

WCMS in interaction with alpha ventus

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Supervisor

Coordination



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für Umwelt, Naturschutz
und Reaktorsicherheit



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



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

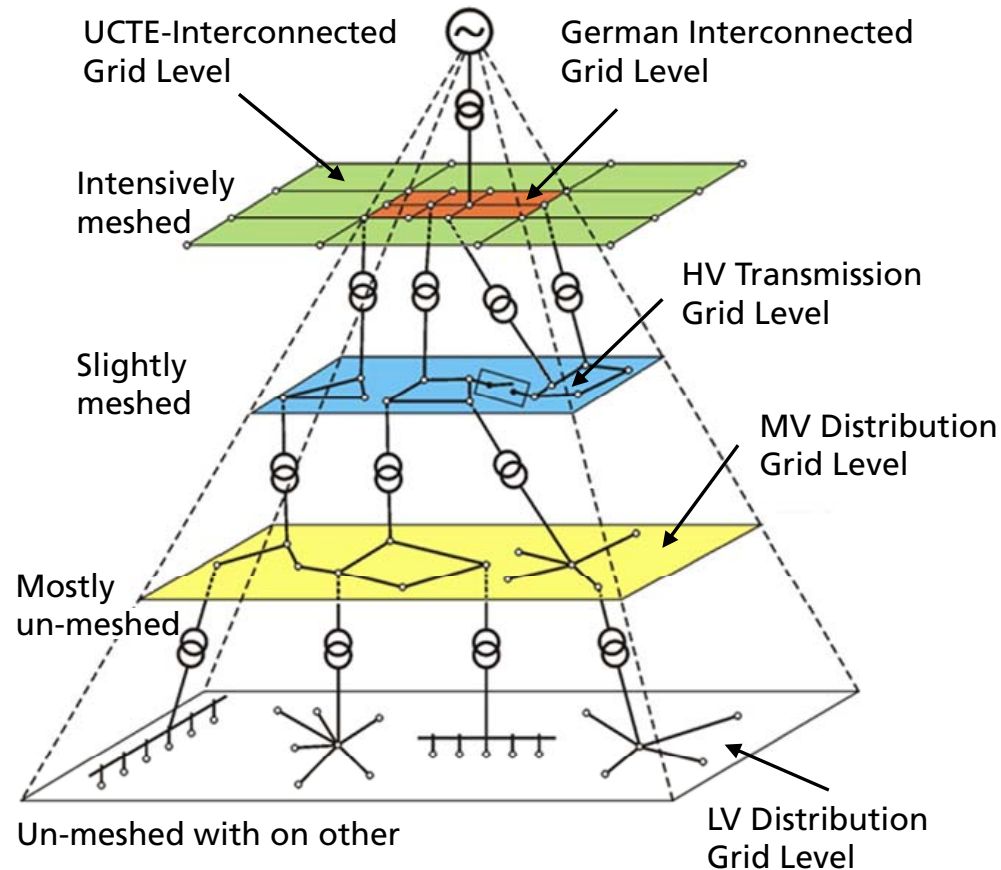
- Ensuring voltage and frequency stability
- Avoiding congestion
- Optimizing operation (minimization of losses and fluctuations)
- Supply wind power according an externally specified schedule

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



Meshed Grid:

