WCMS in interaction with alpha ventus

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Content

- WCMS – description of the system

- General Topology of the Electrical Grid

- Grid Topology of alpha ventus

- Assumptions for the Grid Calculations

- Screenshots of the WCMS Program

- Outlook

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WCMS - Wind Cluster Management System

The WCMS is a software system which combines geographically distributed wind farms as a single "Wind Power Plant" and manages these farms in order to provide grid and system services.
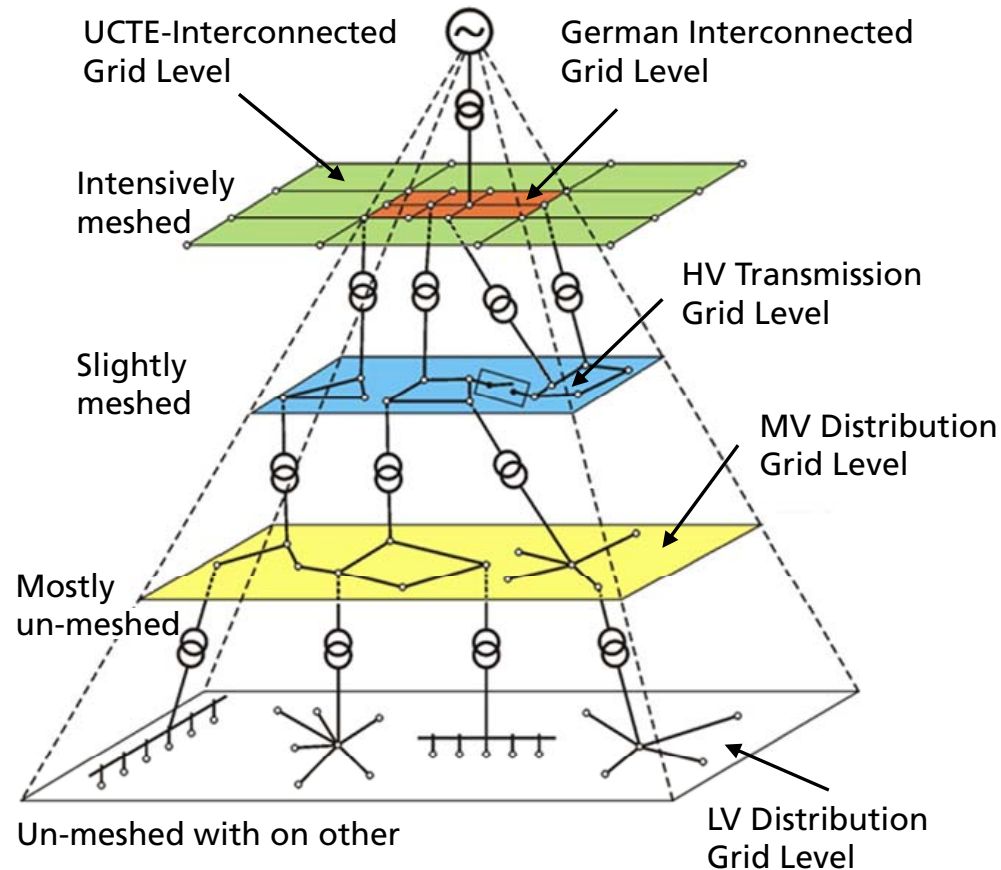
Overall Goals
- Ensuring voltage and frequency stability
- Avoiding congestion
- Optimizing operation (minimization of losses and fluctuations)
- Supply wind power according an externally specified schedule

Necessary information
- Wind power forecast
- Reactive power capabilities (PQ-curves) of single turbines or wind farms
- Current grid topology

