Smart Energy Networks

VISION FOR SMART ENERGY IN DENMARK

Research, Development and Demonstration

Vision for Smart Energy in Denmark

– Research, Development and Demonstration

The Danish agenda for climate and energy is very ambitious aiming at a renewable-based energy system by 2050. The road to 2050 will not be easy - new technologies, architectures, markets, actors and business models need to be developed, and including changes in the regulation of the energy systems and tax systems, which allow for and support new business models and new consumption patterns.

The ambition can only be achieved in a sustainable way through combinations of high energy efficiencies, integration of the various energy infrastructures (electricity, gas, heating and cooling), flexible energy consumption in buildings, industry and transport, and smart system operation.

The transition of the energy system requires rethinking the energy management and the way we use energy. It is essential that the overall design and solutions for the future smart energy system are cost-effective and not least socially acceptable and feasible.

THE DEFINITION OF A SMART ENERGY SYSTEM:
A smart energy system is a cost-effective, sustainable and secure energy system in which renewable energy production, infrastructures and consumption are integrated and coordinated through energy services, active users and enabling technologies.

Research, Development and Demonstrations (RD&D) are key enablers for the development of a smart energy system. Research-based innovations and large-scale demonstration of new system solutions with multiple interacting sub-systems and components have to be carried out to enable a cost-efficient transition of the energy system and explore the unique opportunity of utilizing the Danish stronghold position within renewable energy integration into more jobs and green export.

THE VISION FOR SMART ENERGY IN DENMARK – RD&D:
The Danish Smart Energy Research, Development and Demonstration will support a smooth transition towards a future, sustainable and cost-efficient energy system, providing new world-wide business opportunities for the Danish companies by identifying, developing and demonstrating smart energy knowledge, technologies and solutions

The future Smart Energy System

The future Smart Energy System will be sustainable, efficient, cost effective, integrated and intelligent. The overall aim of the energy system is to provide energy services, requested by the customers, in a reliable, sustainable and cost efficient way.

DENMARK IS INTERNATIONALLY RECOGNIZED FOR HAVING A RELIABLE AND EFFICIENT ENERGY SYSTEM WITH A HIGH SHARE OF FLUCTUATING RENEWABLE ENERGY SOURCES.

We have established dynamic energy markets, enhanced district heating and gas networks and well integrated interconnectors to our neighboring countries, which makes the energy system robust and ready for even larger amount of fluctuating energy.

The main renewable energy sources in Denmark are wind, solar and biomass. The fluctuating nature of the wind and solar sources requires high flexibility of the energy systems at all scales in both time and space to balance power and energy.

In the future: Buildings, urban areas, cities, regions and countries like Denmark may become more or less energy self-sufficient in average over the year. However, more energy flow and exchanges are expected, due to the increasing variation in energy demand and generation, initiated by dynamic prices, new use practises, etc.

The necessary flexibility in the energy system is most cost-efficient provided through a combination of different and complementary

means – including increased responsiveness of the controllable energy generations and consumptions (demand responses), storages, conversions and exchanges with the neighbouring countries.

Large-scale storage of electricity is expensive. However, it is possible to convert electricity into heat or gas. The heating system can provide short-term and middle-long term energy storage capacities and the gas system long-term energy storage capacities. Cost and flexibility of these technologies have to be enhanced.

Information and Communication Technology (ICT) will play an essential role in the transition of today's electricity, gas and heating grids into the smart energy system of tomorrow. This transition not only requires each grid to be smart, it also requires the grids to be interconnected through conversion, storage or generation and demand technologies. Management and operation of the grids have to be coordinated in a scalable manner. Information and communication technology have to be deployed at all levels in each grid in order to coordinate the management and operation of the grids, including control of the underlying systems.

Efficient tools and solutions for collecting, managing, analyzing and utilizing large amounts of data in the smart energy system are needed to provide operational basis and decision support for more intelligent energy services.

A successful implementation of a smart energy system will require reliable and secure communication and control for optimizing and balancing the energy production and consumption. Security in a smart energy system is about protecting and ensuring the required confidentiality, integrity, and availability. Security and privacy are crucial to guarantee safe operation and non-disclosure of user data.

