing.*

A prerequisite for the electrification of the transportation sector is the coordinated development of charging stations for electric vehicles. Government initiatives to support the charging infrastructure should be prioritised, while the energy sector works on making it easier to establish a charging infrastructure and on the expansion of business models across supply areas.

**Part-recommendation 8 – Support a charging infrastructure for electric vehicles and coordinate charging stations across distribution regions**

Government initiatives should prioritise investments in a charging infrastructure and in commercial solutions that ensure the intelligent utilisation of the electric system and its grid capacity.

The energy sector should coordinate charging stations across distribution regions, including connection and billing options, whilst continuing to focus on the development of commercial models that ensure the intelligent charging of electric vehicles.

Municipalities should coordinate their standards for public charging stations so that key market players are not met with varying criteria in regard to colour and shape.

*Time prioritization of part-recommendation: 2013–2015*

*Responsibility for implementation of part-recommendation: Authorities should prioritise investments in the infrastructure and in commercial solutions for the intelligent charging of electric vehicles. The energy sector should coordinate charging stations across distribution regions.*

Customers may demand products from commercial bodies that require separate metering and billing of electricity used by one particular appliance. One example could be a heating service where the customer installs the heat pump in his or her home, and the supplier provides the electricity and optimises hourly electric consumption based on the customer’s needs. In this case, it may be cost-effective to set meters in electrical appliances during production, rather than installing a separate meter afterward. Some appliances already contain built-in modules for communication and control,

and the extra cost of automatically combining these with a built-in meter could prove relatively small.

In the future, it may be unnecessary to connect an electric meter to an installation in order to take an individual meter reading of particular electrical appliances. The goal should be for commercial bodies to use their own electric meters to take meter readings (so-called “third-party metering for billing purposes”).

***Part-recommendation 9 – Standardise specifications for the use of third-party metering for billing purposes***

Key players in the sector should collaborate with authorities to study in detail the standardisation of specifications for the use of third-party metering for billing purposes, so that the responsibility for measuring usage and handling basic customer and meter data remains with the distribution company, while commercial bodies perform by agreement the actual administration and handling of billing data. New commercial models and meter readings ought to be administered by the DataHub.

Note that any incorrect meter readings or missing consumption data from third-party measurements ultimately affect the calculated net losses of the distribution companies. The risks for the distribution companies should be analysed and addressed in their financial regulations.

*Time prioritisation of part-recommendation: 2013–2015*

*Responsibility for implementation of part-recommendation: The energy sector should work together with the municipal authorities on how to standardise specifications for the use of third-party metering for billing purposes.*

**Key recommendation 3: Electricity taxes that support an effective electrification**

*The energy tax system should be organised so that electricity customers are given a balanced incentive to switch their energy consumption in the heating and transport sectors from oil, gas and petroleum to a flexible utilisation of electricity.*

There is currently a tax reduction on electricity used to heat permanent residences. Despite this reduction, electricity used for heating is still more heavily taxed than other forms of energy when measured by energy content. This reduces the financial incentive to use electricity to heat rooms, and encourages consumers to opt instead for fossil fuels, which are less energy efficient and more harmful to the environment.

Flexible electricity usage for heating should not be discriminated against and there should be a balanced and unprejudiced incentive for customers to switch their energy consumption in the heating and transport sectors away from oil, gas and petroleum and toward electricity. Taxes should

be further reduced for flexible electricity consumption to heat permanent residences (heating sources with the potential for demand response), including electricity used to heat VAT-registered companies, so that a balance is achieved between tax levels on electricity and fossil fuels. A similar tax reduction should apply to electricity used in transportation.

Any reduction in electricity taxes, however, is expected to provide only limited incentive to use electricity for transportation, since switching energy consumption to electricity in private transportation is associated with high investment costs and relatively low variable costs. With existing prices and tax structures, it is not financially worthwhile for consumers to choose an electric car. Other taxes, including technology-neutral taxes – e.g. differentiated registration costs and green taxes, based on the car's CO<sub>2</sub> emissions – should remain in place so as to encourage the use of electricity for transportation.

#### ***Part-recommendation 10 – Introduce balanced taxes for electricity used for transportation and heating***

Taxes on flexible energy consumption for transportation and in heating permanent residences (heating sources with the potential for demand response), including electricity used to heat VAT-registered companies, should be further reduced to create a balance between taxes on electricity and fossil fuels.

Other taxes, including technology-neutral registration costs and green taxes based on CO<sub>2</sub> emissions from cars, should remain in place to promote the use of electricity for private transportation.

*Time prioritisation of part-recommendation: 2013–2015*

*Responsibility for implementation of part-recommendation: The municipal authorities.*

### **Key recommendation 4: Effective activation of storage and decentralised production**

*A framework should be established to ensure the effective utilisation of storage facilities and decentralised production.*

An important part of the solution to electrifying the transport sector is the effective utilisation of batteries, which also opens up significant future potential for the discharging of power back into the grid. Batteries are thus crucial to the local challenges met by distribution companies in maintaining overall system balance. This includes batteries for charging stations and individual electric-driven vehicles as well as battery systems installed by distribution companies and other actors in the grid. In addition to batteries, other technologies with electricity-based energy storage – for example, pumped-storage hydroelectricity or hydrogen production for fuel cells – can deliver energy back into the system, thus helping overcome balance and capacity challenges.

