

Running the Cell Controller Pilot Project as a Virtual Power Plant

2010 Full Scale Test Results

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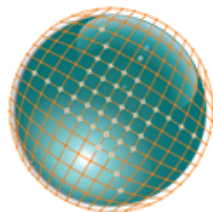
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4th International Conference on
**Integration of
Renewable and Distributed
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This Presentation

- Brief introduction to the Project
- Test 1. Market Operation and DNO Voltage Control
- Test 2. Market Operation, DNO Voltage Control
and TSO Reactive Power Import/Export Control
- Further Work and Project Perspectives for Energinet.dk

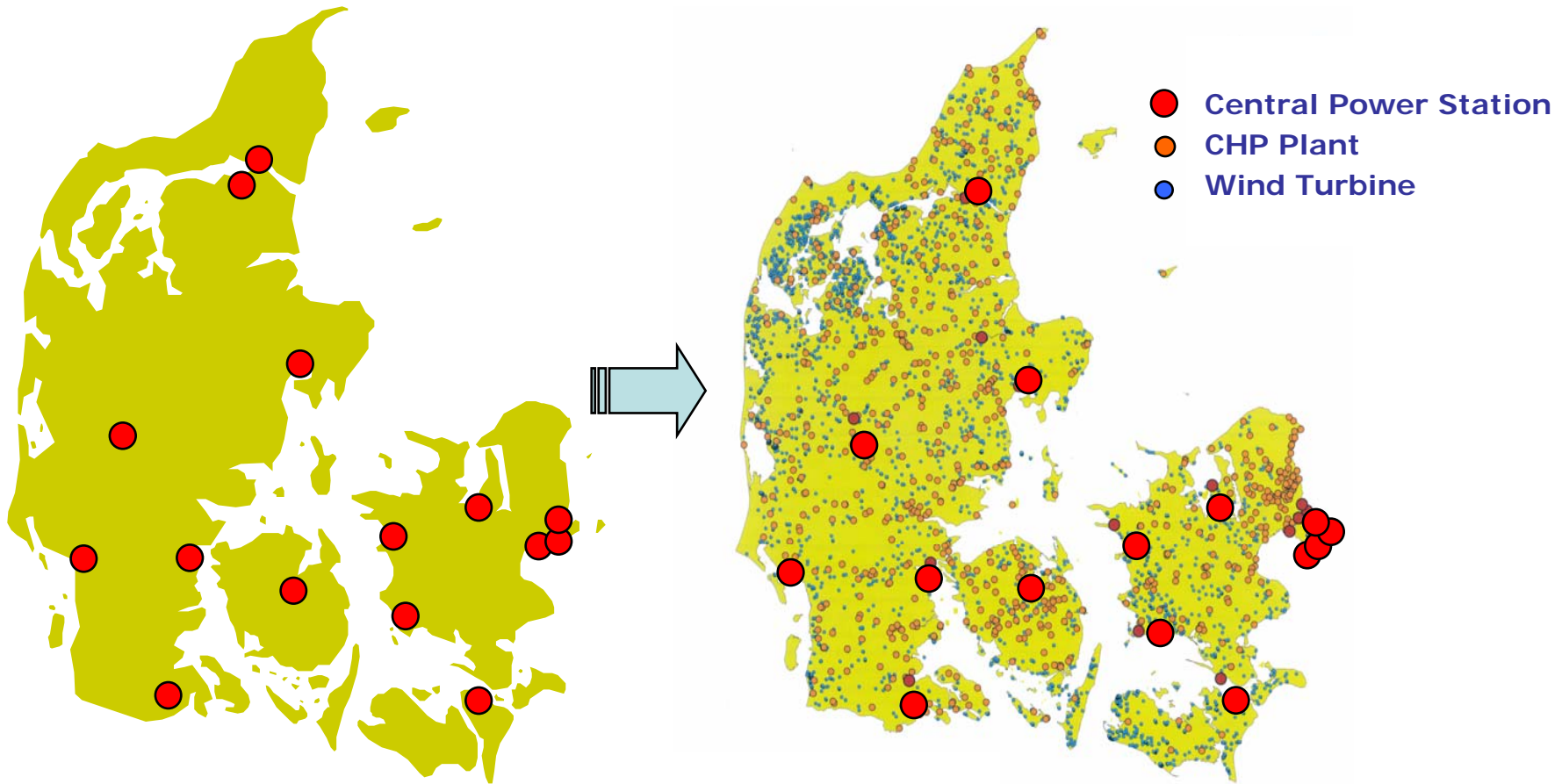
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Development from the 1980'ties until to day