WCMS - Description of a Grid Topology

UCTE-Interconnected Grid Level

German Interconnected Grid Level

Intensively meshed

HV Transmission Grid Level

Slightly meshed

MV Distribution Grid Level

Mostly un-meshed

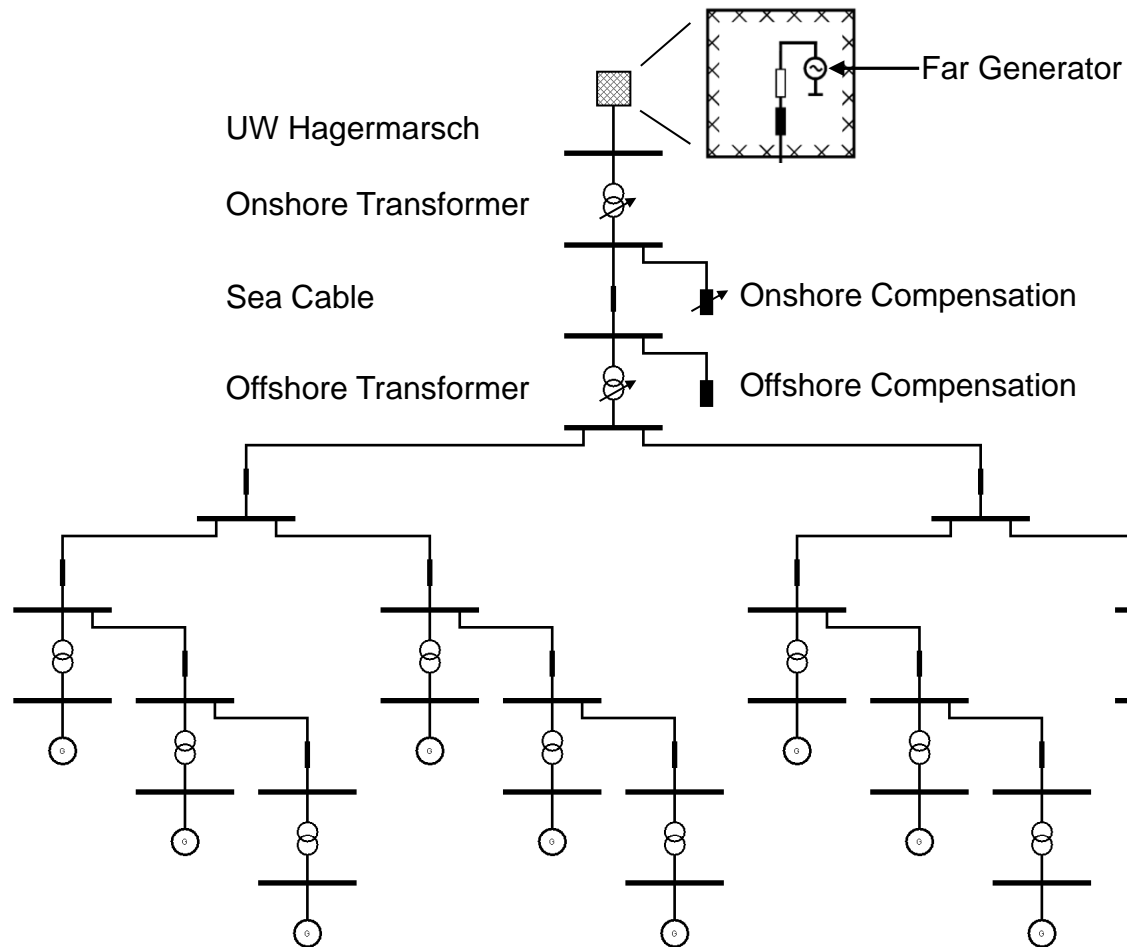Un-meshed with on other

LV Distribution Grid Level

Meshed Grid:

Not designed for worst case power flow

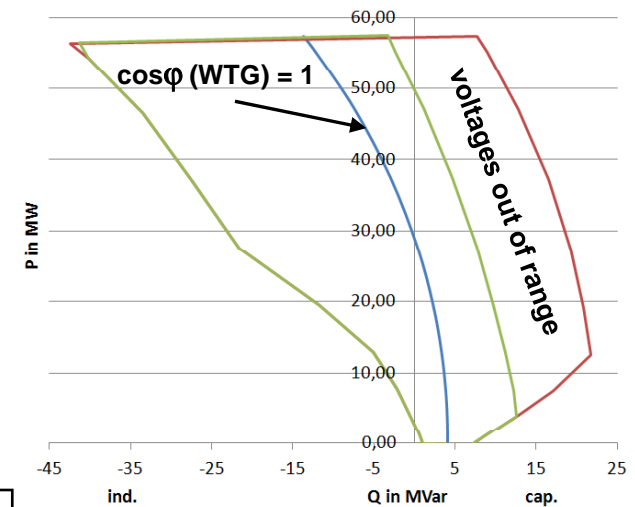→ mainly problems with congestion in time periods of high feed-in