A framework to maintain the effective utilisation of decentralised storage facilities must therefore be established. Taxes on electricity used for storage devices (batteries, etc.) should be administered so that only the end-use of energy is subject to tax. Otherwise, electricity used for storage devices

will effectively be double taxed; i.e. charges will apply to both storage and consumption. In practice, taxation on electricity used for storage devices should be administered according to the existing rules for the storage of fuels, whereby energy taxes are imposed only upon the end-use of the fuel.

***Part-recommendation 11 – Support the utilisation of electricity used for storage devices (batteries, etc.), using principles from the tax regulation for fuel stockpiles***

Taxation on electricity used for storage devices should be administered according to the existing regulations for the storage of fuels, whereby taxes are imposed only upon the end-use of fuel, thus ensuring that electricity used for storage devices is not taxed twice. In practice, this is done by net-billing, i.e. charging only the electricity used for storage. In this way, energy used in storage is taxed along with production.

Storage devices, including batteries, should pay network tariffs relative to the grid costs incurred by charging and discharging; the same rules should also apply to own-producers over 6 kW.

More research is needed into which specific tariff model and potential model for supporting payments could be used for storage devices, including the charging/discharging of batteries used in connection with renewable electricity production.

*Time prioritisation of part-recommendation: 2013–2015*

*Responsibility for implementation of part-recommendation: It is up to the municipal authorities to administer taxes on electricity used for storage devices in accordance with the rules for the storage of fuels. It is up to the electric industry to determine a set tariff model for storage devices.*

Technological advancements and political initiatives mean that more and more customers are installing small, renewable-energy installations. These own-producers are entitled to net-billing according to the relevant regulations, so that in principle customers only pay taxes and public-service obligation (PSO) costs on the net difference between their consumption and own-production. Nor are own-producers charged an availability fee to cover the grid capacity used in periods when they do not produce electricity themselves.

As own-producers are exempted from taxes and PSO costs for electricity produced for their own use, as well from charges for the distribution and transmission capacity of the grid utilised in periods when they do not produce electricity, this corresponds to a sizeable tax reduction.

A tax exemption for the own-production of electricity is a visible, political demonstration of financial support for own-production. However, exemption from charges for the distribution and transmission of electricity is an indirect and less visible contribution.

***Part-recommendation 12 – Ensure effective integration of own-production (including micro-power/heat) by coordinating terms for utilisation of the power grid***

An integrated framework for decentralised, net-billed own-producers is established across renewable-energy technologies and production capacity, so that the conditions applied to own-producers with net-billed systems above 6 kW are extended to include smaller installations.

In the longer term, an availability fee should be charged for own-producers to cover the network capacity utilised when they do not produce electricity themselves. Alternatively, a separate capacity fee could be charged for this service.

For a limited period of two years, the distribution companies have provisionally decided to waive availability fees for net-billed installations with a capacity under 6 kW; i.e. installations that are charged annually according to net-billing regulations. This initiative should be phased out to create a level playing field regardless of own-production capacity.

*Time prioritisation of part-recommendation: 2013–2015*

*Responsibility for implementation of part-recommendation: Integration of rules for net-billing across renewable-energy production s and capacity by municipal authorities. The electric industry develops network services targeted at decentralised own-producers.*

The supply of ancillary services to the entire electric system, including the balance between transmission and distribution, is provided in several ways. In a future that places different demands on ancillary services and with many potential new decentralised sources, it becomes even more important for this area to be exposed to the market. It becomes harder to find universal solutions that are optimal at all times, in all situations, and throughout the entire electricity system.

Ancillary services can be supplied for appliances connected to the grid. Requirements for production facilities are regulated through connection conditions. Requirements related to the supply of ancillary services, which apply to all production facilities in one particular category, would lead to the costs associated with fulfilling connection requirements being met by everyone. The social-economic cost of such an investment must be weighed against the overall costs and benefits of providing the service in a market that encourages a range of potential suppliers to make an investment. If only some of appliances and facilities that deliver ancillary services are needed, then the market approach could reduce overall investments. It is essential that connection conditions are clear and non-discriminatory whilst indicating a well-defined and logical assignment of roles between TSO and other parties.

***Part-recommendation 13 – Focus on a high level of market exposure of system services***

Parties in the electric industry should remain focused on market exposure of ancillary services as an alternative to, for example, the general requirements for connection conditions. It is essential to optimise market design on an ongoing basis for ancillary services exposed to the market. Both distribution companies and TSO must define their needs as clearly and unambiguously as possible. Going forward, the challenge will be to continuously develop



market design that can handle the new, untraditional resources that a Smart Grid will introduce.

The development and adaptation of market design should be an ongoing process, where both TSO and distribution companies make regular use of their experience, and where investors are confident that the direction is solid, even though the framework is continuously adjusted. Full transparency is particularly crucial in an iterative process within market design and regulation if investors' confidence is to be maintained.

*Time prioritisation of part-recommendation: 2013–2015*

*Responsibility for implementation of part-recommendation: The electric industry prioritises the continual market exposure of ancillary services.*

It should also be ensured that relevant commercial actors are able to allocate ancillary services for both transmission and distribution systems. This means that there must be an opportunity for distribution companies to optimise their operations by purchasing these services at market conditions commercially.