Primary Generation

Distributed Generation



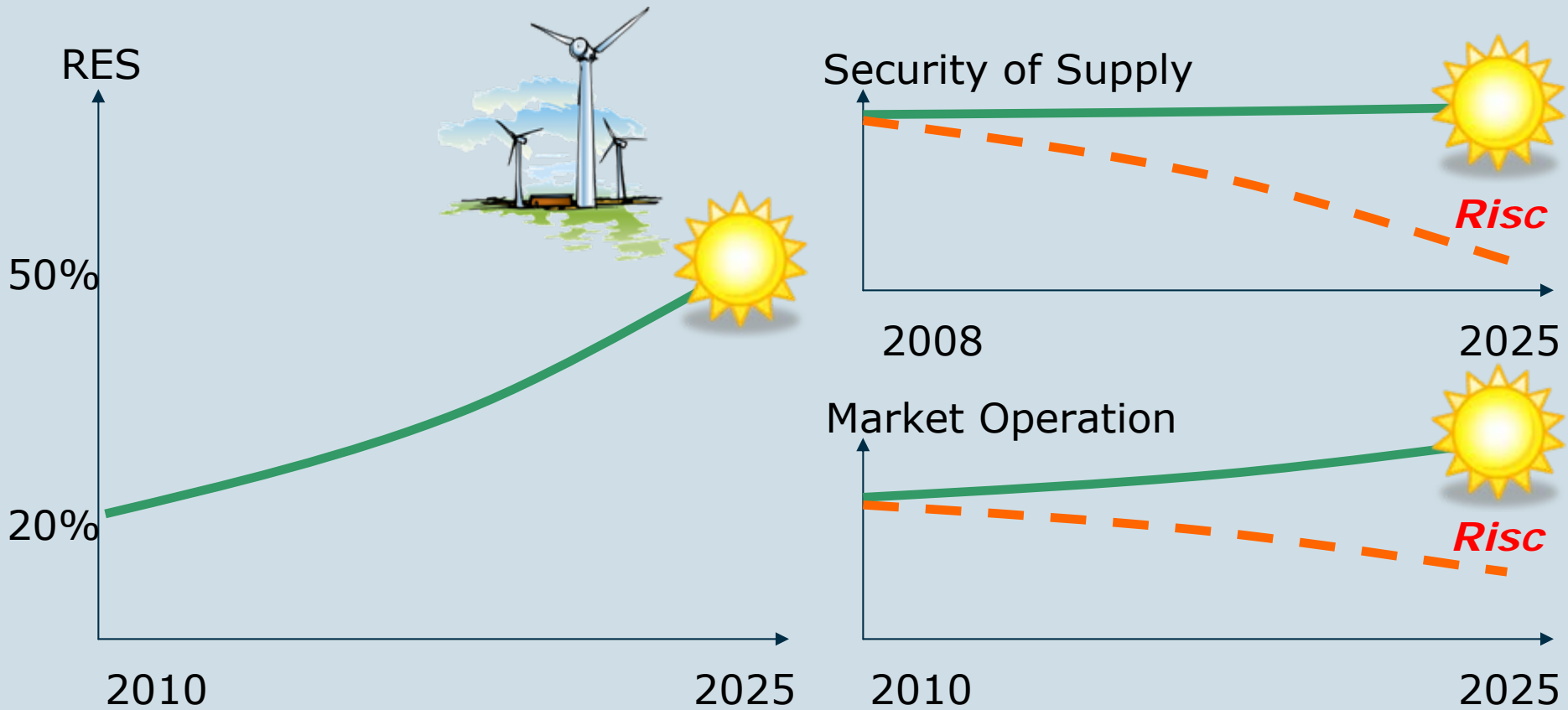
Challenge for the Danish Power System

Progressive Danish Climate and Energy strategy

	2010	2025
Wind Energy	24 %	50 %
Biomass, Solar and Wave Energy	10 %	20 %
Total RES	34 %	70 %
Electrical Vehicles	100	600,000
Heat Pumps with storage	30,000	300,000

(Danish population approx. 5,500,000)

