From Smart Grid to Smart Energy with storage

Energinet.dk Presentation

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The Transmission system is very robust

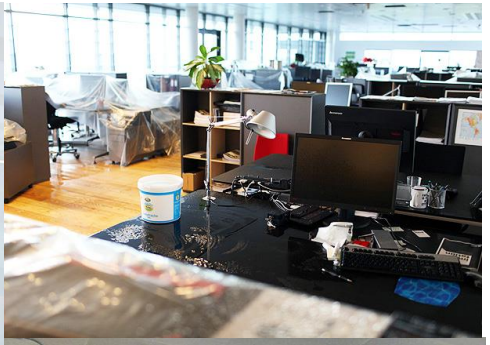
The storm of October 28th 2013 – **We did survive**!

- The 400 – 220 – 150 – 132 kV transmission systems didn't fail
- There was several n-1 situations in the transmission grid due to the strong wind – up to 53 m/s – new Danish record!
- The wind power generation dropped from 3,600 MW to 1,088 MW in several hours since the turbines automatically stops at 25 m/s
- The HVAC interconnector between DK1 and Germany was scheduled for 700 MW import – we only got 11 MW
- The Great Belt HVDC (600 MW) between DK1 and DK2 had a short failure – that required technical assistance on the East side. The technician was on the Vest side and the bridge was closed!
- All available power generation in Denmark was asked to go into force majeure mode. The NOIS balancing power marked was suspended and all generation was compensated fully.
- The main control room in Fredericia was close to point of evacuation. The second control room in Egtved was fired up – but local power supply had a black out and the emergency power supply started. So a team vent to the third control room facility.
- The Energinet.dk head quarter in Fredericia was sincerely damaged, since 1/3 of the roof disappeared. Heavy rain caused sever water damages.
- For three hours the entire building (except the control room) was evacuated to the basement. More than 100 working stations is out of operation in up to three weeks.

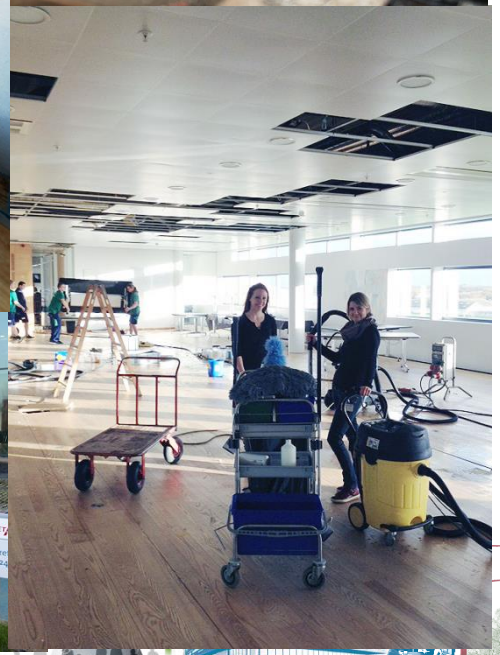
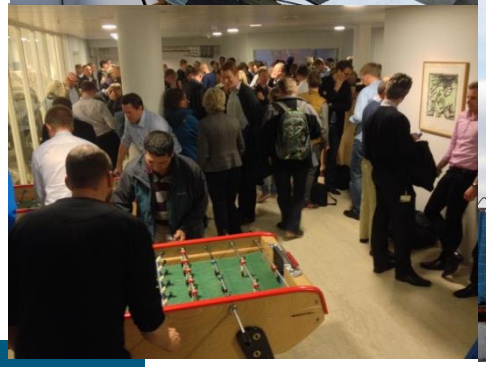
The Energinet.dk building was not robust!

Pictures showing the result of the October 28th 2013 storm





Energinet.dk – back to normal in a few weeks

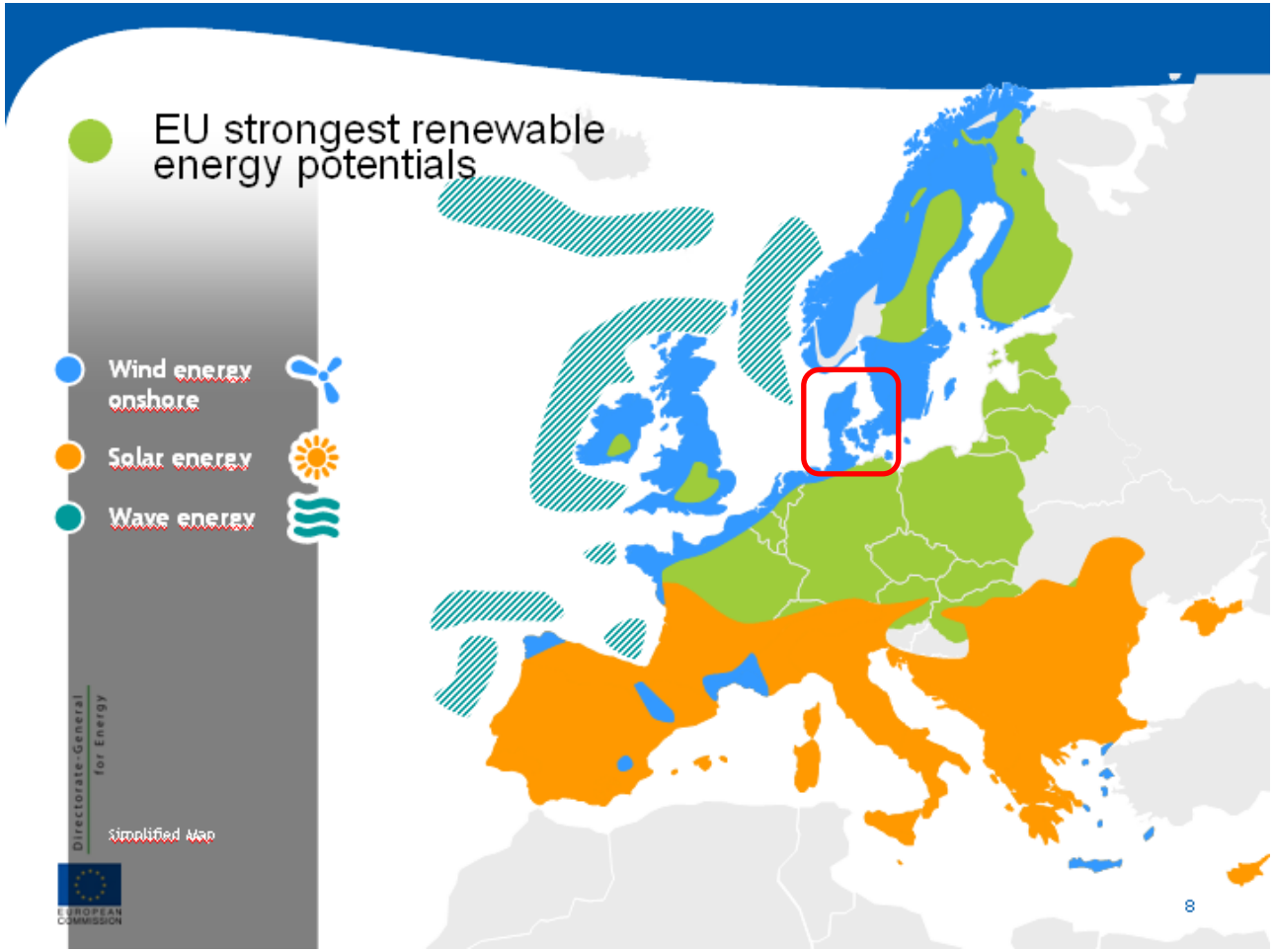
Pictures from the normal situation of the head quarter