The distribution company is responsible for the regional/local balances in the distribution system. A growing volume of variable decentralised production along with more dynamic consumption increases the stabilisation needs of both the transmission and distribution networks. Today, a wholesale market ensures a “global” balance in the effect and handling of transmission bottlenecks. As it cannot ensure regional/local balance, however, there is a need for services that can be applied to specific areas of the grid in order for services to have the necessary impact on local network operations.

***Part-recommendation 14 – Establish a framework for the commercialisation of ancillary services to the distribution system***

As an alternative to investing in engineering solutions connected to the supply of ancillary services, it should be possible for distribution companies to enter into commercial agreements. The distribution companies' role in handling transmission bottlenecks and voltage regulation should be taken into consideration in the existing/future market model and in the assignment of roles in the electricity market.

*Time prioritisation of part-recommendation: 2013–2015*

*Responsibility for implementation of part-recommendation: The authorities adapt legislation to make it possible for distribution companies to enter into commercial agreements for the supply of ancillary services.*

## **Key recommendation 5: Strengthening of standardisation and interoperability**

*Goals should be instituted to ensure the establishment and implementation of standards of communication between the equipment used by electricity customers and others involved in the electric system. The goal is a plug-and-play future, standardised so that customers can easily install new equipment, including both appliances and small production installations.*

*Furthermore, the electric industry should initiate a coordinated effort to establish a shared road map for the rollout of the Smart Grid. In particular, this should focus on the role of distribution companies and a plan of action for the rollout of a coordinated concept for a data and communication infrastructure to manage the electric system of the future, as well as a consolidated suggestion for the future Danish information model for the electric system.*

The rollout of the Smart Grid is largely dependent on the entering of international agreements on standards of communication between appliances and those in the electric system. Work is taking place within a number of standardisation groups with Danish participation. The Danish position is that the standards should be open and allow customers to easily change suppliers and equipment without being bound to particular producers.

In relation to the standardisation process, one important activity is pre-standardisation, in which research projects are used as a starting point to influence and impact the process. There is a need for national awareness and political initiatives regarding standardisation in areas such as charging stations for electric cars, electricity meters, test facilities for the demonstration of Smart Grid functionality, etc, in order to promote development and to secure Denmark's position in Smart Grid advancement. This is reflected in the following part-recommendations.

At the same time, the interoperability of Smart Grid solutions should be promoted. By using shared open-source software, the integration costs of cohesive Smart Grid solutions are reduced for both existing and new standards. Furthermore, the interoperability between electricity-consuming and electricity-producing appliances in buildings will be promoted by requiring that these be able to communicate with external control signals, including pricing signals.

In addition, a decision should be made regarding Danish requirement specifications for technical services and communication technologies, which must apply to all charging stations installed in Denmark, based on European standards. The Netherlands and Germany have decided their standards, to the benefit of both distribution companies and the electric industry. In 2010, the Danish Energy Association compiled a report about public charging stations that provides a thorough basis for analysis.<sup>3</sup>

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<sup>3</sup> The report "Electric and hybrid cars – interaction with the electric system" can be downloaded from the Danish Energy Association's website (Danish version only).

### **Part-recommendation 15 – Standardisation of charging stations for electric vehicles**

It is proposed that the Climate and Energy Minister assemble a fast-acting working group with representatives from relevant commercial bodies, with the objective of compiling a report by Autumn 2012. This report should contain recommendations for subsequent political agreement regarding Danish requirement specifications (based on European standards) to apply to charging stations for electric vehicles.

*Time prioritisation of part-recommendation: 2012–2013*

*Responsibility for implementation of part-recommendation: The authorities.*

In addition, a decision should be made about the Danish requirement specifications (based on European standards) for the technical services and communication technologies that at the very least are to apply to the new electricity meters – so-called Smart Meters – to be installed in Denmark. Several countries have already entered into similar national agreements with distribution companies that should ensure high standards in the future. The Danish Energy Agency has compiled several reports on the subject that can provide a basis for this.

### **Part-recommendation 16 – Standardisation of electricity meters**

The Minister should assemble a fast-acting working group with representatives from relevant commercial bodies, with a view to compiling a report in Autumn 2012 containing recommendations for subsequent political agreement regarding Danish requirement specifications (based on European standards) that will apply to new electricity meters.

*Time prioritisation of part-recommendation: 2012–2013*

*Responsibility for implementation of part-recommendation: The authorities.*

It is important that the private foundation Danish Standards continues to host working groups and spearhead Denmark's participation in the international standardisation process. In order to promote the development of standards in areas related to the Smart Grid, it is necessary to strengthen Danish Standards' mandate and with it the opportunity to include more Danish businesses, trade organisations and consumers in this process. At present, much of this work is completed voluntarily and paid for by the participants themselves, which discourages many small businesses from participating. This is a problem that should be remedied.

### **Part-recommendation 17 – Strengthening of the Smart Grid standardisation process by Danish Standard together with the inclusion of more businesses, consumer representatives and trade members**

The Minister should take the initiative to ensure the necessary financial framework – or a prioritisation of funds within the existing budget – so that Danish Standard can promote work on standards related to the Smart Grid, including the establishment of a fund that would reimburse small businesses, consumer representatives and individuals from trade organisations

for expenses incurred through their participation in the Smart Grid standardisation process.