Challenge for Security of Supply and Market Operation

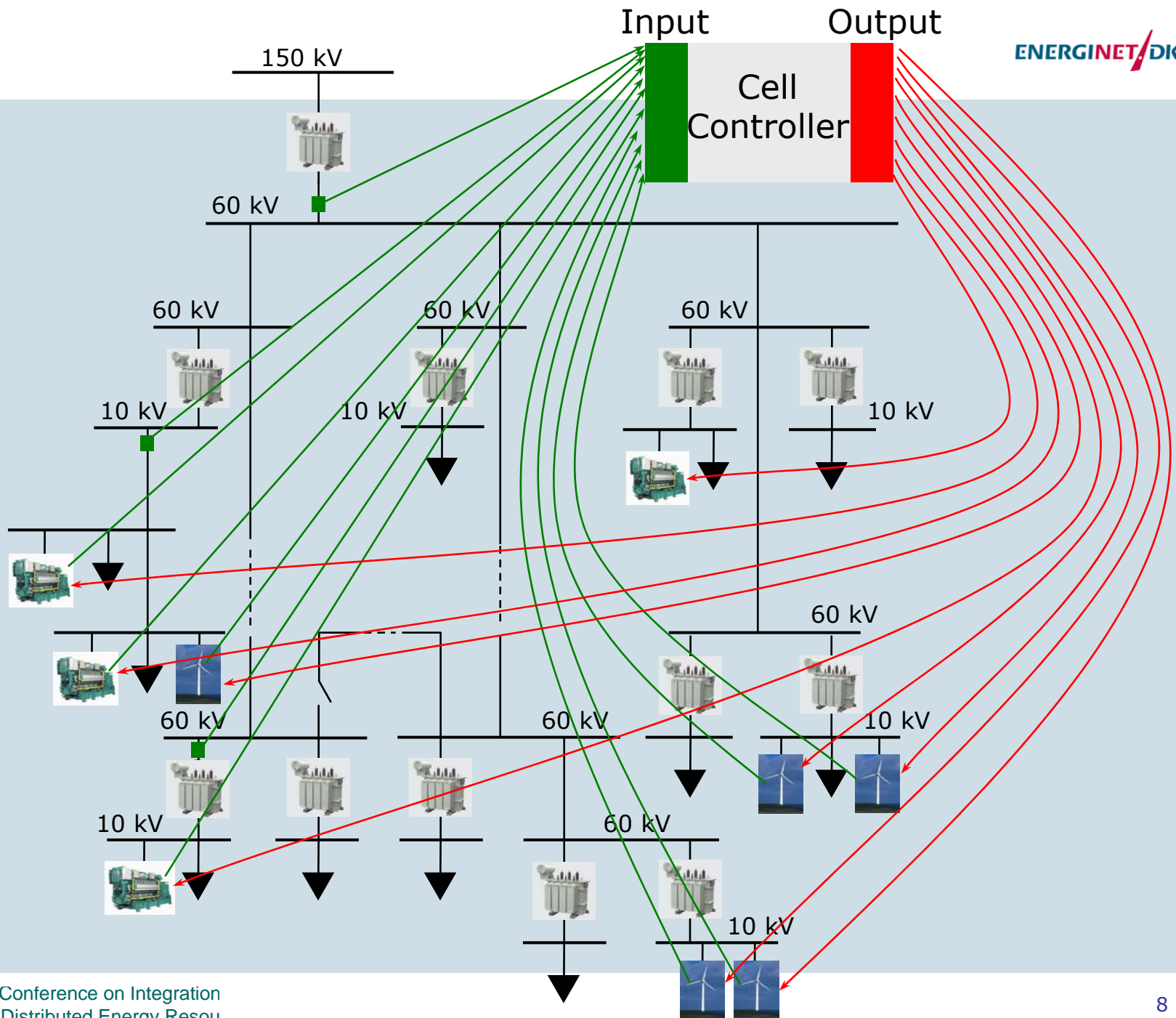


In 2008 Energinet.dk formulated strategic goal for 2025:

The Worlds best RES based Power System
in Safe Operation in 2025

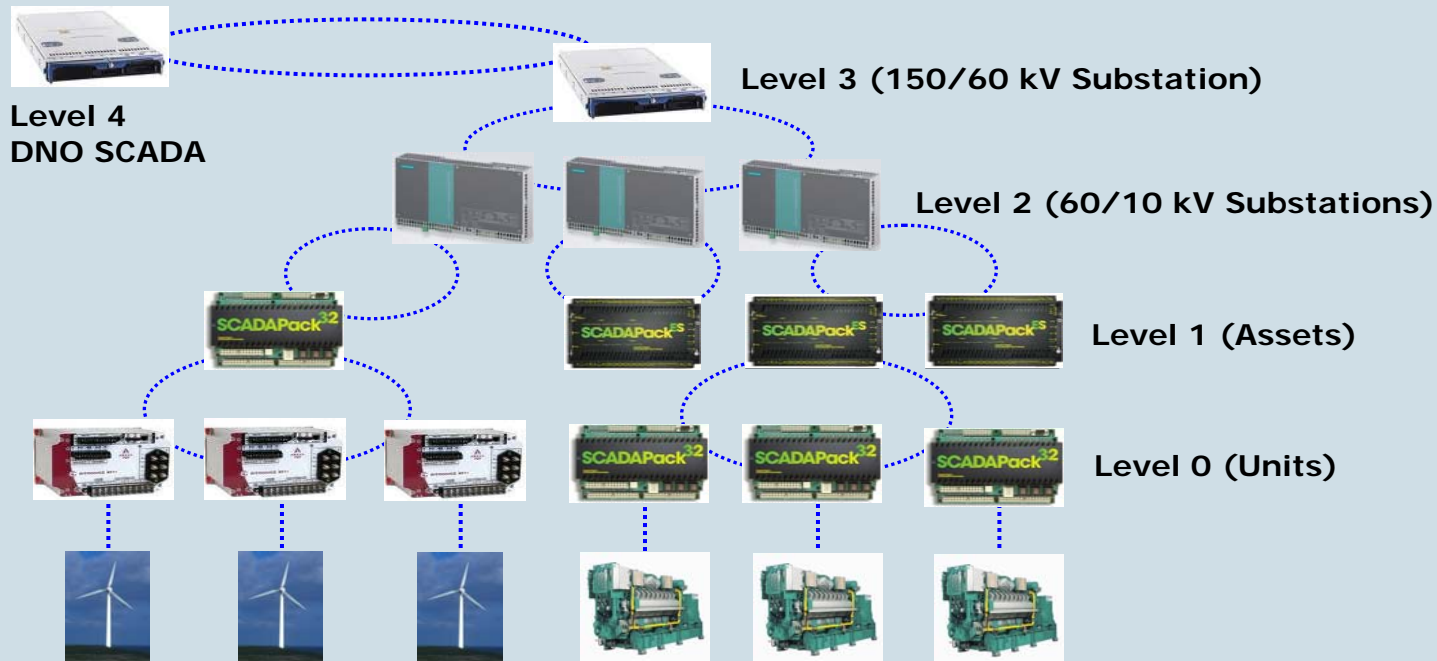
based on 3 pillars

- **Strong Transmission Grid, Interconnectors and Market Integration**
- **Integration of Transportation and Heat Sectors**
- **Intelligent Control**



Cell Controller Architecture

- Layered control hierarchy using distributed agent technology and high speed fiber network
- Each agent consists either of an industry CPU, a high-end RTU or an intelligent meter