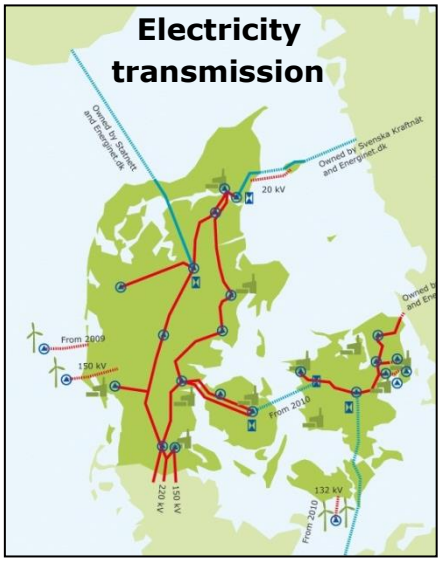
Smart Grid meeting with stoRE Friends

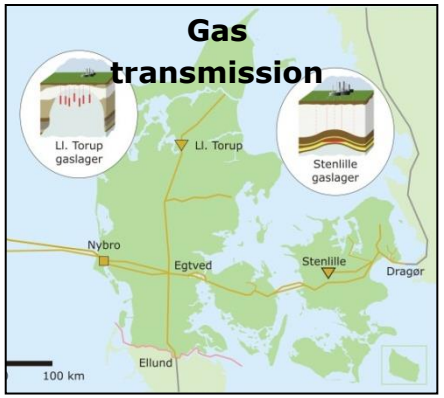
- Transition - from black to green energy
- Denmark going all the way to 100 % renewable energy supply
- Why is storage a crucial component in the renewable energy system?
- Storage – substantial needs including P2G – Power to Gas conversion


Transition
- from black to green energy

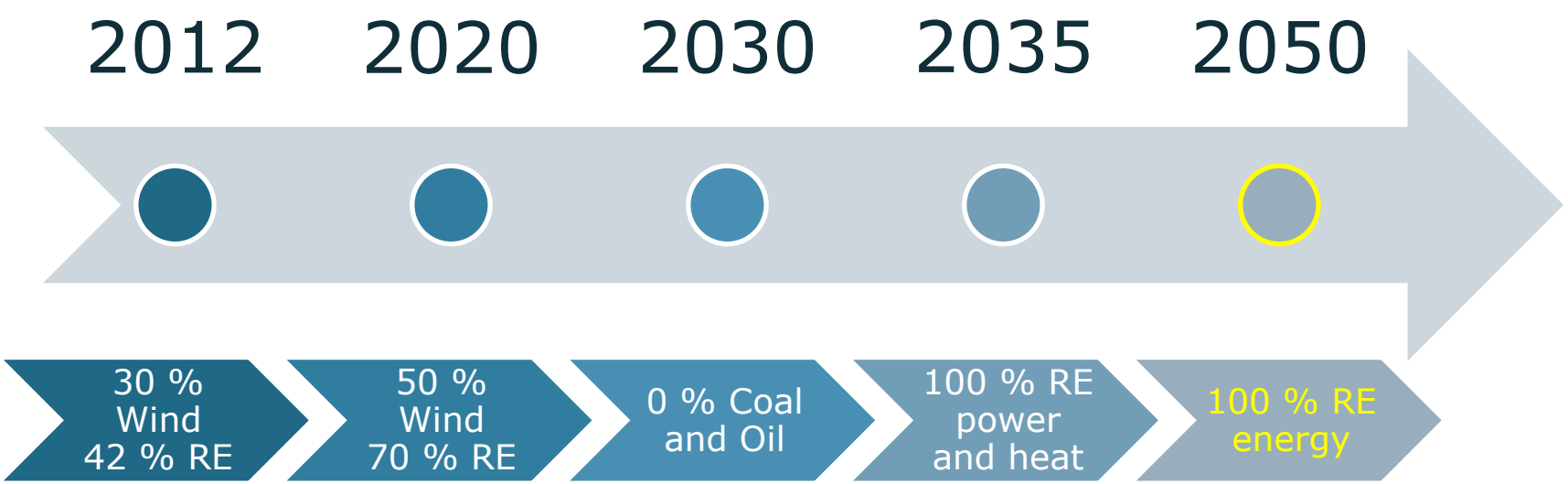
Scandinavia situated in a wind power area