*Time prioritisation of part-recommendation: 2012–2013*

*Responsibility for implementation of part-recommendation: The authorities.*

Many of the smaller electricity-producing installations (up to 50 kWh) are now, and will continue to be connected locally to the electric system. TSO issues Technical Regulations governing which services apply to electro-technical relationships. It is also important that the Smart Grid be able to communicate with these installations. One of the requirements of Plug-and-Play is the distribution and integration of communication standards. This should be considered in relation to the international work in this area.

***Part-recommendation 18 – Establish communication standards for small electricity-producing units***

TSO, in cooperation with the Danish Energy Association, should establish a working group with relevant commercial bodies to draw up Danish requirements for communication standards applicable to small electricity-producing installations (up to 50 kWh), based on equivalent international standards. The working group should convert the international standards into Danish guidelines, including a clarification of how this field should be regulated.

*Time prioritisation of part-recommendation: 2013–2015*

*Responsibility for implementation of part-recommendation: TSO in cooperation with the Danish Energy Association.*

Providers of Smart Grid products and solutions require testing facilities in order to help strengthen the Danish position and make it possible for these suppliers to test and demonstrate the interoperability of their equipment and IT solutions in relation to international Smart Grid standards. Products such as heat pumps, solar panels, private wind turbines, electric cars, etc. must have Smart Grid functionality in the future. Consumers and other parties also need to be certain that they are choosing appliances that are compatible with the Smart Grid. In the long term, the aim is to provide consumers and other parties with a uniform European certification system based on detailed and complete standards, so that implementation into the Smart Grid of the future will be Plug-and-Play.

Type approval and certification should take into account the European regulations in this field as well as being compatible with equivalent approval systems in other EU countries. Furthermore, tests on interoperability of Smart Grid IT solutions should be brought into a European or international framework. Qualified testing facilities should be impartial organs with the knowledge and resources to conduct testing as well as to contribute to the development of a uniform European certification system.

**Part-recommendation 19 – Establish a Smart Grid test scheme**

The Minister, along with the Danish Energy Industries Federation and relevant electric-industry members, should introduce a Danish Smart Grid test scheme with the objective of bringing Danish industry to the forefront of the development of a shared European type approval and certification of electricity-producing and electricity-consuming appliances.

*Time prioritisation of part-recommendation: 2013–2015*

*Responsibility for implementation of part-recommendation: The authorities in cooperation with the Danish Energy Industries Federation.*

Although the traditional electric system is relatively well-standardised, there are a number of challenges with regard to making decentralised energy-management systems and components compatible with each other, other sources of data and interfaces, as well as with the traditional electric system. This interoperability is a prerequisite for customers to combine solutions in which different suppliers provide the sub-elements.

One example is the variety of communication standards used in different suppliers' products. The communication standards have different advantages and disadvantages, though none of them seem likely to prevail in the near future. The costs involved in implementing standards means that only a few of the larger suppliers will be able to support all of the standards in their products. This type of challenge should be addressed in the best possible manner.

**Part-recommendation 20 – Strengthen the interoperability of Smart Grid solutions**

A cooperative should be established between relevant bodies, based on international standards regarding the development of shared integration building blocks with open source code. The aim is to support the rapid introduction of new uniform Smart Grid standards in commercial solutions as well as in the public infrastructure, together with a reduction of integration expenses in consumer-oriented and lateral Smart Grid solutions.

*Time prioritisation of part-recommendation: 2012–2013*

*Responsibility for implementation of part-recommendation: The authorities, together with the electric industry.*

Electricity-consuming and electricity-producing appliances in buildings – such as heat pumps, charging stations for electric cars, solar panels and ventilation systems – will play an important role in the Smart Grid. It is important to ensure that these appliances are able to communicate with Smart Grid solutions and meet Smart Grid requirements.

**Part-recommendation 21 – Institute Smart Grid requirements for buildings**

Requirements should be implemented for electricity-consuming and electricity-producing appliances – such as heat pumps, solar-panel installations, charging stations for electric cars, etc. These appliances should be integrated with external control signals, including pricing signals. The electric industry should establish pilot projects to test the ability of managing such

appliances, with a view to gaining valuable insight to be used in the drafting of the requirements for buildings.

*Time prioritisation of part-recommendation: 2012–2013*

*Responsibility for implementation of part-recommendation: The authorities, together with the electric industry.*

If the total production network is to be increasingly based on fluctuating electricity production, it becomes necessary to raise requirements for the communication systems that control and monitor the electric system. This applies to the uppermost transmission system as well as to the local power grid, to both commercial bodies and distribution companies.

There is a need to develop and implement a future communication and control concept, which will make it possible to achieve the ideal interaction between the technical control of the power system, electricity production and electricity consumption; see Figure 8.

TSO has been developing a proposal for a management concept of the power system with 50 percent renewable energy in 2025. Based on the use of commercial mechanisms, this concept is a model of how the electric system of the future can be managed, with updated data communication between both commercial bodies and distribution companies in the electric system. This description of *Concept 2025* will be the basis for TSO's cooperation with the industry in its plan of action for the implementation of a future Danish electric system.