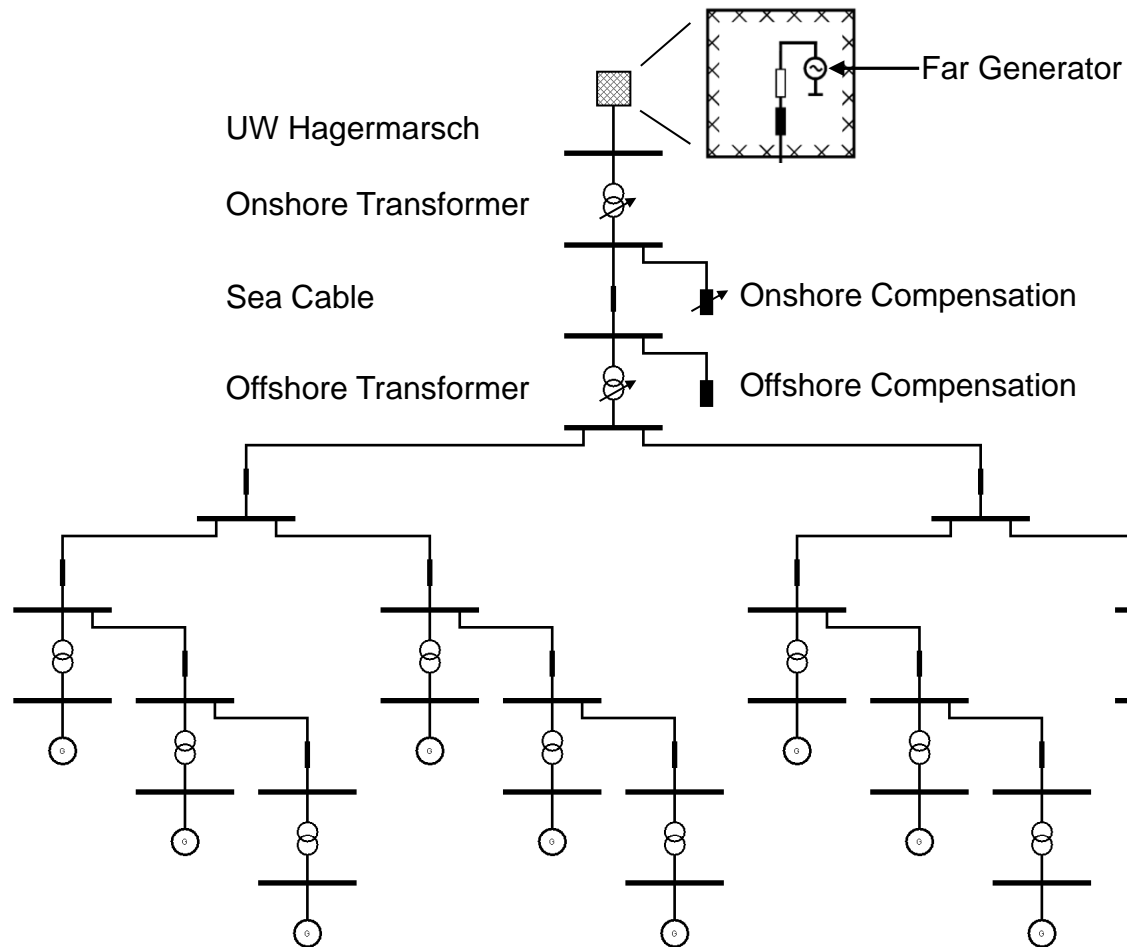
Not designed for worst case power flow
→ mainly problems with congestion
in time periods of high feed-in

Un-Meshed / Radial Grid:

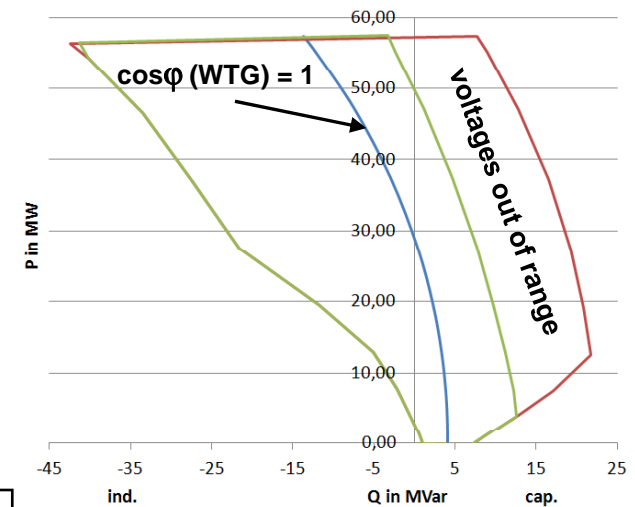
Designed for worst case power flow
→ basically no congestion problems
→ mainly voltage problems



WCMS – Grid Topology of alpha ventus



PQ-Curve at UW Hagermarsch:



