

The Danish Wind Case

Fast Facts

Integration of 20% wind power into the Danish power system - and a road map to 50% wind power

Political objective

In 2020, 30 per cent of Danish energy consumption must be covered by renewable energy. Ensuring that renewable energy, especially from wind turbines, covers almost half of Denmark's electricity consumption could make an important contribution to achieving this objective.

Status

Power generation 2007	Denmark total	Western Denmark	Eastern Denmark
Renewable energy in total	28.1%	31.5%	22.2%
Wind power	19.4%	23.8%	11.8%
Wind power in % of power consumption	20.3%	26.3%	11.3%

Installed capacity	Turbines	Capacity	Land-based	Offshore
End of May 2008	5,206	3,147 MW	2,724 MW	423 MW
Planned new capacity 2008-2013	-	1,125 MW (+36%)	325 MW (+12%)	800 MW (+189%)
2025 political objective	-	6,000 MW	-	-

Challenges posed by a power system with a 50% wind-power share

If half of Denmark's power consumption is to be covered by wind turbines in about 20 years' time, Denmark must develop a far more intelligent and flexible power system capable of dealing with a number of all-important issues:

- Where should the power come from when there is no wind?
- What shall we do with the surplus power when there is so much wind that we cannot use all the wind power generated?
- How do we ensure that a power system with a 50% wind-power share is so dynamic and operationally flexible that it is capable of responding sufficiently fast to unpredictable events?

Power grid:

- Reinforcement and expansion of the power grid so that power can be transmitted from new offshore wind farms to where the demand is in the international power market.

Power system:

- As power cannot be stored, the power system must always strike a balance between generation and consumption. A 50% wind-power share markedly increases the necessity of resolving situations with power shortage when there is no wind and power oversupply when there are strong winds.

Power shortage

When power supply is threatened, for example due to high power consumption, low wind-power generation and few reserves being available to compensate for the lack of wind power.

Power oversupply

When the amount of power available exceeds power consumption, for example when power consumption is low and wind-power generation is high because of stormy weather.

Balancing a power system with a 20% wind power share (situation today)

- Renewable energy displaces large amounts of fossil fuels, lack of power to meet peak demand is not a problem as the system is based on the existence of large power stations
- Power oversupply is a problem for approx. 100 hours a year. The problem is expected to become three to five times worse in a few years unless other means are introduced.

Today, imbalances are handled through the following means:

- Power market: Supply and demand balance at a given power exchange price on the day before the day of operation.
- Export/import: When power generation is high, the price drops, and surplus power is exported. When power generation is low, the price increases, and the power required is imported.
- Upward and downward regulation: Energinet.dk is the Danish TSO and handles imbalances during the day of operation by buying upward and downward regulation from power stations and local power units and by importing/exporting power. In emergency situations power stations are ordered to stop generation, and in extremely rare cases controllable wind turbines are ordered to suspend generation.

Means of handling power systems with a 50% wind-power share

Energinet.dk works determinedly on integrating the energy systems within electricity, heat and transmission thus enabling the market to utilise wind power in a flexible manner. New types of electricity consumption (eg heat pumps, electric cars, etc.) must be set up in such a way that the consumption pattern can be adapted to wind-power generation on the basis of market signals. Extensive research and development is being conducted into means of handling increasing volumes of wind power in the power system. Such means include:

Means	Short term	Medium term	Long term
Primary focus: Power system balancing	<ul style="list-style-type: none"> • Expansion of interconnections - cross-border electricity trade • Reinforcement and expansion of existing grid • Downward regulation of production through negative spot prices 	<ul style="list-style-type: none"> • Geographical spread of offshore wind farms • Demand response • Flexible electricity generation 	<ul style="list-style-type: none"> • Electricity storage in hydrogen for fuel cells • Compressed Air Energy Storage • Electricity storage in batteries
Primary focus: Electricity integration in other energy sectors	<ul style="list-style-type: none"> • Heat pumps in power stations • Electric boilers in power stations 	<ul style="list-style-type: none"> • Heat pumps in private households • Plug-in hybrid cars • Electric cars 	<ul style="list-style-type: none"> • Use of (electrolysis-based) hydrogen in transport sector • Use of (electrolysis-based) hydrogen in natural gas grid

Energinet.dk is an independent public enterprise. As the owner of the main electricity and natural gas grids in Denmark we maintain security of supply and ensure efficient electricity and gas markets. We also integrate renewable energy into the power system. We support research and development of environmentally-friendly electricity production, and we administer the public subsidies for renewable energy. Energinet.dk has annual revenue of about DKK 9bn, and the consumers contribute to our activities via the tariffs on their electricity bills and indirectly via their gas bills.