Dedicated Danish climate and energy goals

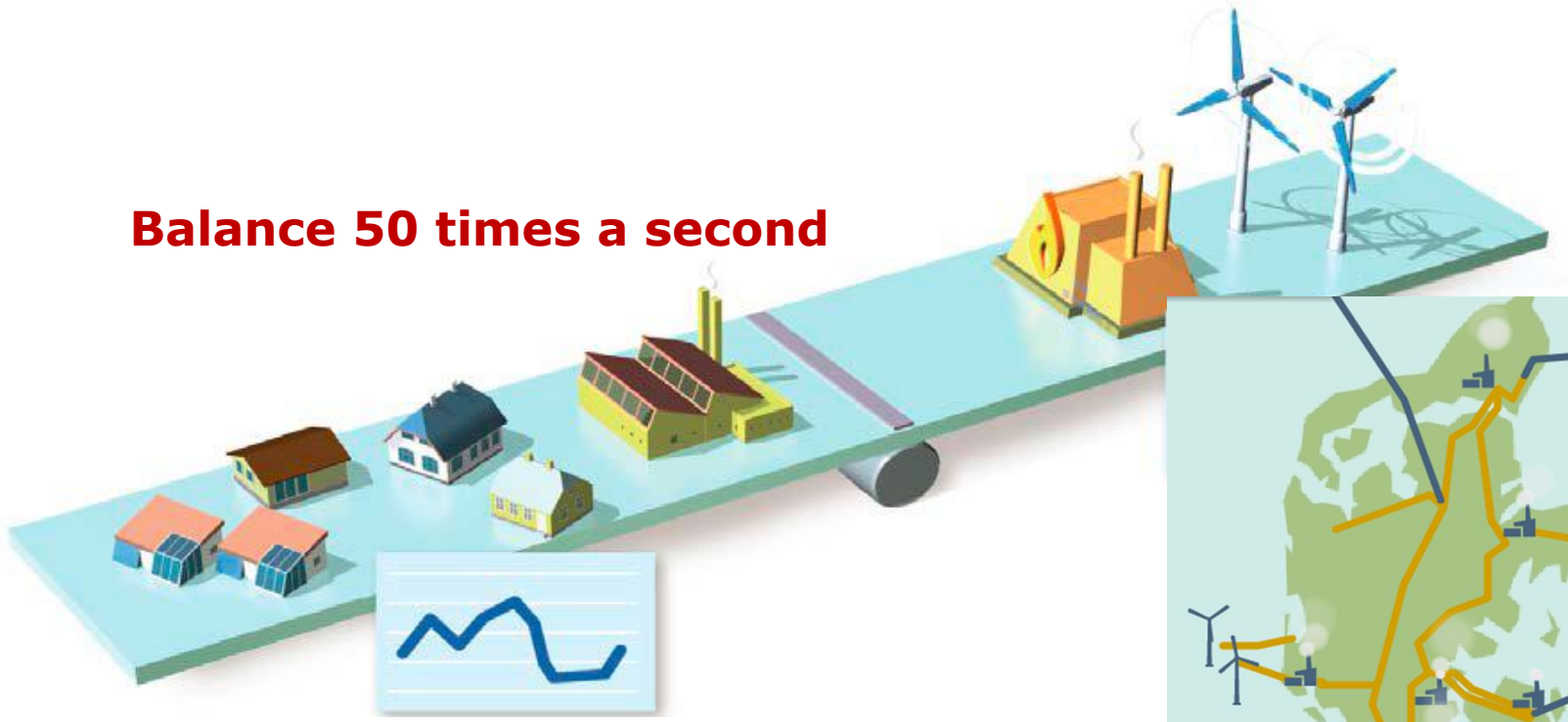


This is only possible if large amount of power is being stored

Energinet.dk – most important task

Hour 20.50 Year 20 50

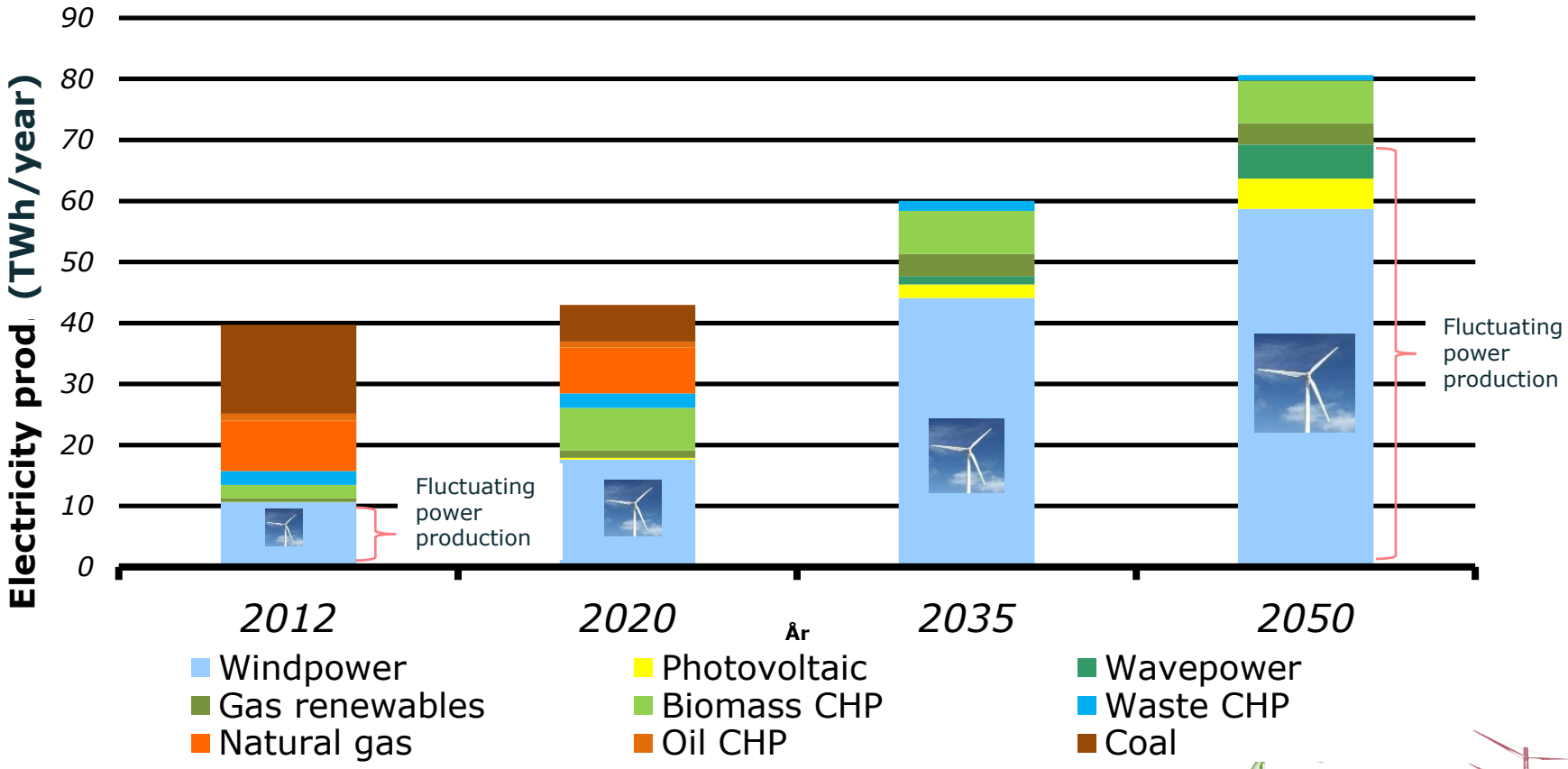
Balance 50 times a second



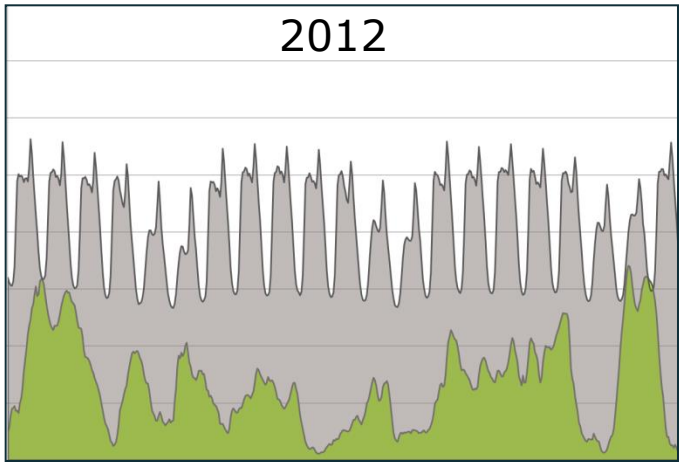
Consumption

.. and international interconnectors!

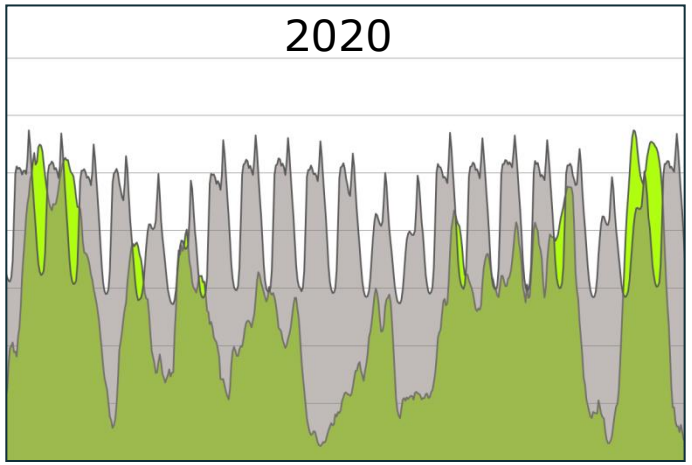
Electricity production in wind power scenario