PQ-Curve of a wind turbine:



WCMS - Assumptions for Grid Calculation

Assumption for the calculations, presented within the following slides:

- No voltage controlled grid nodes – except Far Generator

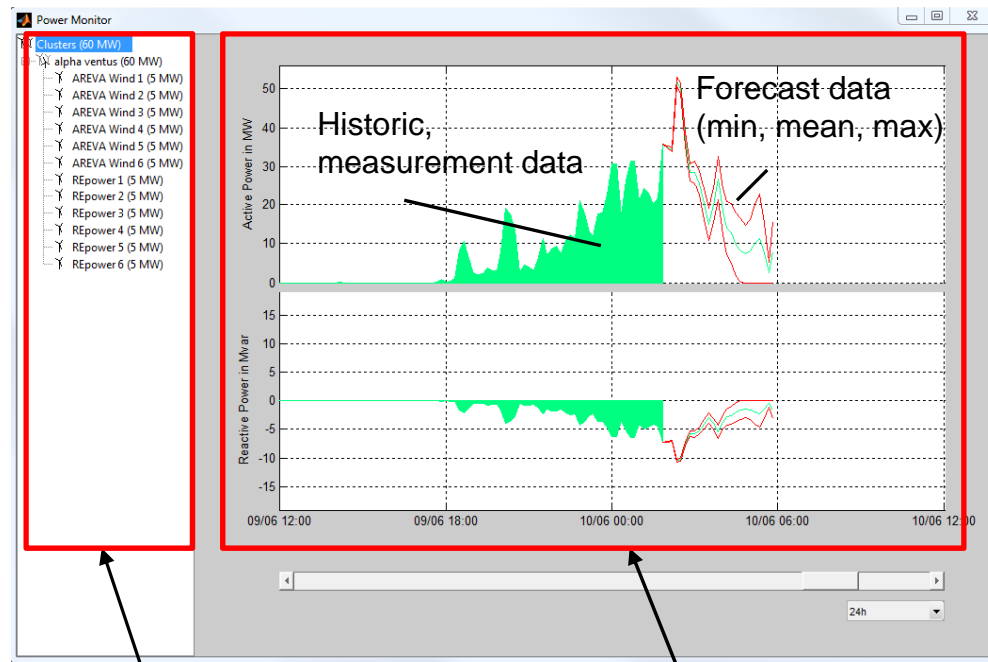
Voltage value at the Far Generator: $105\% * U_n = 115.5 \text{ kV}$

- Compensation units in maximum position
- Transformer taps in neutral position (rated transmission ratio)
- Wind turbines feed-in maximum available power; $\cos \varphi = 0.98$ inductive



WCMS – Active and Reactive Power Forecast

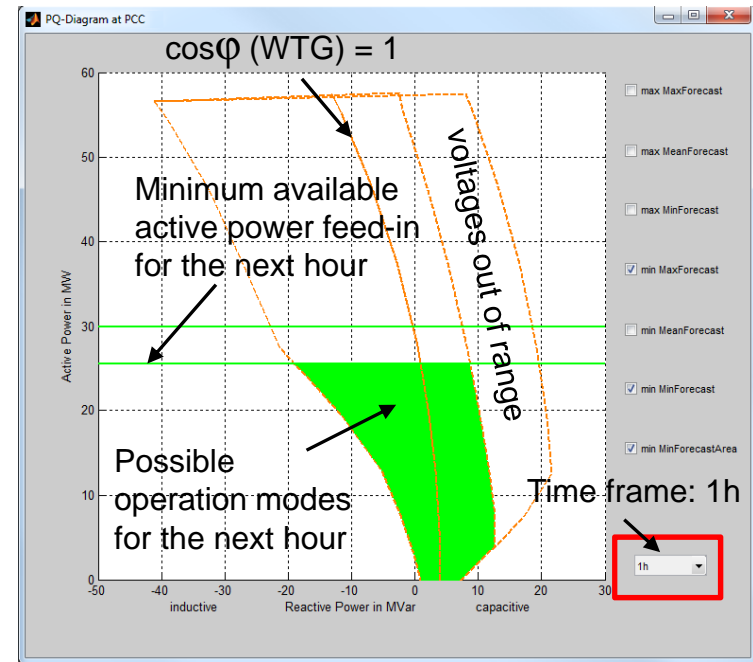
Power Monitor



Get information of a single turbine or the whole cluster

Active and reactive power data (gross values – without grid losses)