Virtual Power Plant

Following assets are included in the Cell area

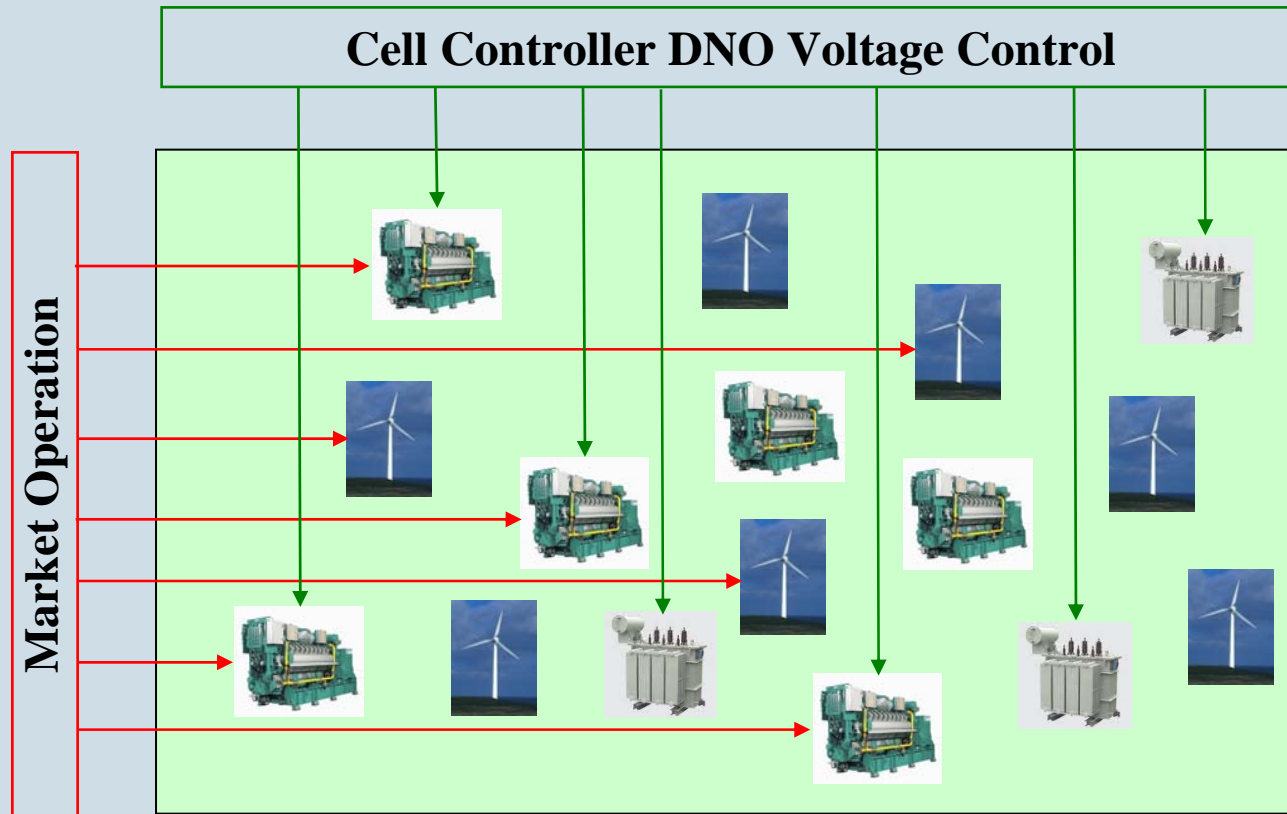
- Billund CHP with 3 each 2875 kW generators
- Hejnsvig CHP with 2 each 1030 kW generators
- Holsted CHP with 1 each 3060 kW generator
- Brørup CHP with 1 each 3.845 kW generator
- 47 wind turbines between 600 and 1300 kW
- 1 each 150/60kV substation inclusive of transformer with tap changer
- 13 each 60/10 kV substations inclusive of all transformers which all have tap changers
- All 60 kV lines and cables connecting all 60 kV substations
- 69 each 10 kV load feeders inclusive of all load and smaller production units not listed above

The extend of the Cell area is some 1000 km²
including 28.000 customer meters

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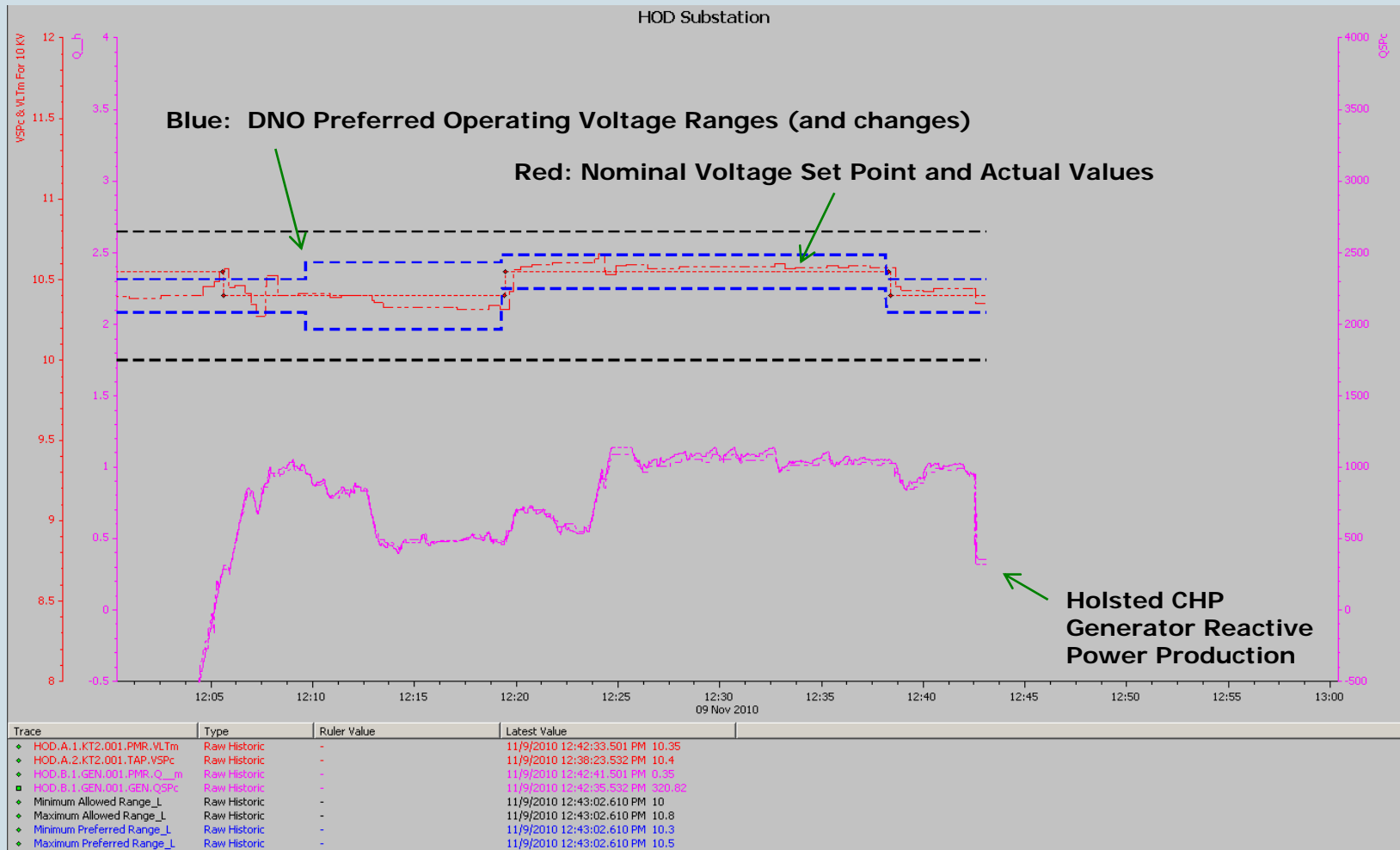
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Market Operation and Voltage Control