Un-Meshed / Radial Grid:

Designed for worst case power flow

→ basically no congestion problems

→ mainly voltage problems

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WCMS – Grid Topology of alpha ventus

Far Generator

UW Hagermarsch

Onshore Transformer

Sea Cable

Onshore Compensation

Offshore Transformer

Offshore Compensation

PQ-Curve at UW Hagermarsch:

cosφ (WTG) = 1

voltages out of range

P in MW

ind.   Q in MVar   cap.

PQ-Curve of a wind turbine:

P in MW

Q in MVar

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WCMS - Assumptions for Grid Calculation

Assumption for the calculations, presented within the following slides:

- No voltage controlled grid nodes – except Far Generator

  Voltage value at the Far Generator: 105%* U_n = 115.5 kV

- Compensation units in maximum position

- Transformer taps in neutral position (rated transmission ratio)

- Wind turbines feed-in maximum available power; cos φ = 0.98 inductive

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WCMS – Active and Reactive Power Forecast

Power Monitor

PQ-Curve at UW Hagermarsch
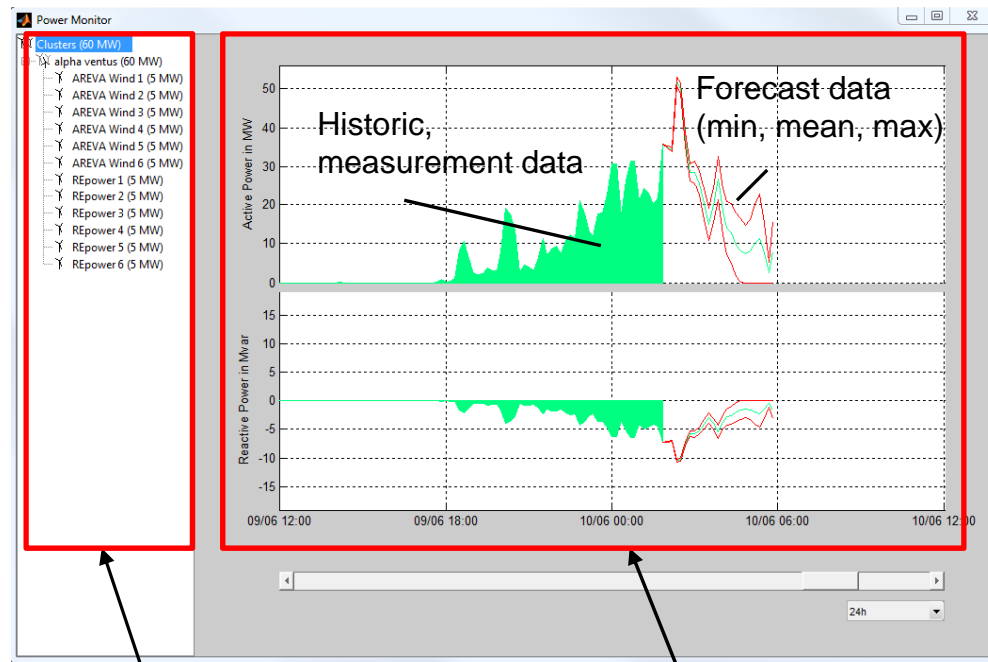
Get information
of a single turbine
or the whole cluster