PQ-Curve at UW Hagermarsch



Active and reactive power data relating PCC node (net values – including grid losses)



WCMS – Voltage and Utilization Factor Monitor



Voltage Monitor

Utilization Factor Monitor

WCMS – Main Monitor - Creating a Setpoint

Main Monitor

Messages

Time of info	Type	Level	Time	Message	forecast	voltage/load	node/component
24-Apr-2012 10:49:27	warning	2	01:00 10-Jun-2010 02:50:00	voltage > 105% Un	min.	voltage	Sea Cable - Offshore Transformer
24-Apr-2012 10:49:27	warning	2	01:00 10-Jun-2010 02:50:00	voltage > 105% Un	mean	voltage	Sea Cable - Offshore Transformer
24-Apr-2012 10:49:27	warning	2	01:20 10-Jun-2010 03:10:00	voltage > 105% Un	max.	voltage	Sea Cable - Offshore Transformer
24-Apr-2012 10:49:27	warning	3	02:20 10-Jun-2010 04:10:00	voltage > 105% Un	min.	voltage	Sea Cable - Offshore Transformer
24-Apr-2012 10:49:27	information	4	02:50 10-Jun-2010 04:40:00	voltage > 105% Un	mean	voltage	Sea Cable - Offshore Transformer
24-Apr-2012 10:49:27	information	5	03:50 10-Jun-2010 05:40:00	voltage > 105% Un	max.	voltage	Sea Cable - Offshore Transformer

Inbox

Time	Status	Message
		create setpoint
		send selected setpoint(s)
		delete selected setpoint(s)
		calculate grid interactions

Sent

Time	Status	Message
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Create setpoint

Cluster: Clusters

Node: Default Cluster Node

Start time (HH:MM:SS): 2 : 20 : 0

Start date (dd/mm/yy): 10 June 2012

End time (HH:MM:SS): 5 : 20 : 0

End date (dd/mm/yy): 10 June 2012

Control: P, Q

P in MW: 20

Q in MVar: 5

Cancel OK

Can define setpoint via context menu

WCMS – Main Monitor – Finding Setpoints

The screenshot shows the 'Main Monitor' window with a 'Messages' table and an 'Inbox' section. A context menu is open over the 'Sea Cable - Offshore Transformer' entry in the messages table, showing options like 'find solution' and 'clear selection'. The 'Find solution' dialog box is also open, showing settings for voltage at node, comparison operator, forecast type, and controlling elements.

Time of info	Type	Level	Time	Message	forecast	voltage/load	node/component
24-Apr-2012 10:49:27	warning	2	01:00 10-Jun-2010 02:50:00	voltage > 105% Un	min.	voltage	Sea Cable - Offshore Transformer
24-Apr-2012 10:49:27	warning	2	01:00 10-Jun-2010 02:50:00	voltage > 105% Un	mean	voltage	Sea Cable - Offshore Transformer
24-Apr-2012 10:49:27	warning	2	01:20 10-Jun-2010 03:10:00	voltage > 105% Un	max.	voltage	Sea Cable - Offshore Transformer
24-Apr-2012 10:49:27	warning	3	02:20 10-Jun-2010 04:10:00	voltage > 105% Un	min.	voltage	Sea Cable - Offshore Transformer
24-Apr-2012 10:49:27	information	4	02:50 10-Jun-2010 04:40:00	voltage > 105% Un	mean	voltage	Sea Cable - Offshore Transformer
24-Apr-2012 10:49:27	information	5	03:50 10-Jun-2010 05:40:00	voltage > 105% Un	max.	voltage	Unshore Transformer - Sea Cable

Find solution dialog box settings:

- Voltage at node: Sea Cable - Offshore Transformer
- shall be: lower than 103 % Un
- using: max. forecast
- controlling: PQ nodes - generators
- Time (HH:MM:SS): 3 : 10 : 0
- Date (dd/mm/yy): 10 June 2010

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:

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

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

Voltage problems

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

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

Congestion

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



WCMS – Main Monitor - Proposed Setpoints

Main Monitor

Messages

Time of info	Type	Level	Time	Message	forecast	voltage/load	node/component
24-Apr-2012 10:49:27	warning	2	01:00 10-Jun-2010 02:50:00	voltage > 105% Un	min.	voltage	Sea Cable - Offshore Transformer
24-Apr-2012 10:49:27	warning	2	01:00 10-Jun-2010 02:50:00	voltage > 105% Un	mean	voltage	Sea Cable - Offshore Transformer
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24-Apr-2012 10:49:27	information	4	02:50 10-Jun-2010 04:40:00	voltage > 105% Un	mean	voltage	Onshore Transformer - Sea Cable
24-Apr-2012 10:49:27	information	5	03:50 10-Jun-2010 05:40:00	voltage > 105% Un	max.	voltage	Onshore Transformer - Sea Cable

Inbox

Assisted Dispatch

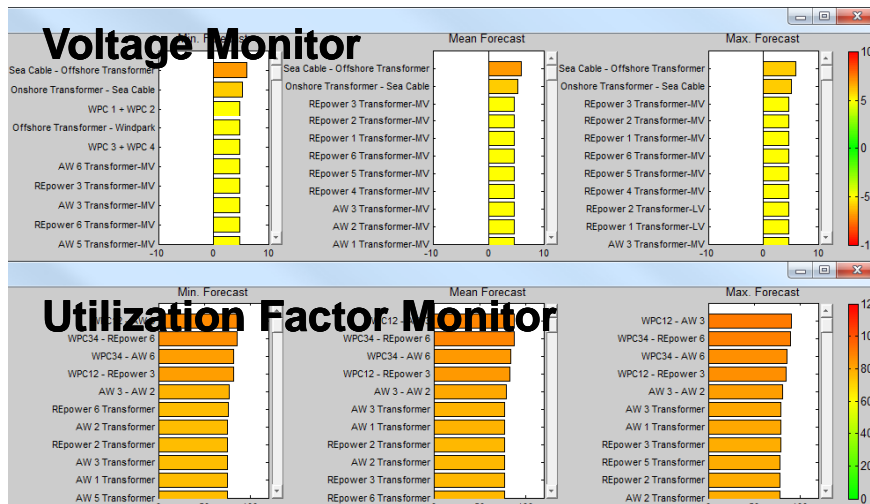
Time	Status	Message
24-Apr-2012 14:36:54	proposed	sending: AREVA Wind 1 Q = <input type="text"/> MVar
24-Apr-2012 14:36:54	proposed	sending: AREVA Wind 2 Q = <input type="text"/> MVar
24-Apr-2012 14:36:54	proposed	sending: AREVA Wind 3 Q = <input type="text"/> MVar
24-Apr-2012 14:36:54	proposed	sending: AREVA Wind 4 Q = <input type="text"/> MVar
24-Apr-2012 14:36:54	proposed	sending: AREVA Wind 5 Q = <input type="text"/> MVar
24-Apr-2012 14:36:54	proposed	sending: AREVA Wind 6 Q = <input type="text"/> MVar
24-Apr-2012 14:36:54	proposed	sending: REpower 4 Q = <input type="text"/> MVar

Sent

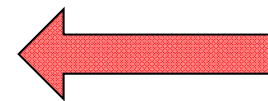
Time	Status	Message
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Setpoints
needed
to reach the
specified
solution
(values hidden
to preserve
confidentiality)