The main principle behind the management concept is that future data communication between all involved in the electric system be based on a coordinated communication structure with well-defined interfaces. Data, management and communication structures should meet the existing international standards. This entails making the electric system and the new communication system so open and accessible in the future that new, small production facilities and consumer appliances could be linked together using simple Plug and-Play solutions.

## Key elements in the future Smart Grid electricity system

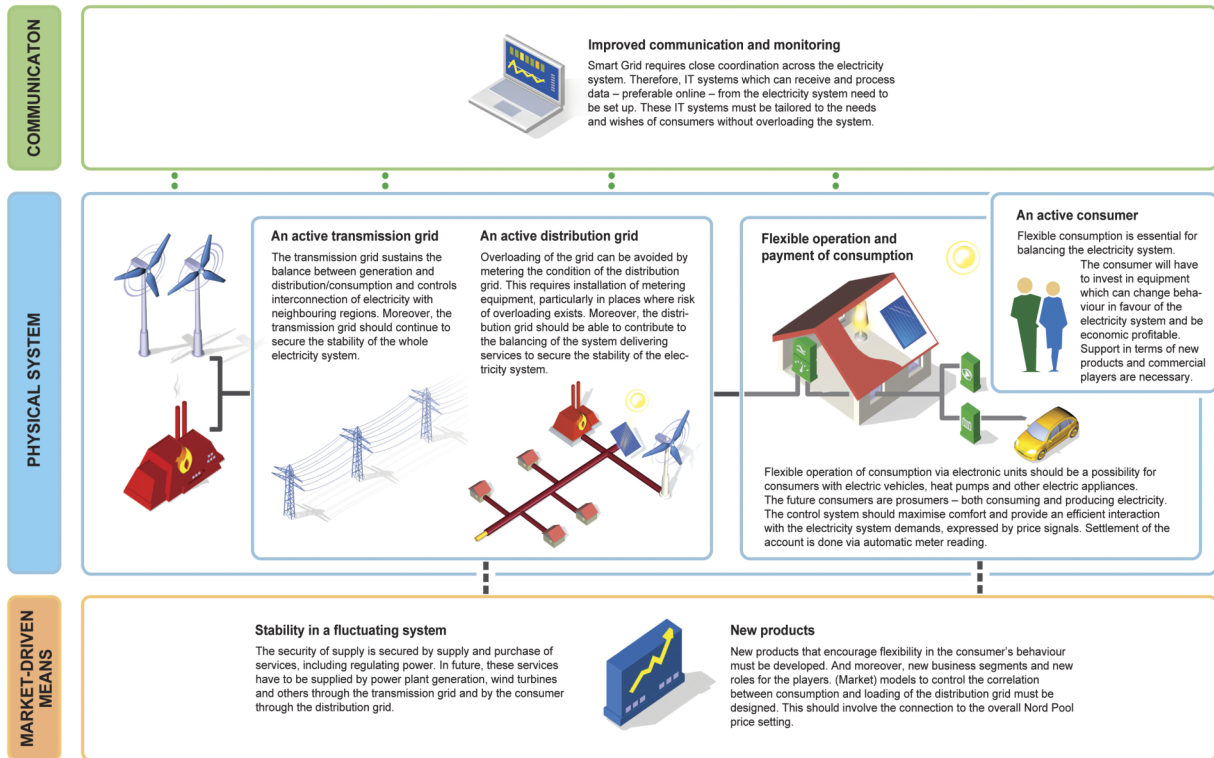


Figure 5: Key elements of a future electric system with Smart Grid

### **Part-recommendation 22 – Action plan for the rollout of a coordinated concept for the data and communication infrastructure that will control the electric system in 2025**

TSO, together with the electric industry, should work toward creating a common road map and action plan for the rollout of a coordinated data and communication infrastructure concept that will manage the electric system in 2025. This work should be concluded by the end of 2012, by which point Denmark should have a cohesive plan for the development and creation of the future communication system that optimises the commercial and technical operations of the electric system.

*Time prioritisation of part-recommendation: 2012–2013*

*Responsibility for implementation of part-recommendation: TSO together with the electric industry.*

The electric system is comprised of both technical and commercial interests, and requires a uniform information model so that data can easily be communicated to all parties. This information model should be based on uniform international Smart Grid standards (IEC 61850, IEC 61970 and IEC 61968), and should focus on including the consumer and service-provider domains in the interface.

The information model is a key aspect in:

- defining consistent data attributes for monitoring, status, control signals, etc. so that all relevant parties are able to aggregate data and/or add new aggregated attributes, depending on their level of access.
- minimising overheads in the entire information chain for conversion, interpretation and other circulation processes that are necessary in the absence of a coordinated information model.
- ensuring the necessary conditions so that all parties involved can develop effective and usable Plug-and-Play solutions.

***Part-recommendation 23 – Consolidate recommendations on the introduction of a Danish information model for data communication between those involved in the electricity sector***

TSO and the Danish Energy Industries Federation, along with the electric industry and other relevant parties, should establish a working group for the consolidation of recommendations on a future Danish information model for the electric system by the end of 2012. The work should be coordinated with the development of a consolidated management concept for the electric system, and must follow guidelines based on the risk assessment of data security.