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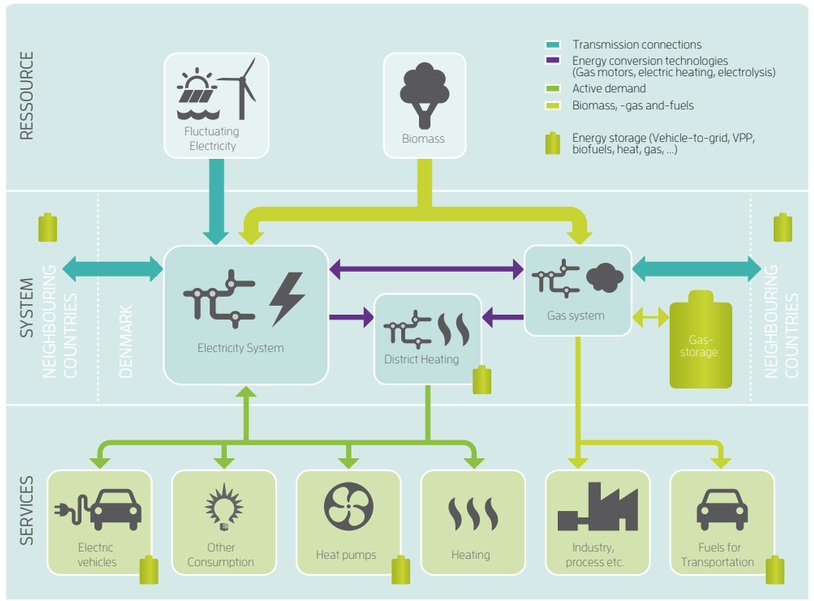
COST EFFICIENCY can be achieved through the introduction of new business models and well established energy markets with a high degree of interaction and competition.



Interaction between the various energy infrastructures helps to provide the flexibility required in a fully renewable energy system (Source: DTU National Laboratory for Sustainable Energy)

Challenges

THE CHALLENGES MAY BE GROUPED INTO TECHNICAL, INSTITUTIONAL AND SOCIO-ECONOMIC CHALLENGES:

TECHNOLOGY LEVEL:

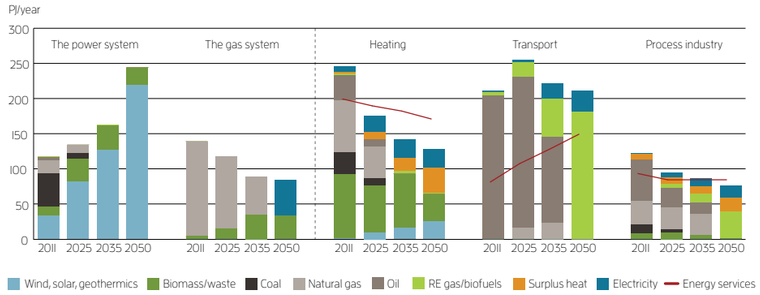
- Controllable centralized and decentralized generation capacity is expected to be reduced, and new fluctuating energy generation is introduced faster than the redesign of the power system.
- Immature energy conversion and energy storage technologies.
- Lack of implementation of integrated energy design and integrated energy storage in buildings and industries as well as lack of system operation tools.
- Not sufficient global standards for communication and smart control of the integration of energy components.
- Data and control options are not available for the small-scale smart energy components.

INSTITUTIONAL LEVEL:

- Existing regulatory frameworks and tariff systems does not offer enough support the deployment of energy integration and flexible energy consumption in the energy grids.
- Lack of integration of national policies, regulations and requirements across the energy, building and transport sectors.
- New planning competences (at local, regional and national scales) are required in order to ensure coordination across business interests and policy domains.

SOCIO-ECONOMIC LEVEL:

- Lack of strong business cases for smart energy solutions across sectors, regions and domains
- Lack of incentives among system owners, building owners, authorities and end-users for flexible consumption
- Inadequate of end-user engagement and insights.



Possible development process for the production and consumption of energy, by sector. Note that the red line indicates the development in the final net energy requirement, while the columns to the left refer to the total energy production to cover domestic consumption in Denmark (for the gas and power systems) and the columns to the right illustrate the gross consumption for heating, transport and the process industry, respectively. Source: Energinet.dk

THE TRANSITION towards the future sustainable, smart and integrated energy system requires fundamental changes – in system design, technologies, operation, regulations, organisations, and actors.

NEW STEPS must be made to overcome the many challenges and to develop a cost-effective and sustainable smart energy system. New system concepts and novel technologies must be developed and tested in practise, which creates a great opportunity for Danish companies and knowledge institutions to demonstrate Danish solutions.

CONTINUOUS EFFORTS must be made to attract both capital and the brightest minds in order to keep Denmark as a leading hub for innovation and research in the field of Smart Energy.