Active and reactive power
data (gross values – without
grid losses)
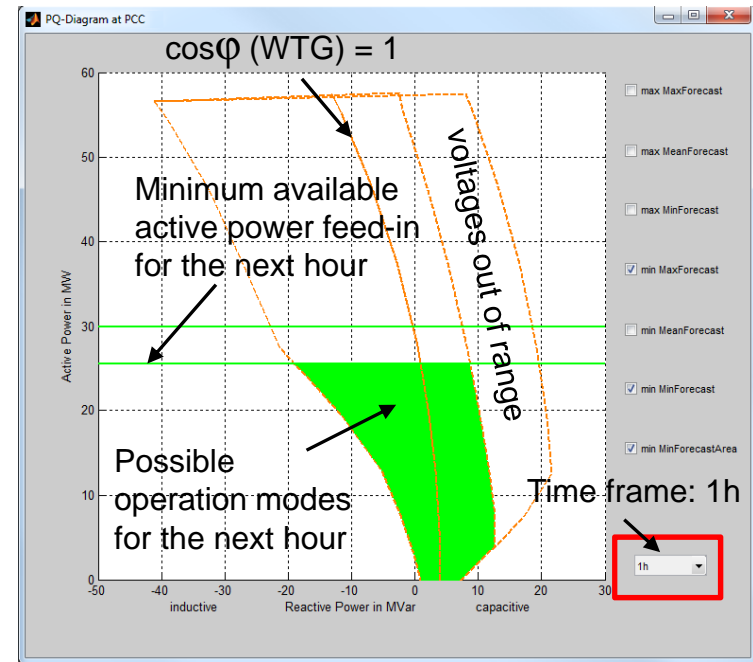
Active and reactive power data
relating PCC node
(net values – including grid losses)

WCMS – Voltage and Utilization Factor Monitor

Voltage Monitor

Utilization Factor Monitor

Actual values

Data based on power forecast

WCMS – Main Monitor - Creating a Setpoint

Can define setpoint via context menu

WCMS – Main Monitor – Finding Setpoints

Can define setpoint using 'problem solver' via context menu

Perform necessary specifications

WCMS – Breaking Down a Setpoint

Single turbine consequences of a PCC setpoint are calculated, with relationships such as:

$$\Delta U_{node} = f(\Delta P_{nodes}, \Delta Q_{nodes})$$

$$\Delta \varphi_{u,node} = f(\Delta P_{nodes}, \Delta Q_{nodes})$$

Voltage problems

$$\Delta P_{component} = f(\Delta P_{nodes}, \Delta Q_{nodes})$$

$$\Delta Q_{component} = f(\Delta P_{nodes}, \Delta Q_{nodes})$$

$$\Delta S_{component} = f(\Delta P_{nodes}, \Delta Q_{nodes}) \equiv \Delta Utilization_{component}$$

Congestion

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WCMS – Main Monitor - Proposed Setpoints