DNO Voltage Control

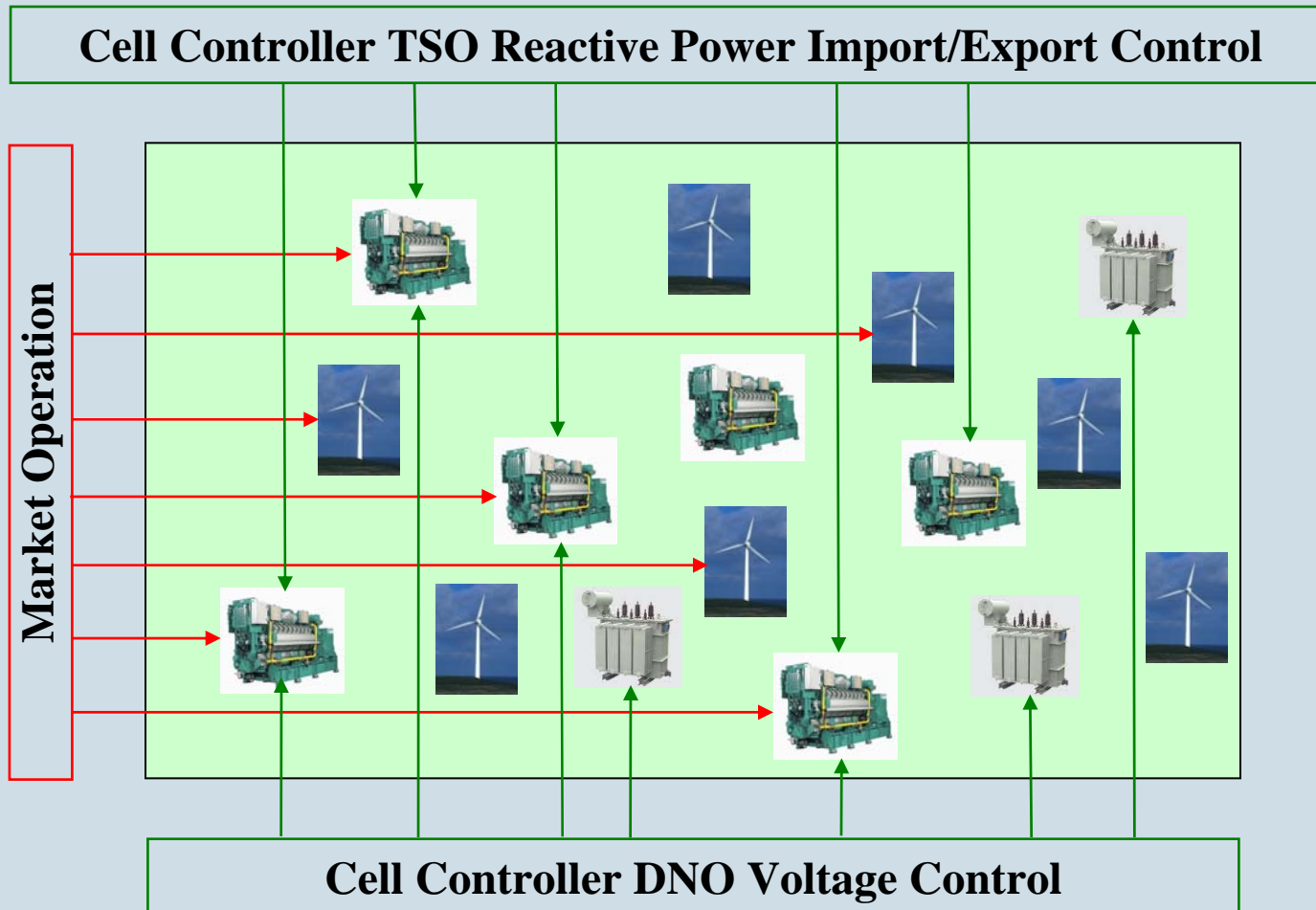
Example of trend at 10 kV substation Holsted