*Time prioritisation of part-recommendation: 2012–2013*

*Responsibility for the implementation of part-recommendation: TSO and the Danish Energy Industries Federation.*

There is a need in the electric industry for a shared vision and road map for the rollout of the Smart Grid, so that a common platform can be established to form the basis for deciding and implementing long-term, economically viable solutions. This road map should focus in particular on the role of distribution companies.

The road map should help to ensure that all parties involved in the implementation of the Smart Grid work toward developing the electricity market as well as in marketing services.

***Part-recommendation 24 – A road map for the rollout of the Smart Grid in the electric industry, focusing on the role of distribution companies***

The Danish Energy Industries Federation, along with other relevant parties, should establish a working group to create an overall consolidated road map for the electric industry as quickly as possible. The road map should place particular focus on the role of the distribution companies, in order to coordinate and accelerate the implementation of Smart Grid solutions.

It should be noted that several of the Network's recommendations concern political initiatives and other industry activities, which should not be postponed until this road map is completed, but should be launched immediately by the parties made responsible for them in the Network's recommendations.

*Time prioritisation of part-recommendation: 2012*



*Responsibility for implementation of part-recommendation: The Danish Energy Industries Federation.*

## **Key Recommendation 6 – Research and development as a dynamo for green growth**

*A common vision and road map that outlines research, development and demonstration (RDD) of the Smart Grid should be defined for research institutions, energy companies and industrial leaders, in order to maintain and strengthen Denmark's position as the global leader regarding the Smart Grid.*

Energy research – including RDD of Smart Grid technologies – is somewhat fragmented in Denmark, with numerous industrial actors and researchers as well as sub-programmes and a number of funding sources. In order to focus efforts and ensure the necessary prioritisation within the sector, a national road map of the area with a clearly defined European dimension should be created.

A compulsory road map is a prerequisite for increased investment in the RDD of Smart Grid solutions, and a road map would also promote Danish interests in EU research programmes.

### ***Part-recommendation 25 – A road map for Smart Grid research, development and demonstration***

The electricity sector should invite the Ministry to participate in the creation of a road map to ensure that solutions are implemented and coordinated with related policy areas. The sector should also establish a fast-acting working group with representatives from universities, distribution companies and the electric industry, in order to produce a mutual, binding schedule for the RDD of the Smart Grid in Denmark.

*Time prioritisation of part-recommendation: 2011–2012*

*Responsibility for implementation of part-recommendation: Universities, along with relevant electric-industry actors, should establish a working group for the completion of a consolidated road map by the end of 2012.*

The research infrastructure must be strengthened if the universities are to contribute effectively to the realisation of action and work programmes based on the road map. This includes laboratory and demonstration facilities and access to data from large-scale surveys of the electric system. The road map will outline the specific needs of the research infrastructure.

### ***Part-recommendation 26 – Strengthening and marketing the research infrastructure that will position Denmark as the global hub for Smart Grid development***

The research infrastructure should be strengthened, including laboratory and demonstration facilities, and access to data from large-scale surveys of the electric system. The research infrastructure should also be marketed internationally to attract companies that will locate

RDD activities in Denmark, thereby helping to position Denmark as a global hot spot for Smart Grid expertise. Systems should be created for activities that integrate with and benefit Danish research communities and businesses. The road map will outline the particular requirements of the research infrastructure.

*Time prioritisation of part-recommendation: 2011–2014*

*Responsibility for implementation of part-recommendation: Universities, together with the electric industry and supported by the Ministry, should implement a national effort to strengthen the Danish research infrastructure and market it internationally.*

In order to maintain Denmark's leading position with the potential to obtain a significant share of a rapidly increasing global market, a short-term prioritisation of the research and development of Smart Grid technologies is of the utmost importance – even before the completion of the planned RDD road map. Other countries have made significant investments to enhance their Smart Grid expertise. A continued focus and prioritisation is necessary if Danish industry is to reap sustainable benefits from its current position. This applies both to areas of advanced, technical engineering science and to areas covered by broader research disciplines, such as market design and consumer behaviour. These areas should be strengthened in the short-term through a prioritisation of the research funding programmes.

***Part-recommendation 27 – Strengthen basic research into the complex relationships in electric systems with large quantities of independent parties***

It is important to strengthen basic research into complex relationships within electric systems with large quantities of independent parties. The following areas should be in focus:

- Advanced technical engineering-science research is central. It should include wide-ranging basic research to develop methods and tools as well as basic theories and models to analyse, plan and run an electric system based on sustainable energy and Smart Grid technologies. It is necessary to achieve a better understanding of the complex relationships within electric systems with large amounts of independent parties; for example, in relation to ensuring the stability of the system, maintaining supply and in new ways of monitoring, managing and optimising the system.
- The wider research potential should be realised through broad cooperation in market design. The development and demonstration of future market design is a key element for a functional and efficient Smart Grid. One part of this is research into and development of simulations and models of the markets and electric systems. The potential for commercialisation can be catalysed through these research themes.

*Time prioritisation of part-recommendation: 2011–2012*

*Responsibility for implementation of part-recommendation: The Climate Minister, together with the Minister for Science, Innovation and Higher Education, will initiate the strategic prioritisation of the Smart Grid in relevant research programmes.*

Consumer habits and social economics are key elements in understanding consumer responses. In order to achieve a high level of market penetration with the Smart Grid and to ensure that new products and services are quickly accepted, it is imperative to have a better understanding of consumer responses – both in the form of changes in response patterns related to the switch to Smart Grid components and in relation to new services.