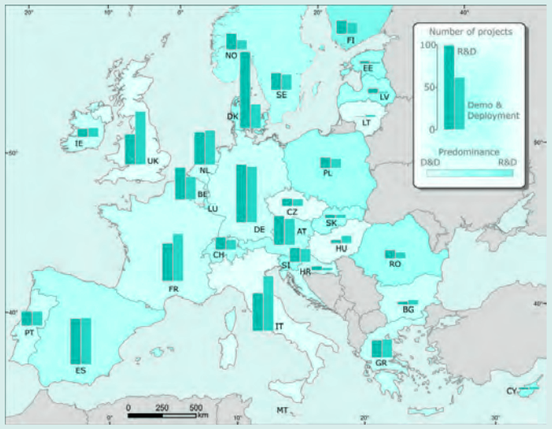
Recommendations

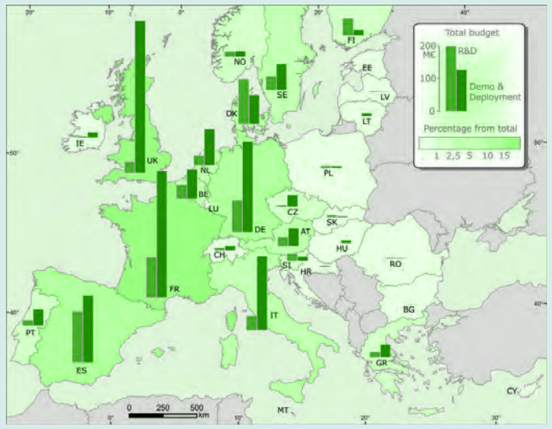
I: THE DANISH STRONGHOLD POSITION of having excellent energy infrastructure and extensive experience with integration of large share of renewable energy sources in the system, must be exploited even further. The development of smart energy systems with more complex solutions will require new investments and large scale demonstrations.

2: THE DEVELOPMENT should focus on a holistic and socio-economic perspective to secure coordinated efforts across sectors, regions and domains. In order to specify needs, identify potentials and to prioritise the research, development and demonstration effort, the process of establishing a Smart Energy roadmap should be initiated.

3: THE TRANSFORMATION will require new energy technologies and existing technologies to interact as individual building blocks of a complete smart energy system. Therefore, it is recommended to develop large-scale demonstrations in city- and community-scale living labs with interaction of multiple sub-solutions and components as part of a coherent smart system and as platform for integrated research and development.

4: RD&D EFFORTS regarding system architectures and frameworks, which enable the development of a smart energy system, should be intensified. This includes focus on developing new framework for integrated system operation, multi energy carrier market designs, and business models. These architectures and framework will foster development of new components, tools, and specific solutions, which pave the way for commercialization and export of key technologies and solutions for the future sustainable energy system.





Source: Joint Research Centre - European Commission 2014

THESE OVERALL RECOMMENDATIONS SHOULD BE ACCOMPANIED BY THE FOLLOWING FOCUS AREAS AND ACTIONS:

TECHNOLOGY LEVEL:

- Contribute to European technology standards on component and system level with respect to interoperability to optimise and accelerate development and deployment, while reducing costs.
- Develop new planning methodologies and tools for secure operation and control of a smart energy system - also addressing the end-users.
- Develop cost-effective storage and energy conversion technologies, increasing flexibilities in distribution and demand.
- Develop new control strategies for industrial processes and building energy management systems, increasing their energy flexibilities.
- Use tools, protection systems and approaches for data treatment

INSTITUTIONAL LEVEL:

- Develop and promote projects that demonstrate diversity in the energy system by integrating multiple renewable technologies.
- Address institutional barriers of inadequate regulations by suggesting and demonstrating solutions.
- Evolve energy system regulation to address changing system needs and harvest advantages of new technologies.
- Address system-wide and cross-sector barriers to enable practical sharing of smart energy costs and benefits.
- Address privacy issues proactively through both regulation and application of best practice.

SOCIO-ECONOMIC:

- Build up open, large-scale demonstration sites that operate across energy infrastructures and energy services, incorporating business models addressing cost, security, user behaviour and sustainability.
- Exploit the technical and economic potentials in the smart integration of the individual energy infrastructures with coordination of the energy demands, the energy generations and the energy conversions.
- Initiate a coordinated development approach across the energy, building, industry and transport sectors with closer interactions (in the form of partnerships etc.) between stakeholders e.g. authorities, companies and knowledge institutions, and energy users.
- Develop and demonstrate novel energy services and engaging technologies for smart energy end-users.

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ABOUT THE PARTNERSHIP

Smart Energy Networks is Denmark's national public private partnership for Smart Energy with emphasis on the interplay between the electricity system, the gas system, the heating/cooling systems, the energy users and part of the transport system. It acts as catalyst and initiator of a strengthened strategic research, development and demonstration agenda for a smart and integrated energy system that will support initiatives to meet the energy policy goals as well as the creation of attractive and sustainable growth conditions for Danish export and industries.

Smart Energy Networks will initiate analyses and roadmaps to prioritize and specify needs for future RD&D activities in for the short, midterm and long run in order to meet the Danish Energy targets and develop the future Smart Energy system. This work will involve and be made with contributions from relevant stakeholders.

Today the Partnership Smart Energy Networks consists of representatives from industry, universities and knowledge institutions. The partnership is supported by EUDP – Energy Technology Development and Demonstration Program.

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