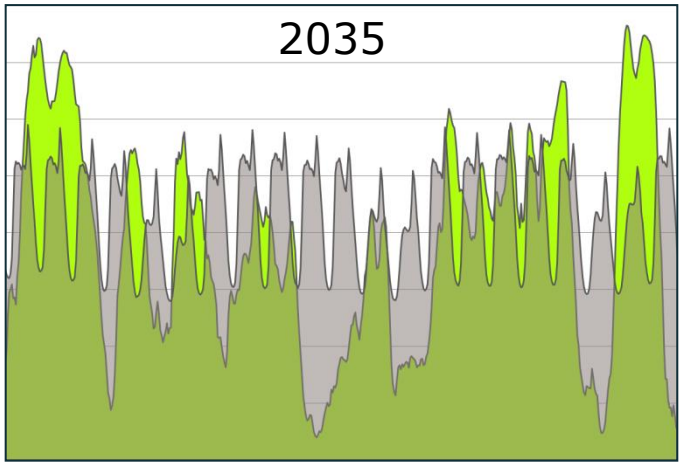
Wind Challenge (Three weeks in November)



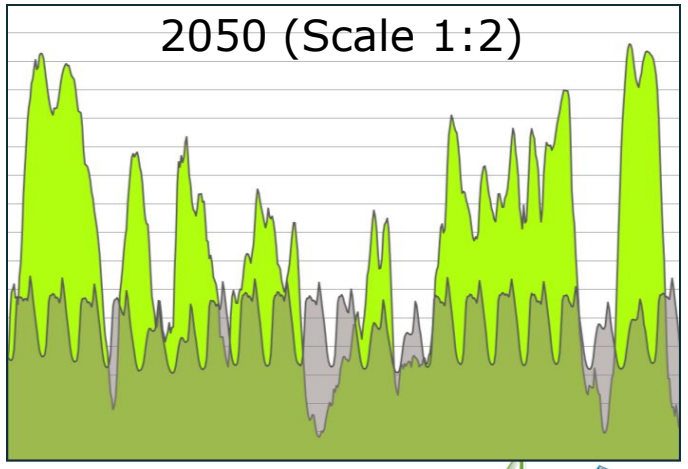
Wind share: Approximately 30% of classic consumption



Approximately 50%

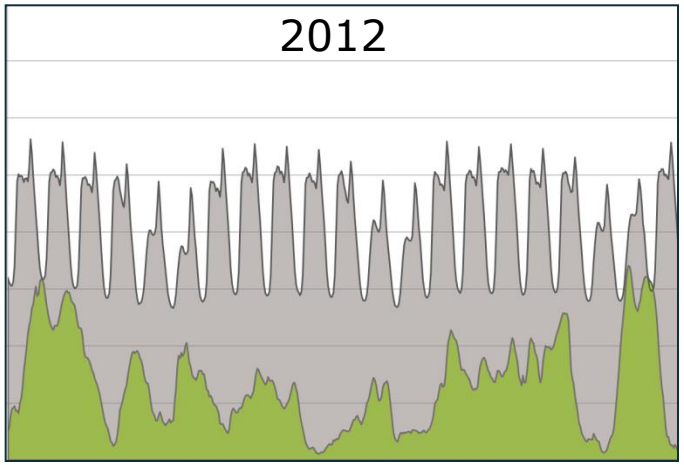


Approximately 80%



Approximately 150%

Wind Challenge (Three weeks in November)



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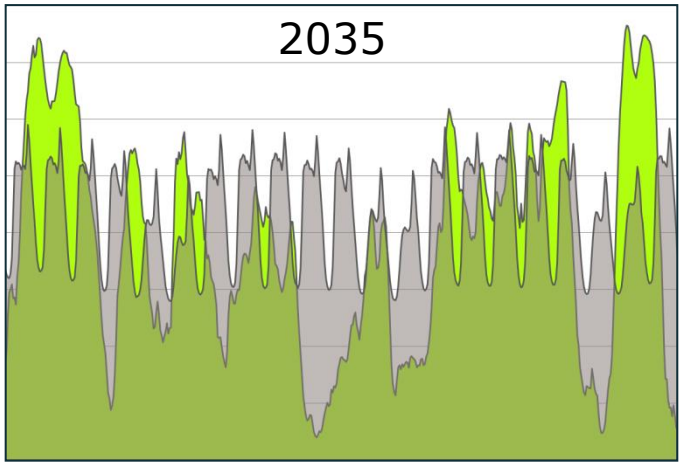

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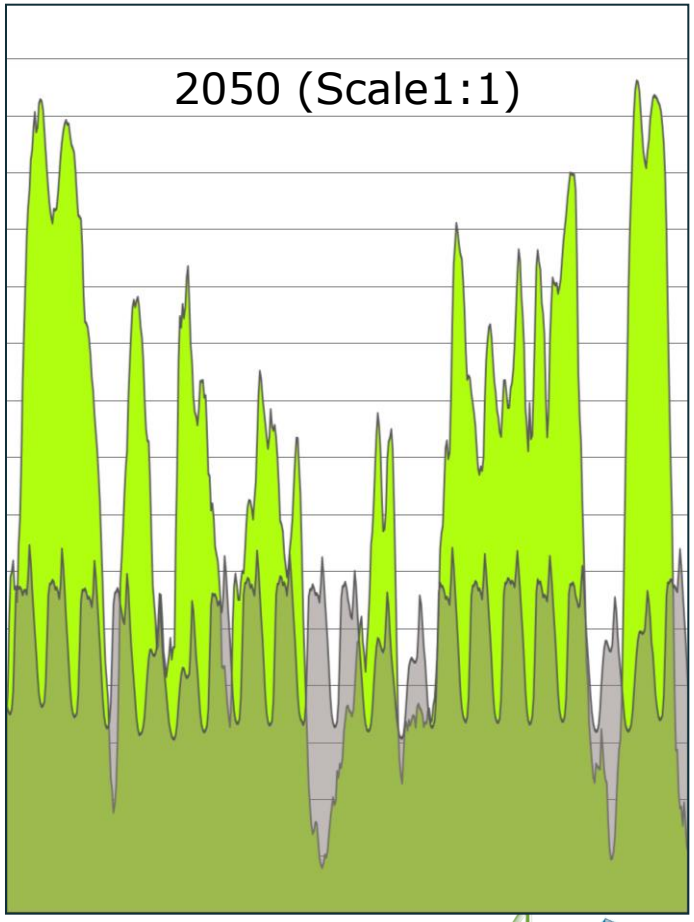
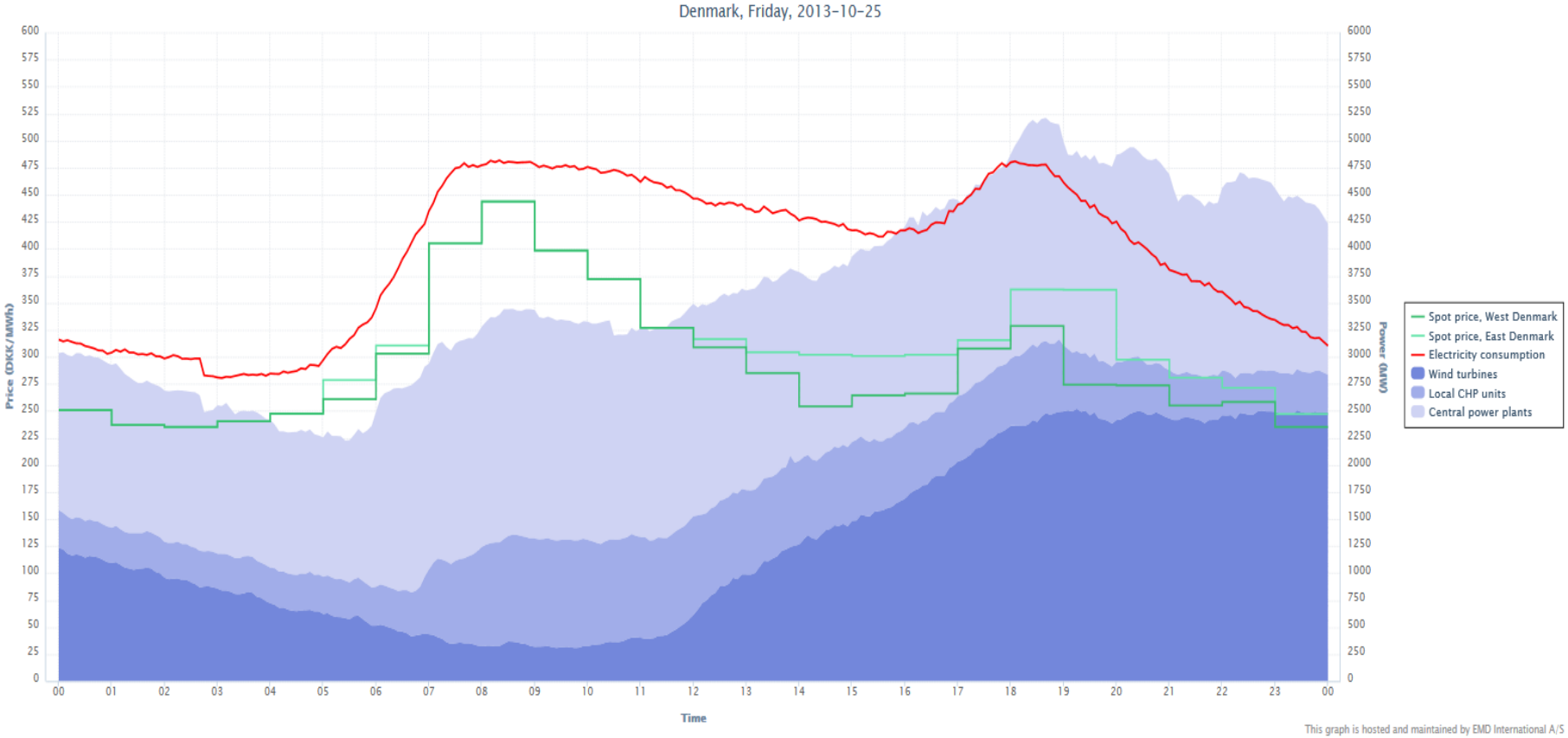