***Part-recommendation 28 – Improved understanding of consumer behaviour and social economics***

Research into consumer habits and social economics should be strengthened, in order to foster a better understanding of consumer responses when using Smart Grid technology and products. This applies to changes in response patterns towards both Smart Grid components and new services.

*Time prioritisation of part-recommendation: 2011–2012*

*Responsibility for implementation of part-recommendation: The Climate Minister, together with the Minister for Science, Innovation and Higher Education will initiate the strategic prioritisation of the Smart Grid in relevant research programmes.*

## **Key Recommendation 7: Strengthen consumer engagement**

*Electricity customers' engagement should be strengthened by increasing their awareness and knowledge about the Smart Grid. This should be done through the launch of education and information initiatives about the Smart Grid.*

If customers are to be encouraged to take on the role of flexible electricity consumers and decentralised electricity producers – along with the necessary rearrangement of their daily routines – they must first be made aware of the Smart Grid. An important element here is that electricity customers know their options, and about the advantages and disadvantages to their personal or business finances, as well as for the climate and the electric system as a whole.

Despite a long-standing Danish tradition of awareness about energy conservation, the Smart Grid and flexible electricity consumption are still unknown concepts for the majority of private customers as well as for a large number of businesses. It is important to ensure that terms such as “Smart Grid”, “flexible consumption” and “demand response” gradually become more widely recognised in society, in the relevant industries and among electricity customers.

***Part-recommendation 29 – Launch educational and information campaigns about the Smart Grid***

Educational and information campaigns about the Smart Grid should be implemented on several levels:

- an improved effort to include the Smart Grid in primary-school and secondary education; for example, by developing teaching materials about the Smart Grid,
- impartial advice about the Smart Grid for private electricity customers, businesses and public authorities,

- dialogue and information about the Smart Grid in physical or virtual forms, demonstrating its technical solutions,
- campaigns in collaboration with the energy industry and others involved, ideally in connection with the marketing of products with the potential for flexible usage,
- advice about Smart Grid solutions provided by businesses involved in selling, installing and improving new installations in homes and other buildings,
- highlighting energy consumption and flexible pricing, including time-differentiated tariffs based on power-grid distribution.

*Time prioritisation of part-recommendation: 2012–2015*

*Responsibility for implementation of part-recommendation: The authorities and the electric industry.*

## **Key Recommendation 8: Minimise the risks for electricity customers and other stakeholders**

*Potential risks for customers and other relevant actors who participate in Smart Grid activities should be minimised.*

It is important that electricity customers and other relevant actors do not encounter significant perceived or real risks by participating in the Smart Grid. In particular, potential risks associated with investments, personal data and supply stability should be taken into account. Competences among professionals should be developed, and a common framework for security should be established.

Involving electricity consumers in Smart Grid solutions requires advice, and the purchase of services and equipment from a number of commercial suppliers. A lack of confidence in these commercial bodies could dissuade the consumer from making the necessary investments and changes in behaviour. Misleading advice or poor-quality Smart Grid solutions could also reduce the benefits of the Smart Grid, or result in customers opting out of Smart Grid solutions.

### **Part-recommendation 30 – Improve professional expertise**

The Danish Ministry of Climate, Energy and Building should establish a taskforce – under *Go' Energi*, for example – in order to provide relevant training for Smart Grid professionals, including IT professionals in the electric sector, architects, engineers, skilled workers, real-estate agents and financial advisors.

*Time prioritisation of part-recommendation: 2012–2013*

*Responsibility for implementation of part-recommendation: The authorities and the electric industry.*

With the Smart Grid, the traditional understanding of safety in electric-supply systems is coupled with the issue of IT security. The Smart Grid involves new connections and flows of information

based on information technology, and entails new threats, risks and vulnerabilities. In particular, the internet's open structure combined with the culture and IT systems of the electricity sector – which was originally designed to operate in isolation from other information systems – creates the potential for the abuse of confidential data, misinterpretation of data, or an attack on the electric system as part of the critical infrastructure. Electricity consumers may feel uneasy about making their detailed energy-consumption data available to a number of different Smart Grid parties.

**Part-recommendation 31 – Create a common security framework**

The security elements of the Smart Grid should be completely analysed, including a risk assessment to identify areas that require attention in order to increase the overall security of the Danish Smart Grid. Information on Privacy by Design should also be included in Smart Grid solutions and future legislation.

*Time prioritisation of part-recommendation: 2012–2015*

*Responsibility for implementation of part-recommendation: The authorities and the electric industry.*

**Key recommendation 9: Make it easier to create new services**

*Favourable conditions should be created for providers of Smart Grid services, for example, by allowing easier access to relevant data, Smart Grid building specifications, improved frameworks for the business models of aggregators and access to realistic testing environments for small- and medium-sized businesses involved in the Smart Grid.*

In the vision for the Smart Grid of the future, energy services will not only be provided by a traditional energy company, but by a series of actors who have developed different business models based on customers' individual energy-consumption patterns. Examples of this kind of service are the supply and management of flexible electricity consumption by heat pumps and electric cars as well as the re-sale of customers' locally produced electricity. A range of services are expected to emerge that include information about customers' electricity consumption, including alarm and messaging services and various forms of energy advice. In order to improve conditions for these service providers, focus is needed on the following areas:

- easier access to data
- the development of a Smart Grid checklist for buildings
- easier access to the role of aggregator in both electricity consumption and production
- creation of new testing and inspiration laboratories for Smart Grid solutions. These should be open to everyone on a non-discriminatory basis, including small- and medium-sized businesses.

