Smart Flexible Energy Solutions for the Future Energy System

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Wind Power in Denmark - it is here...

- Year 2013:
  - Danish wind power covered 33.2% of the electricity consumption

- January 2014:
  - Danish wind power covered 63.3% of the electricity consumption

- March 11th 2014:
  - Only 9 MW out of 4,900 MW wind turbines generated power
  - But 480 MW out of 580 MW solar PV supplied the grid

Renewable Energy Development in Europe

Cumulative wind power installations in the EU (GW)

Ref.: EWEA

Ref.: The EU commission
The Challenges
Energy and Power Balancing

Year 2020 (w. 50 % Wind Power Penetration)

Who will produce?

Who will consume?

Who will deliver fast?

Impact of Wind Power on the Nordic Electricity Market Prices

Main Sources of Flexibility in the Future Energy System

- **Long distance power transmission cables** for balancing across regions (>500-1000 km)
- **Biomass** in the electricity generation
- **Flexible electricity demand** enabled through smart grid technology ('virtual storage' solutions, e.g. heating, cooling and Evs)
- **Energy storage technologies**: pumped hydro, compressed air, batteries etc.
- **Integration of multiple energy infrastructures** operating together in an optimal system (fuel-shift solutions)

Integration of the Energy Systems can provide Flexibility

- Design of an overall optimal and robust smart energy system of multiple integrated smart infrastructures
- Energy conversion technologies with low investment costs and low losses
- Intelligent energy management and control by use of ICT and smart grid technology
- Empower the consumers to be active prosumers

Ref.: Østergaard et al., 2013.
PowerLabDK combines experimental facilities

Flexible multi-purpose laboratories
Large-scale test system

Lyngby & Ballerup Campus
Blue Campus

Full-scale Realistic Power System
Bornholm Power System

Stakeholders:
ABB
Danfoss
Energinet
Siemens
Dong Energy
Eneco
GreenTech
EVRY
IBM

Supported by:
GreenTech

Investment:
18 million Euro

www.powerlab.dk

Bornholm
Test-site for Distributed Energy
with 25,000 customers and 50% Renewables

Resources:
- Wind power
- Biomass
- Biogas
- District heating
- Combined heat and power
- Solar power
- eMobility
- Active demand

Features:
- Nord Pool market
- Islanding capability

www.powerlab.dk
The EcoGrid EU Project - Large-scale Demonstration of the Future Intelligent Energy System
Demonstration with 2,000 customers at Bornholm

The new market enables DER to respond flexible on real-time price signals without direct control or on-line measurements.

* Includes flexible demand

2,000 Participating Customers in the Demonstration

Statistic Control
- 200 households with smart meters
- No access to specific information

Manual Control
- 400-500 households with smart meters
- Receiving simple market price information
- Must move their energy consumption by themselves

Automatic Control
- 700 automated households with IBM-Green Wave Reality equipment and smart meters
- All houses have heat pumps or electric heating - responding autonomously to price signals

Automatic Control
- 500 automated households with Siemens equipment and smart meters
- All houses have heat pumps or electric heating - responding to aggregator control

Smart Businesses
- Up to 100 customers with smart meters
- Include small business and public customers
- Connected smart appliances responsive to control signals
CREATING A FLEXIBILITY MARKETPLACE FOR THE SMART GRID

Demonstration of the future FLEXibility Clearing House - FLECH

8 APRIL 2014 FROM 13:30 TO 16:00

An afternoon of live demonstrations and presentations of the FLECH prototype platform at IBM in Copenhagen (Nymellevej 91, Lundtofte, Kgs. Lyngby).

Full end-to-end demo 18-19 November 2014
www.ipower-net.dk

Autonomous Services from Demand

Central Control Room
Unreliable Data Network
Intelligent Load Controller

Real-time Measurements
and Commands
Real-time Measurements
(V,I)
Demand Units Providing Frequency Controlled Reserves  
Field Test at Bornholm with 200 units (heating, cooling, industry)

- Demand can deliver frequency controlled reserves which today are delivered by large power plants
- Frequency reserves costs 8,000-22,000 €/Mw/year in DK
- Pay pack time: 1-2½ year w/ 1 kW unit
Conclusion

- **Energy flexibility** will play an increasingly important role and get a higher value in the future energy system with high share of renewables.

- By being **flexible** the energy consumption can be ‘green’ and have lower energy costs. It can also lead to energy savings.

- **Promising near-term flexibility solutions** includes solutions utilising the build-in storage in the energy consumption processes and use of autonomous controllers.

- The **market, regulatory framework and technologies** are currently being developed to enable and efficiently support flexibility from demand.

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**Thank you for the attention!**

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