Approximately 150%

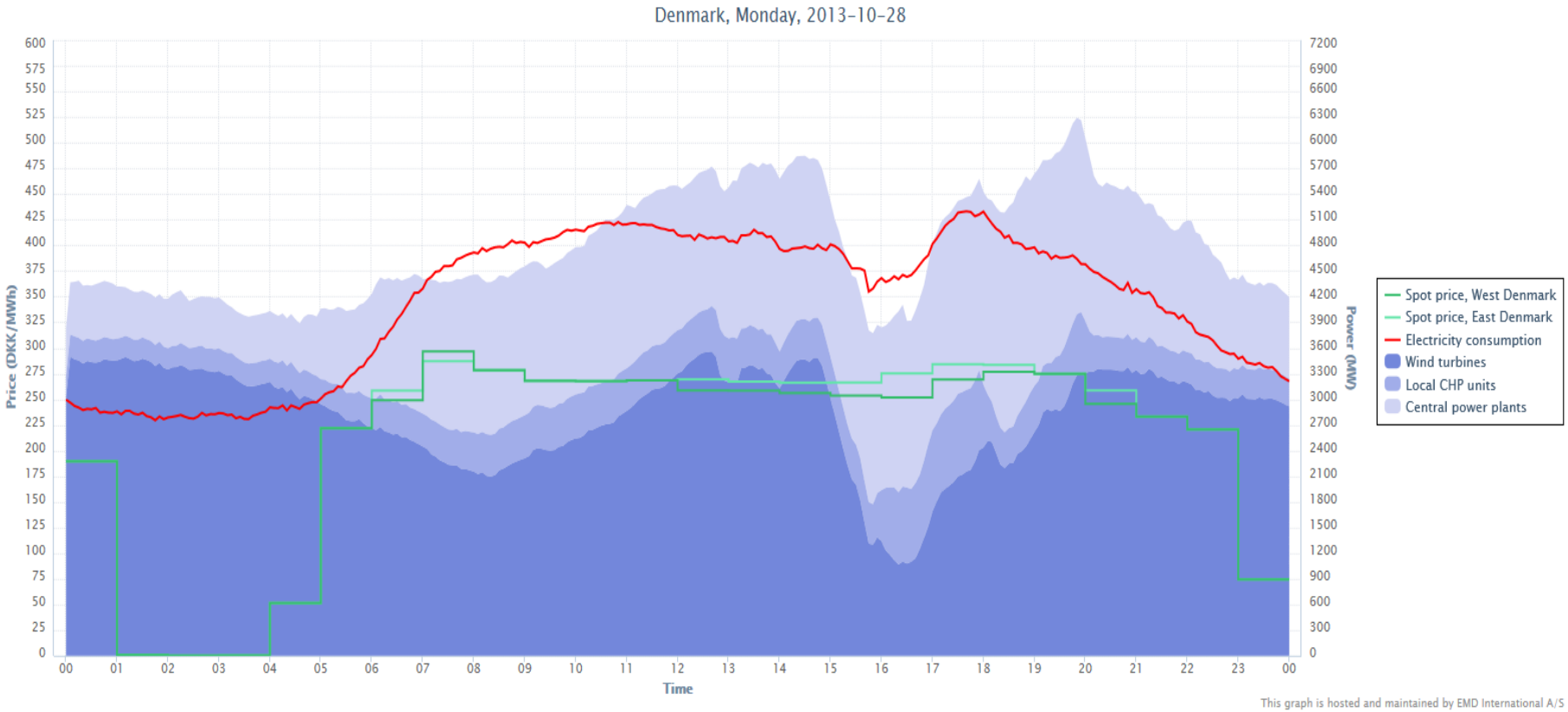
How about the present? – 2013 live situations!