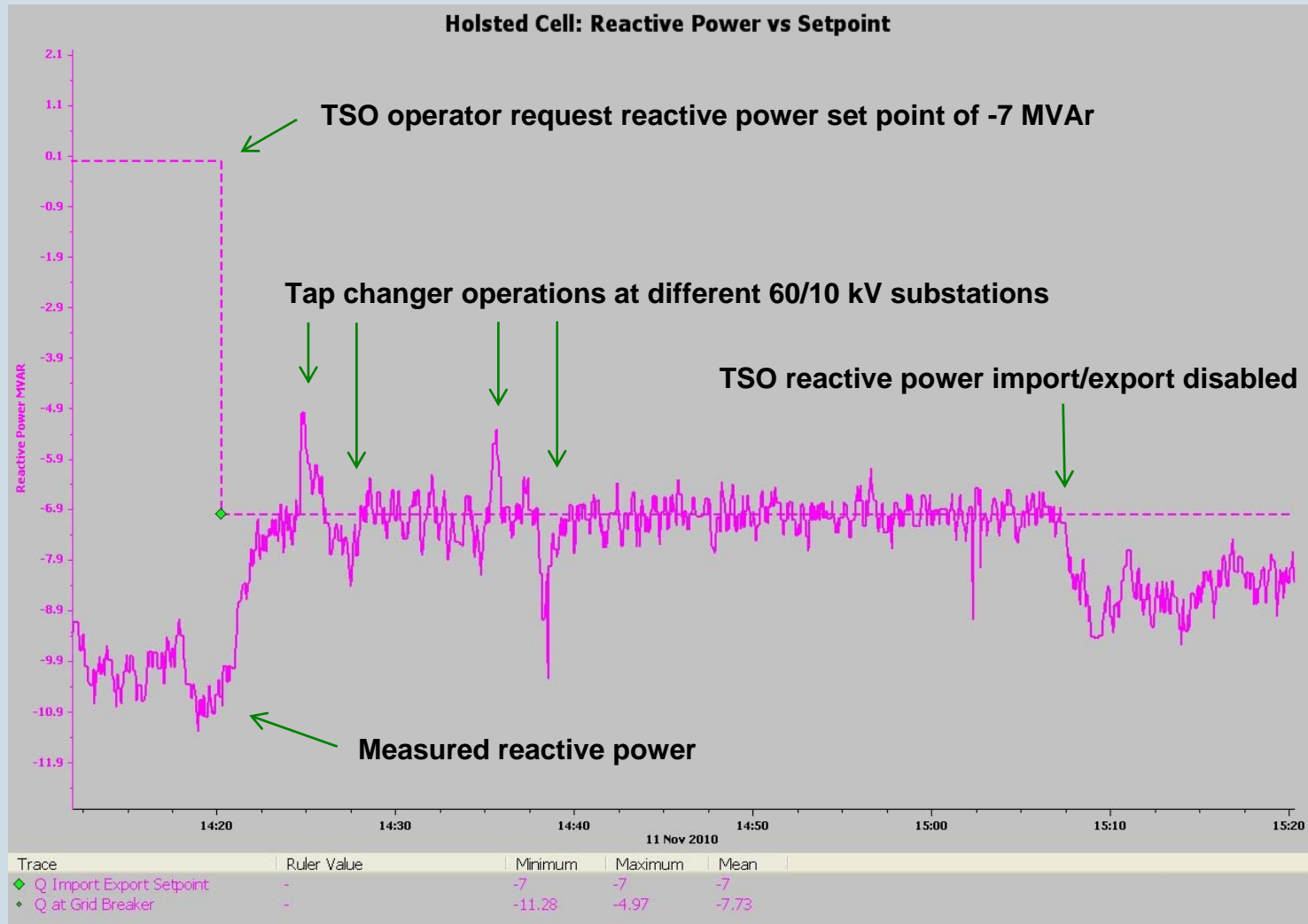
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Market Operation and Reactive Power Import/Export Control