New services for the Smart Grid should be based on the utilisation of energy-consumption data, among other things. Different types of data that could be included in various types of services related to the Smart Grid should also be made available in more appropriate forms or under more favourable conditions than they are today. A proposal for a set of principles for data-handling in relation to the Smart Grid has been completed (see Issue Paper from working group 4).

### **Part-recommendation 32 – Easier access to data**

It is recommended that:

- the existing guidelines for data in the Smart Grid are used in legislation and other forms of regulation,
- user- and privacy-friendly authorisation solutions are developed to govern the dissemination of data,
- data relevant to the Smart Grid (for example, meteorological conditions and future flexible power-grid tariffs) is made available in appropriate machine-readable forms.

*Time prioritisation of part-recommendation: 2012–2013*

*Responsibility for the implementation of part-recommendation: The authorities and the electric industry.*

The buildings of the future must be prepared for the electricity-consuming and electricity-producing appliances that will play a central role in the Smart Grid. It is important to focus on establishing a basic digital infrastructure in both new and existing buildings in the form of data-communication options and digital building management.

### **Part-recommendation 33 – Requirements for a checklist for buildings**

The Danish Ministry of Climate, Energy and Building should establish a working group comprised of representatives from the electricity sector, including Veltek, to compile a checklist for construction projects, which describes a number of points to consider in ensuring that buildings are able to handle the Smart Grid, including:

- establishing an efficient digital infrastructure,
- laying the correct size cable for charging stations,
- installing buffer tanks to increase the flexibility of, for example, heat-pump installations.

*Time prioritisation of part-recommendation: 2012–2013*

*Responsibility for implementation of part-recommendation: The authorities and the electric industry.*

The majority of Danish electricity consumption is distributed among consumers who are individually unlikely to consider it financially attractive to supply flexible energy consumption to balance the power grid. This may also apply to small units with decentralised electricity production. A key requirement in the deployment of flexible electricity usage and decentralised electricity production is the emergence of multiple businesses in the market that can achieve economies of scale by aggregating demand from a number of different consumers or by aggregating decentralised electricity production. If this is to succeed, the aggregators' business models must be given favourable conditions.

### **Part-recommendation 34 – Make it easier to be an aggregator**

It is recommended that:

- consumers should have the option to get some of their electric consumption read by an aggregator whenever possible,
- the cost to install an extra electric meter should be reduced by allowing the meters installed by aggregators as part of their service to be used in consumer billing; see part-recommendation 9, which states that the responsibility for meters and the handling of customer and basic meter data should remain with the distribution companies, whereas the actual administration and handling of billing data should be handled by commercial parties,
- net-billing should be restructured, so that the scheme will not act as a deterrent for decentralised electricity producers when it comes to entering agreements on the aggregation of their production; see also part-recommendation 12.

*Time prioritisation of part-recommendation: 2012–2013*

*Responsibility for implementation of part-recommendation: The authorities and the electric industry.*

Small- and medium-sized businesses that develop new Smart Grid solutions may encounter a scarcity of opportunities for testing products under conditions similar to those in the actual electric system. These businesses often lack a platform to demonstrate to potential clients that their products or services work satisfactorily under realistic conditions.

### **Part-recommendation 35 – Establish testing laboratories for small- and medium-sized businesses**

The electric industry should establish commercial testing environments and *inspiration labs*, so that small- and medium-sized businesses, as well as international companies, are guaranteed access to laboratories and testing facilities on a non-discriminatory basis. This reduces barriers to accessing new technological markets.

*Time prioritisation of part-recommendation: 2012*

*Responsibility for implementation of part-recommendation: The electric industry.*

## Commercial potential of the Smart Grid

There are three areas in which Denmark's current stronghold could potentially strengthen Denmark's commercial potential:

- **System solutions.** The intelligent energy system is more about the interaction between diverse system components than about the components themselves. In this area, Denmark is among the international elite, thanks to the significant expansion of combined heat-and-power and wind energy.
- **Market solutions.** The Nordic electricity trading system "Nord Pool" is the most effective, commercially-based electric system in the world, and Denmark has the solid groundwork for creating commercial solutions for the electric systems of the future.
- **Large-scale demonstration environments.** These allow businesses to test and complete development of their products, solutions and services. In Denmark, TSO and the distribution companies have opened access to the Danish power grid for companies that want to test their solutions on real customers. In this respect, an increasing number of international companies regard Denmark as an attractive market to test new technologies – partly because the Danish market is homogeneous and manageable, and partly because Denmark has a robust and well-managed power grid in relation to the electric system. Finally, the high ratio of fluctuating energy production emphasises the necessity for a flexible and intelligent electric system.

These combined strengths make Denmark a unique market for international companies to locate their development projects. Similarly, these strengths provide a unique platform for Danish consultancy companies to roll out international Smart Grid projects. Utilising these strengths should lead to the further development of exceptional Danish expertise in the long term, thereby providing the basis for increased commercial and export potential.