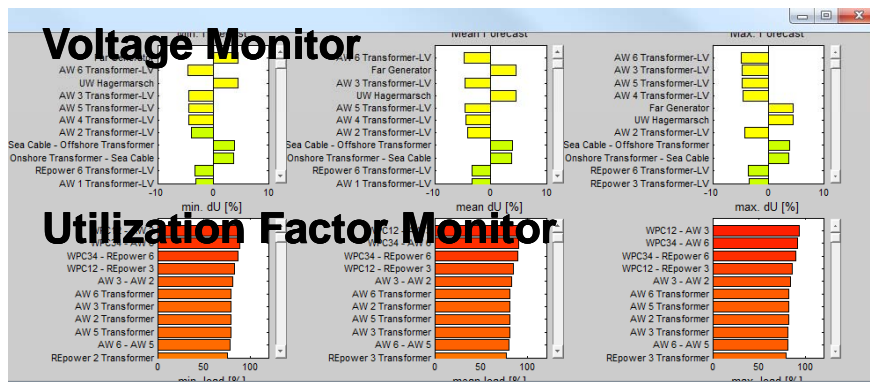
WCMS – Effects of the Proposed Setpoints



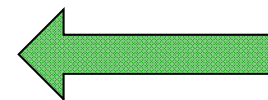
Current condition



Predicted future system state taking the current operation into account (refer to slides before)

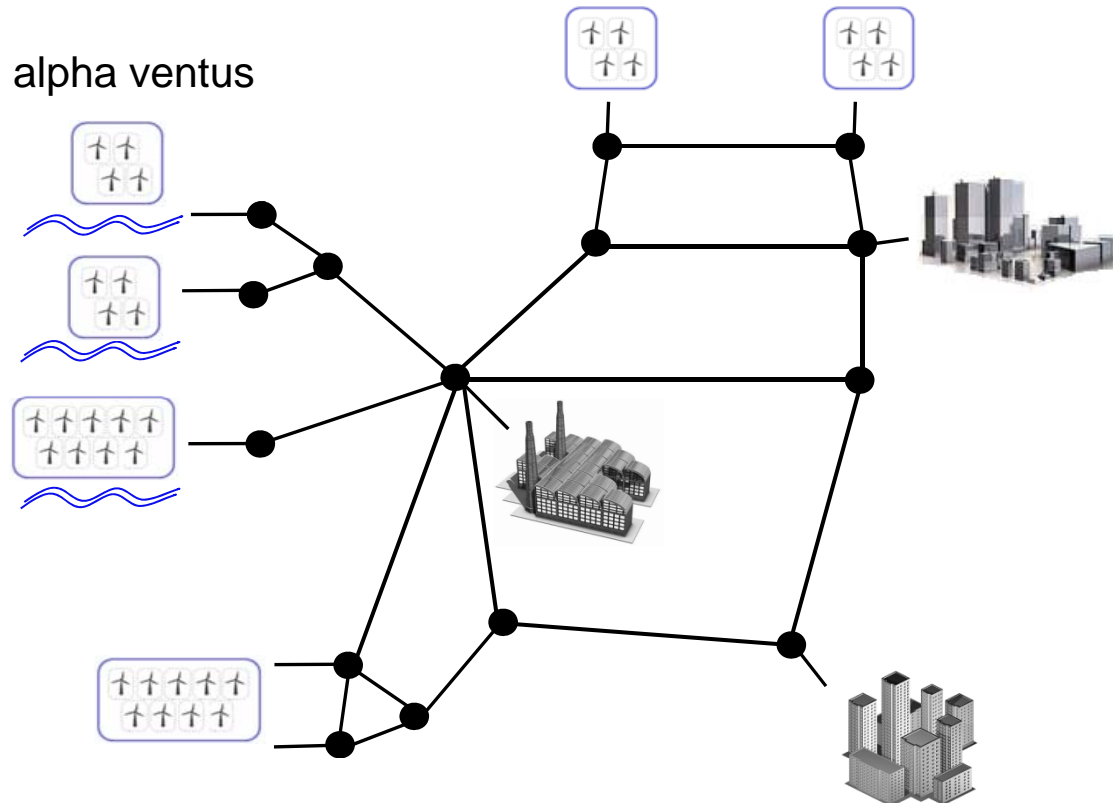


Condition after setpoints



Predicted future system state taking the proposed setpoints into account

WCMS - Outlook



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



Thank you very much for your attention!