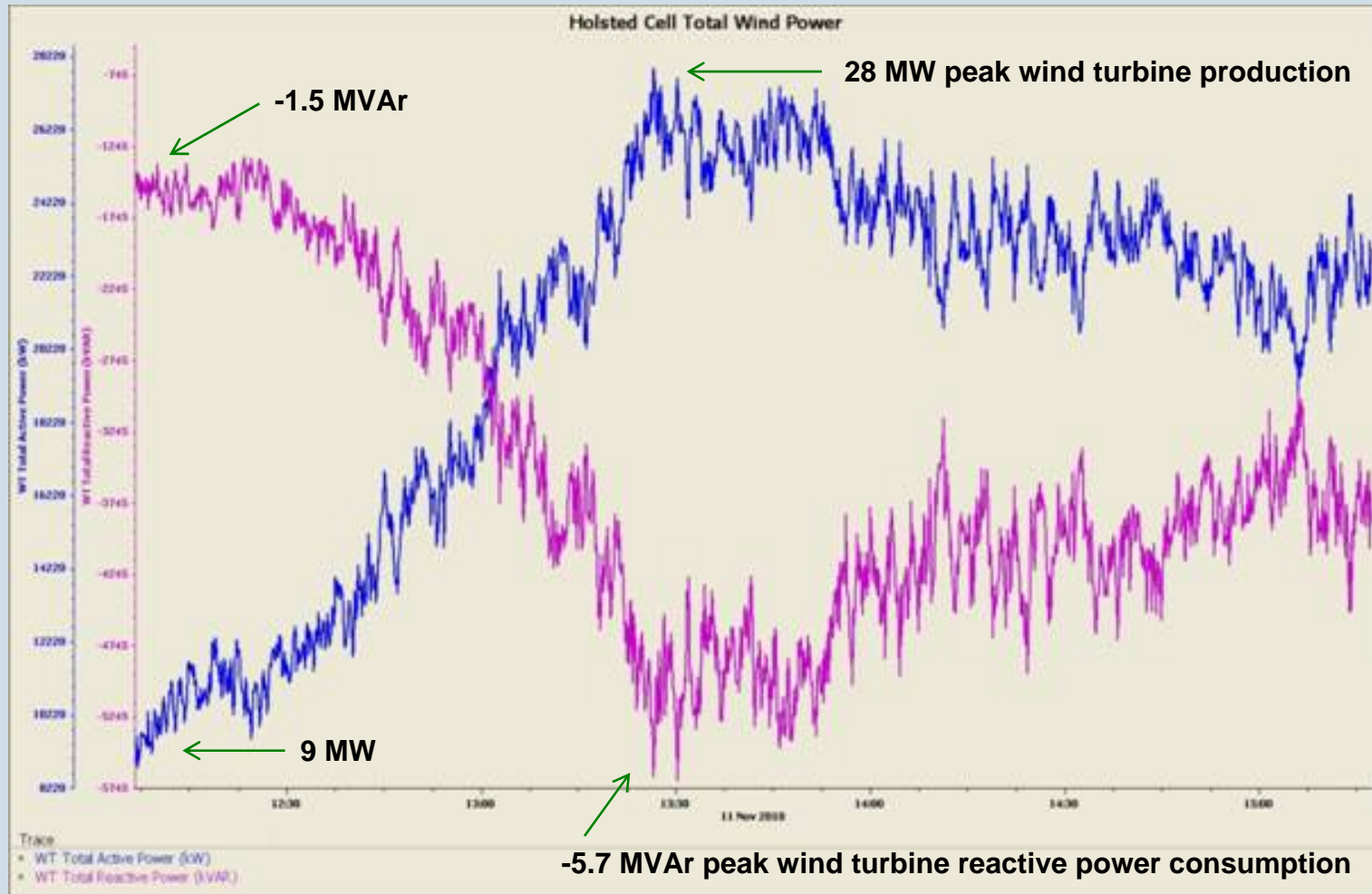


Reactive Power Import/Export to Transmission System



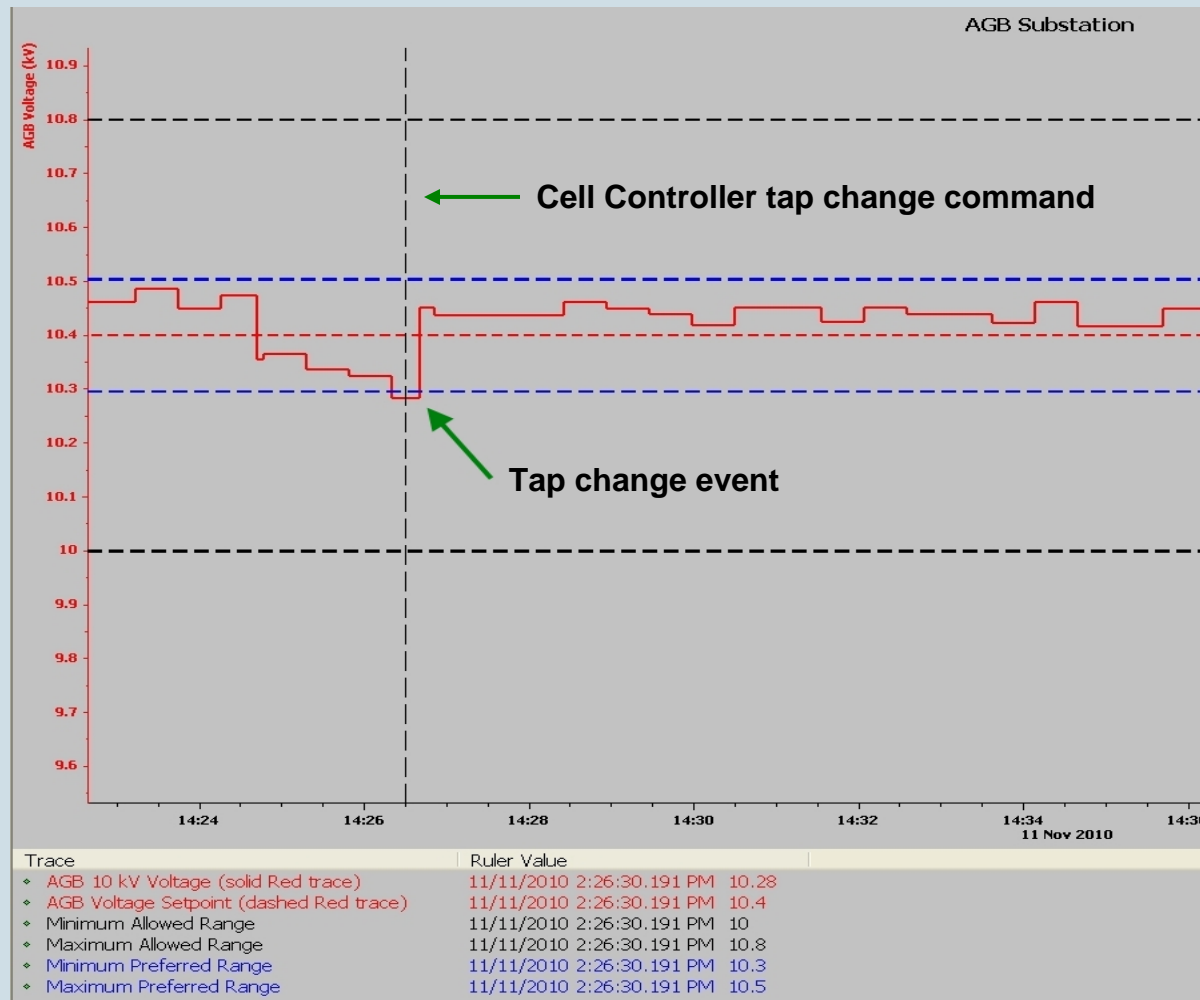
Reactive Power Import/Export to Transmission System