- A perfect Friday – October 25th



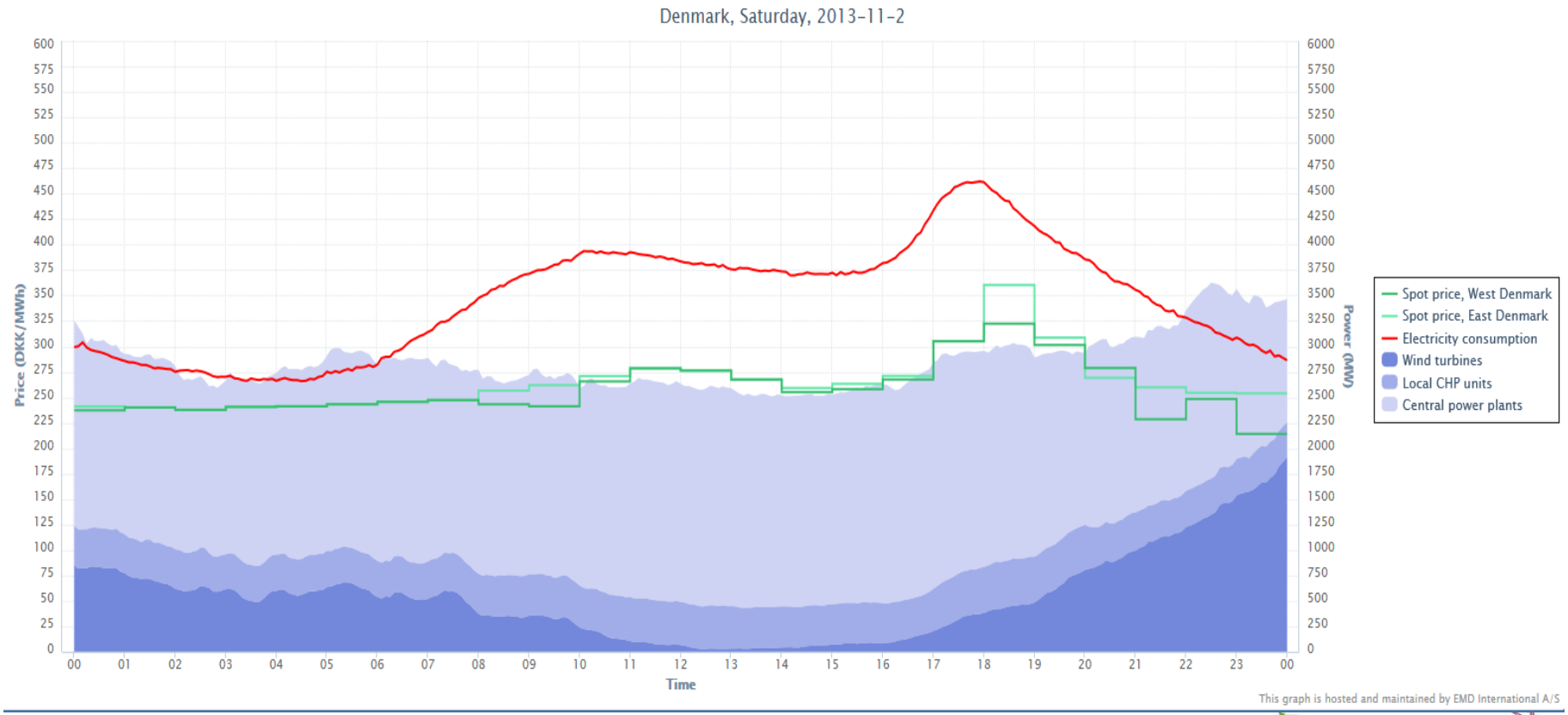
How about the present? – 2013 live situations!

- An extreme Monday – October 28th



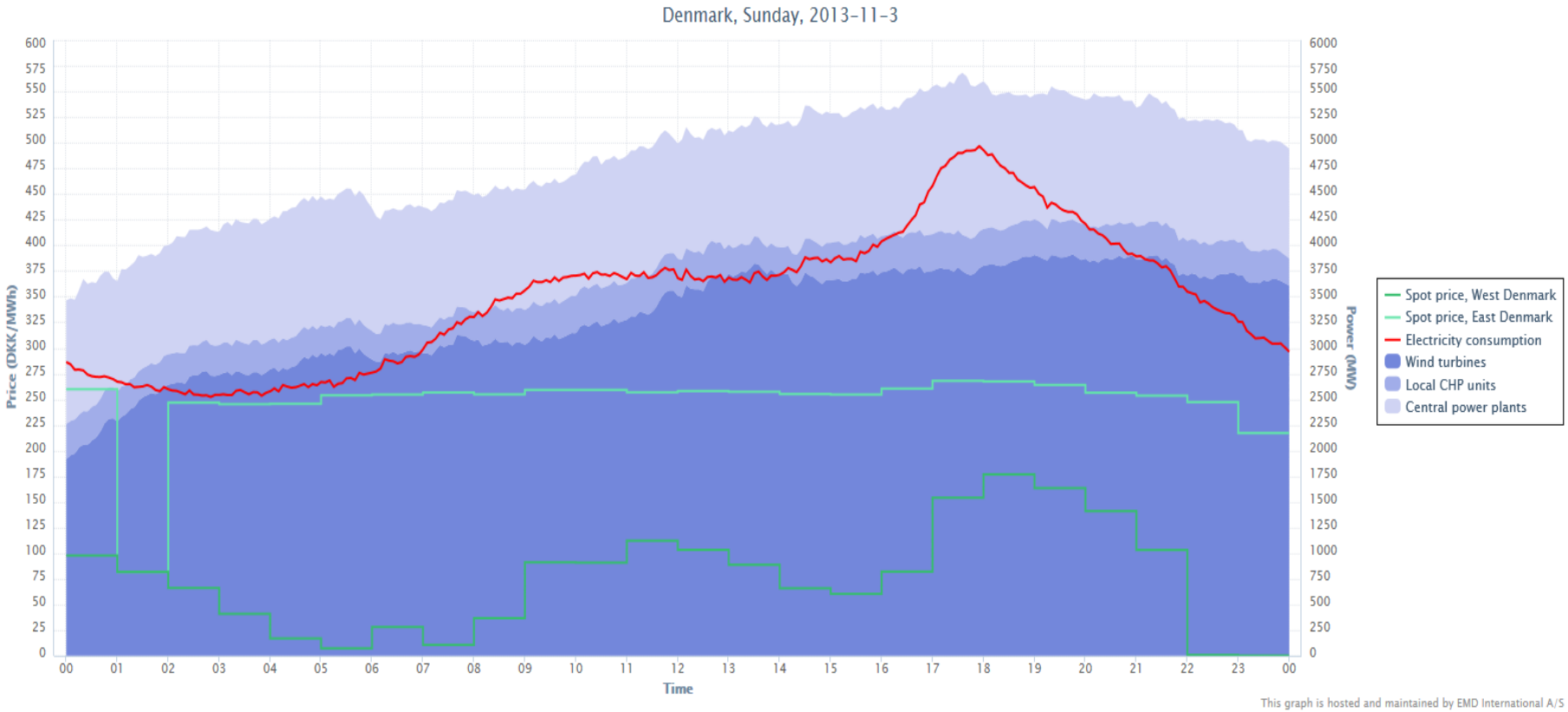
How about the present? – 2013 live situations!

- Saturday without any wind – November 2nd



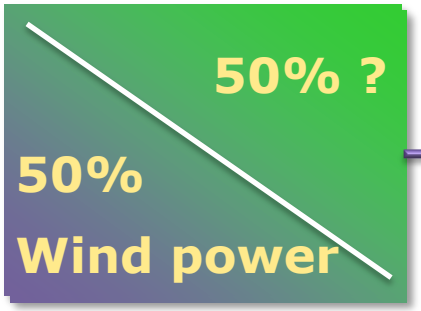
How about the present? – 2013 live situations!