Setpoints needed to reach the specified solution (values hidden to preserve confidentiality)
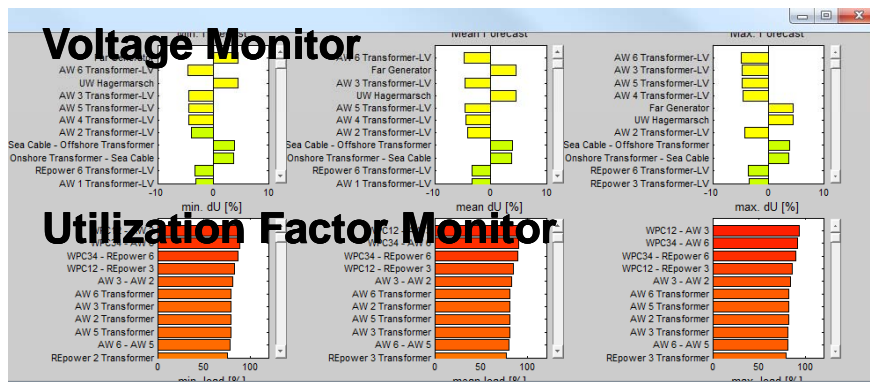
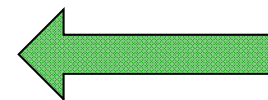# WCMS – Effects of the Proposed Setpoints
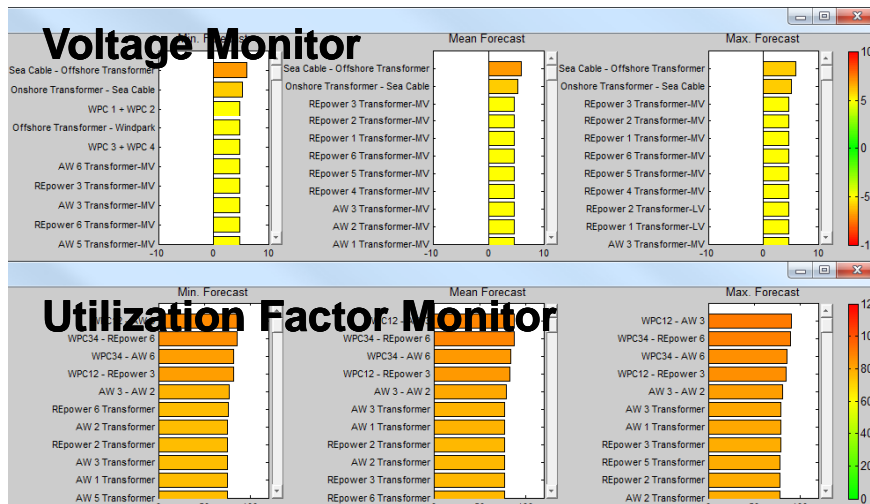
Current condition
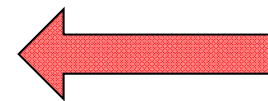
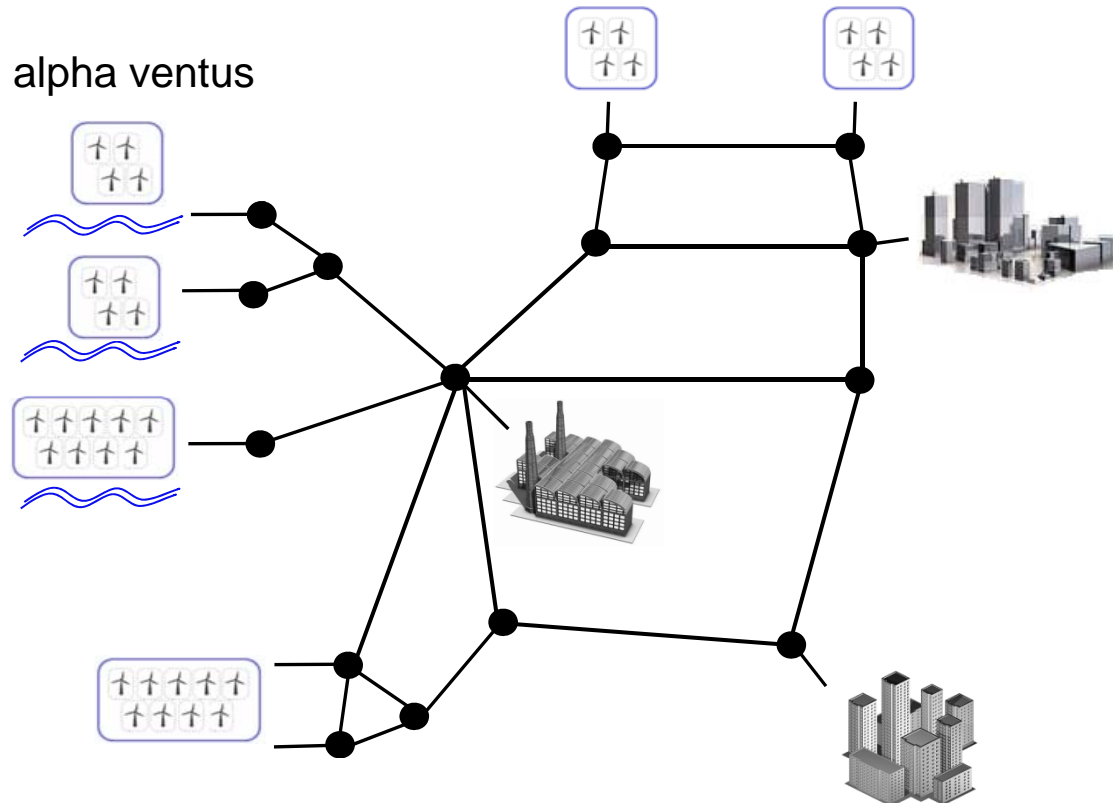Predicted future system state taking the current operation into account (refer to slides before)

Condition after setpoints

Predicted future system state taking the proposed setpoints into account

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WCMS - Outlook

alpha ventus

WCMS is mainly being created for the technical operation of wind farms within extensive, also meshed grid structures

Interaction with a CVPP is required

CVPP = Commercial Virtual Power Plant

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Thank you very much for your attention!

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