Total Wind Power production in Cell area during test



Reactive Power Import/Export to Transmission System

Example of tap changer operation at Agerbæk 60/10 kV substation



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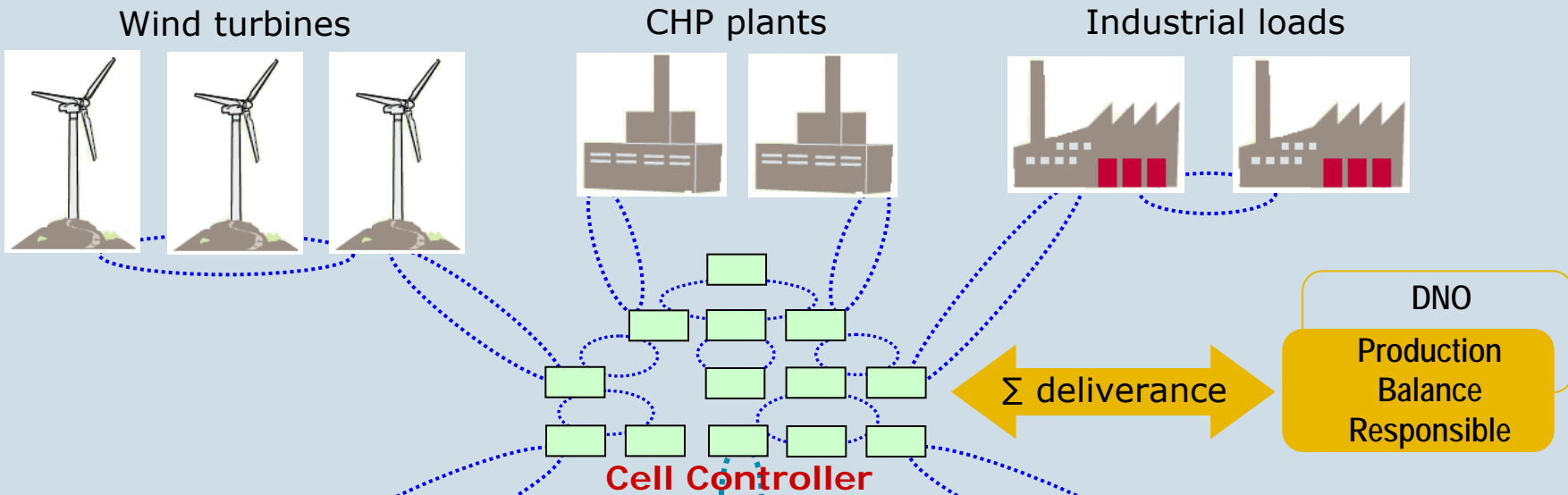
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Finalization of the Cell Controller Pilot Project

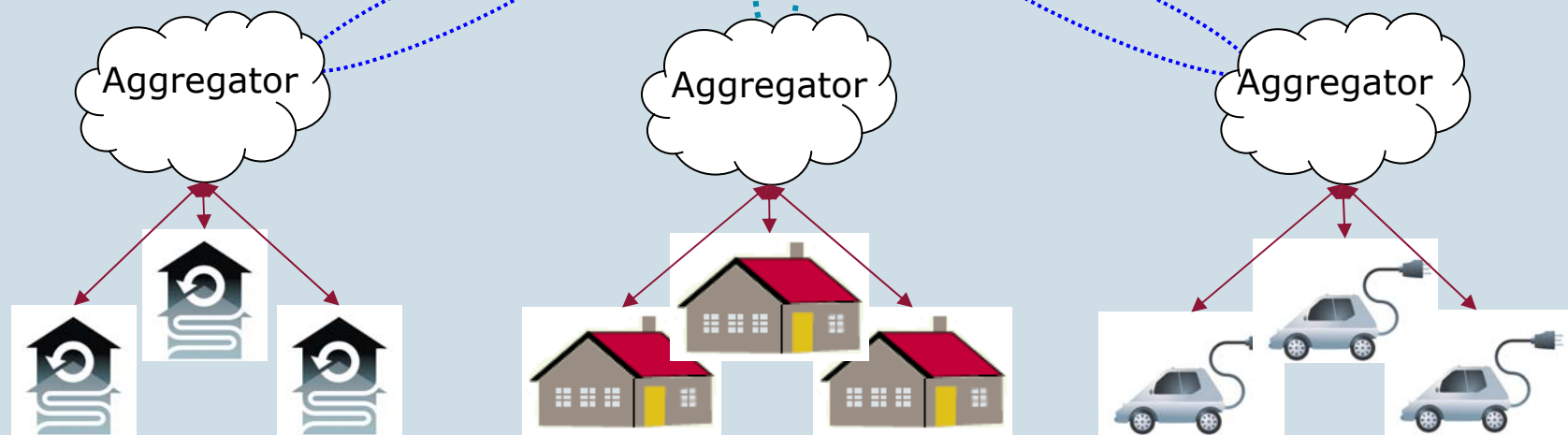
- Extensive analysis of performed tests
- Develop prototype of Cell Controller software
- Test of all grid connected functionalities – May 2011
- Test of transition to and islanded operation – June 2011
- Final reports and documentation – September 2011

Cell Controller as main engine in EcoGrid.EU

Existing system



New in EcoGrid.EU



Thank you for your attention

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