- An other windy Sunday – November 3rd



Energinet.dk strong prioritizing for 2020

Production → **Means and solutions**



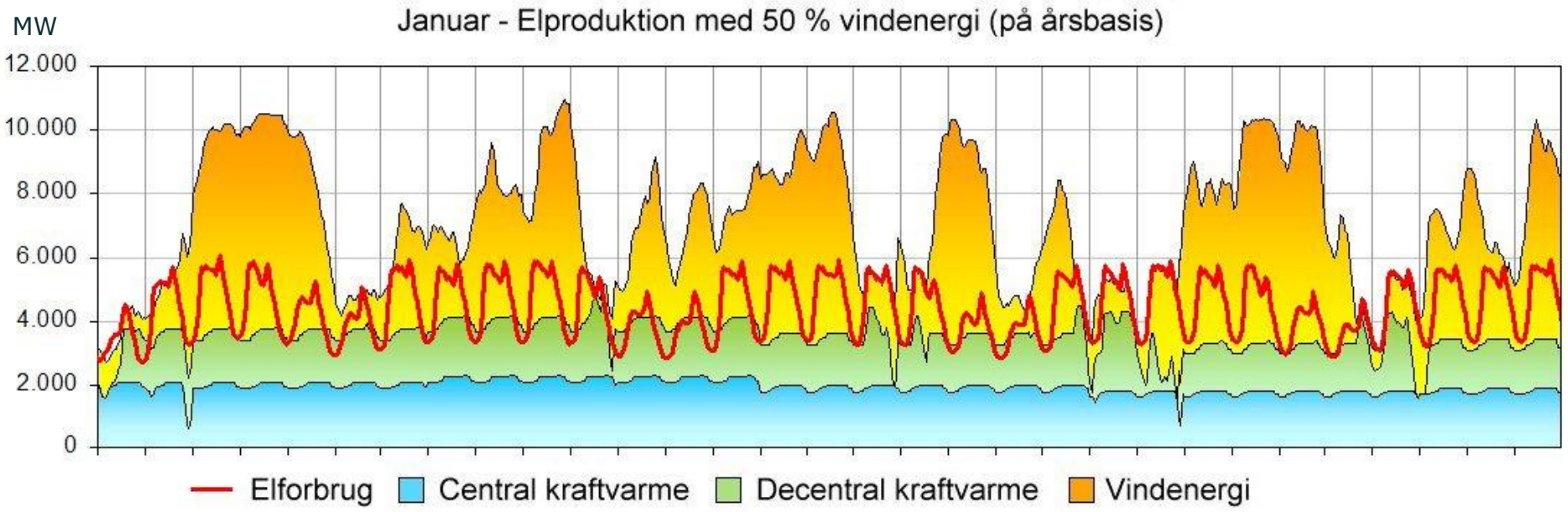
Robust transmission grid, strong interconnectors and market integration

Flexibility in demand and production – cooperation with storage, heat- and transportation sector

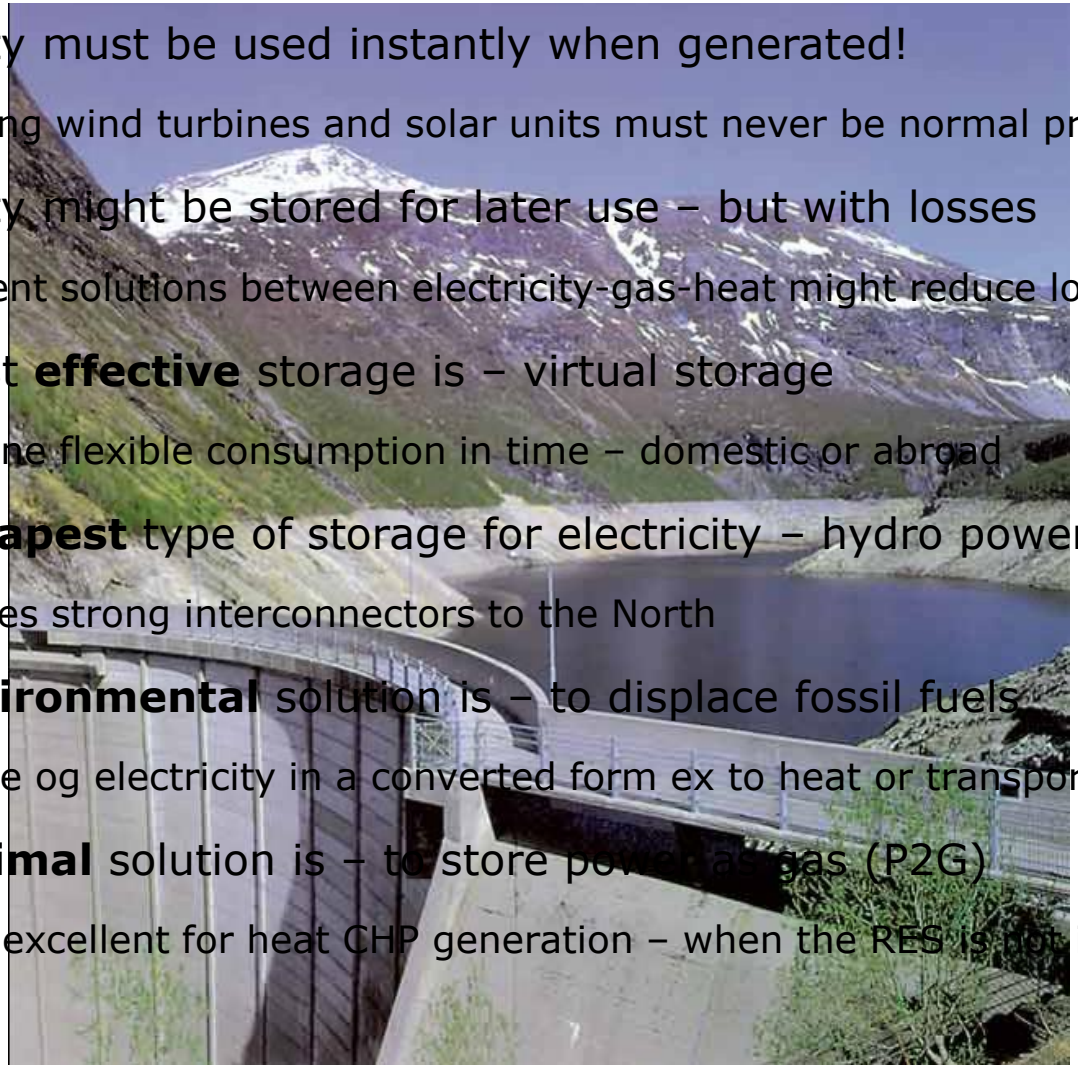
Smart Grid for efficient control and market based regulation of the power system – integrating of all local DER many based on gas

Power generation – with 50 % wind power in 2020

- 50 % wind power (p.a.) and power generation from CHP in a classic January month with heat demand
- Power generation will exceed load with 62 %
- Power overload (not domestic usage) at 40 % of the wind energy



Storage of electricity – the road to 100 % RE

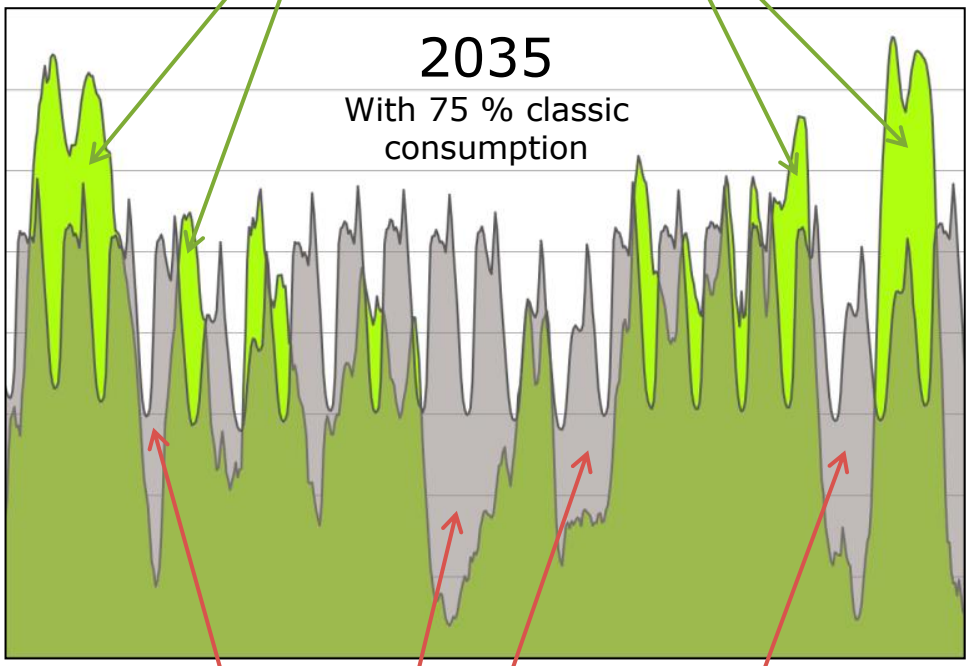


- Electricity must be used instantly when generated!
  - Stopping wind turbines and solar units must never be normal procedures
- Electricity might be stored for later use – but with losses
  - Coherent solutions between electricity-gas-heat might reduce losses
- The most **effective** storage is – virtual storage
  - Postpone flexible consumption in time – domestic or abroad
- The **cheapest** type of storage for electricity – hydro power in Norway
  - Requires strong interconnectors to the North
- The **environmental** solution is – to displace fossil fuels
  - Storage og electricity in a converted form ex to heat or transportation
- The **optimal** solution is – to store power as gas (P2G)
  - Gas is excellent for heat CHP generation – when the RES is not in operation

Wind challenge – three weeks of November in DK

Wind power generation exceed the classic consumption utilization from:

1. Interconnectors
2. New flexible demand and storage



Wind power generation below the classic consumption – balancing from:

1. Interconnectors
2. Domestic flexible generation and storage

New consumption

(With high flexibility)

Example

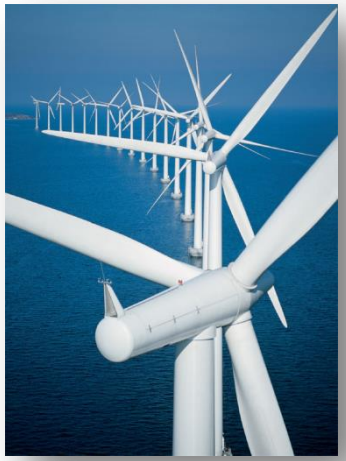
- Electrification of industrial process energy
- Private heat pumps and electric heat/cooling
- Large heat pumps and boilers in the district heat grid and heat storage at the CHP plants
- Electrification of transport
- Storage: Batteries (LV-grid), CAES, Electrolysis and P2G

Domestic flexible power generation

Example

- Power plants (gas and biomass)
- CHP units (gas engine and CCGT)
- Micro CHP
- Storage: Batteries (LV-grid) and CAES

2020 New massive electricity consumption



Wind to Heat - conversion

- 300,000 private Oil Boilers should be converted to Heat Pumps with Smart Grid applications or District Heat – 200,000 before 2030
- 60 % of all Danish homes are using District Heat (from CHP operation)
- Large Heat Pumps (larger than 100 MW each) must be integrated in the major District Heat transmission systems
- Electric Boilers in the District Heat systems – 300 MW already installed

Wind to Wheels - transportation

- Plug in Hybrid cars and Electric vehicle
- The infrastructure; Power supply, communication and Smart Grid applications – being launched and deployed now and in the next 2-3 years

Wind to Storage – with minor losses

- Power to Gas (P2G) conversion is the primary focus area for large scale storage. Ongoing R&D projects aiming for large Demo facilities
- Large Batteries, Compressed Air Energy Storage (CAES), Fly Wheels and other R&D relevant technologies for Demo projects

Energinet.dk vision for the future: 2020 → 2030

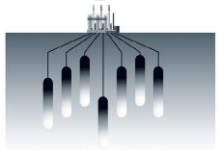
Production → **Means and solutions**

100 % RE

Strong interconnectors and market coupling to Europe

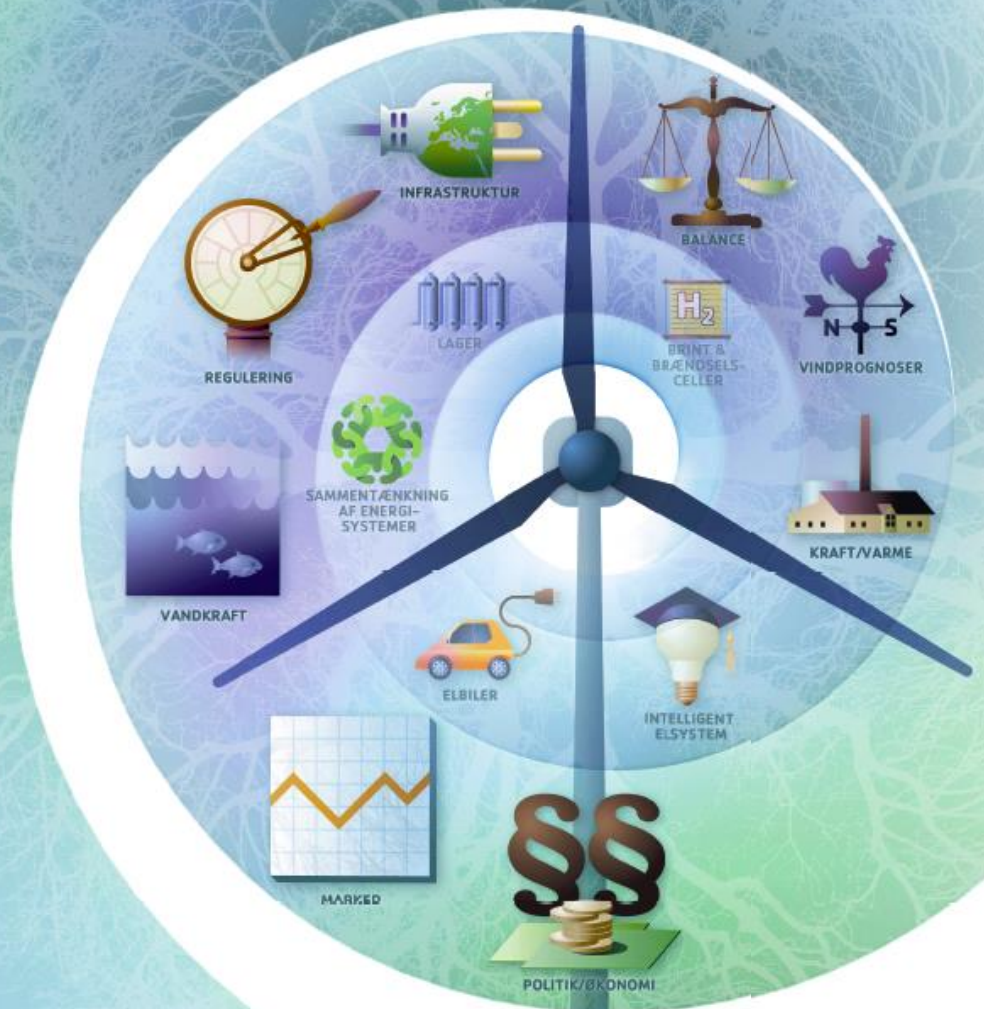
Coherent energy systems, cooperation between gas, electricity, heat and transport

Intelligent energy using smart grid, gas fired CHP units and flexible demand



Gas storage

Conversion of electricity to gas (P2G) for quantitative storage for later use in CHP units to new electricity production



Thanks for the attention