

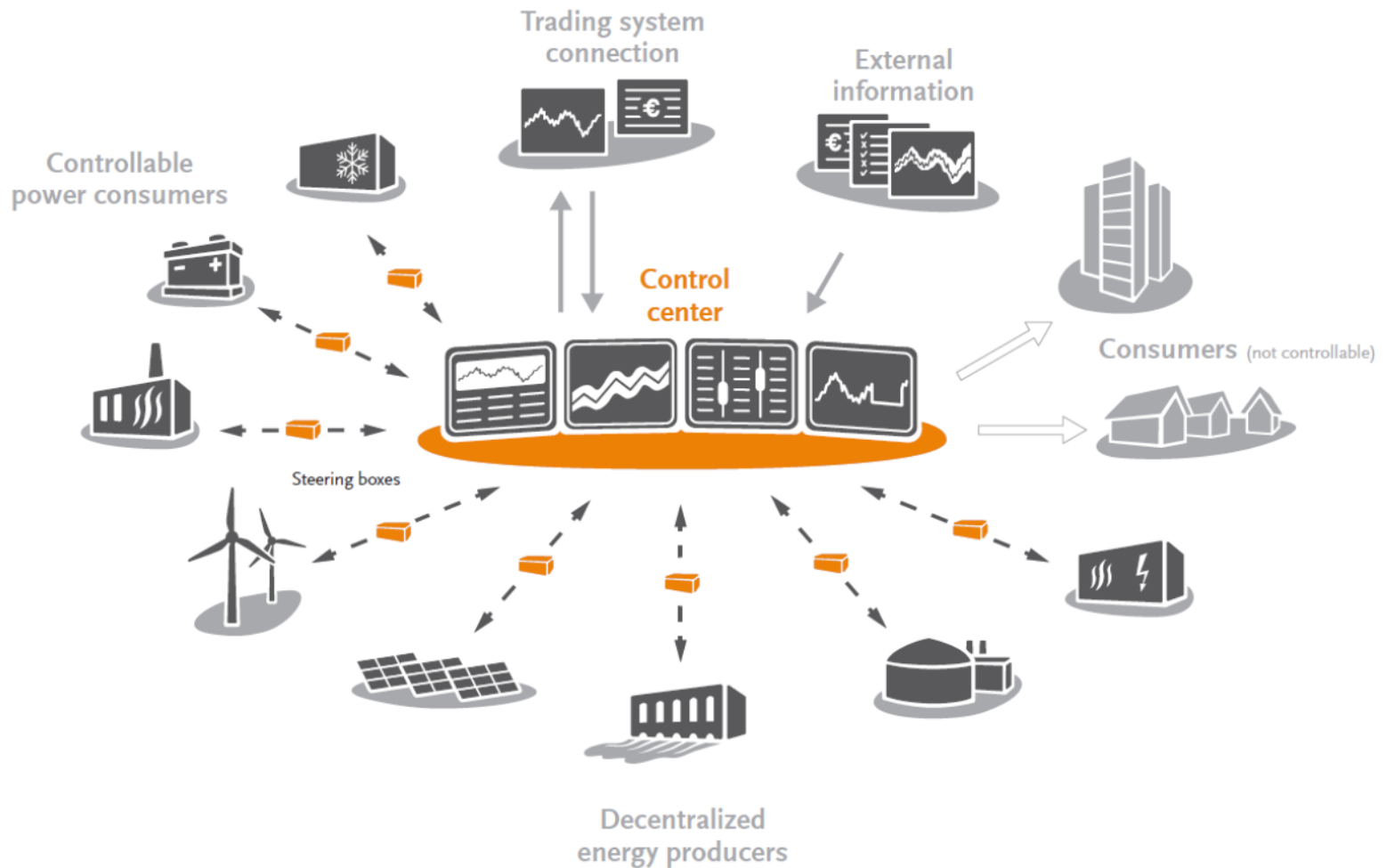
# Virtual Power Plants

**Dr. Ulrich Focken**

ESIG, 2019 Meteorology & Market Design for Grid Services Workshop

04. June 2019

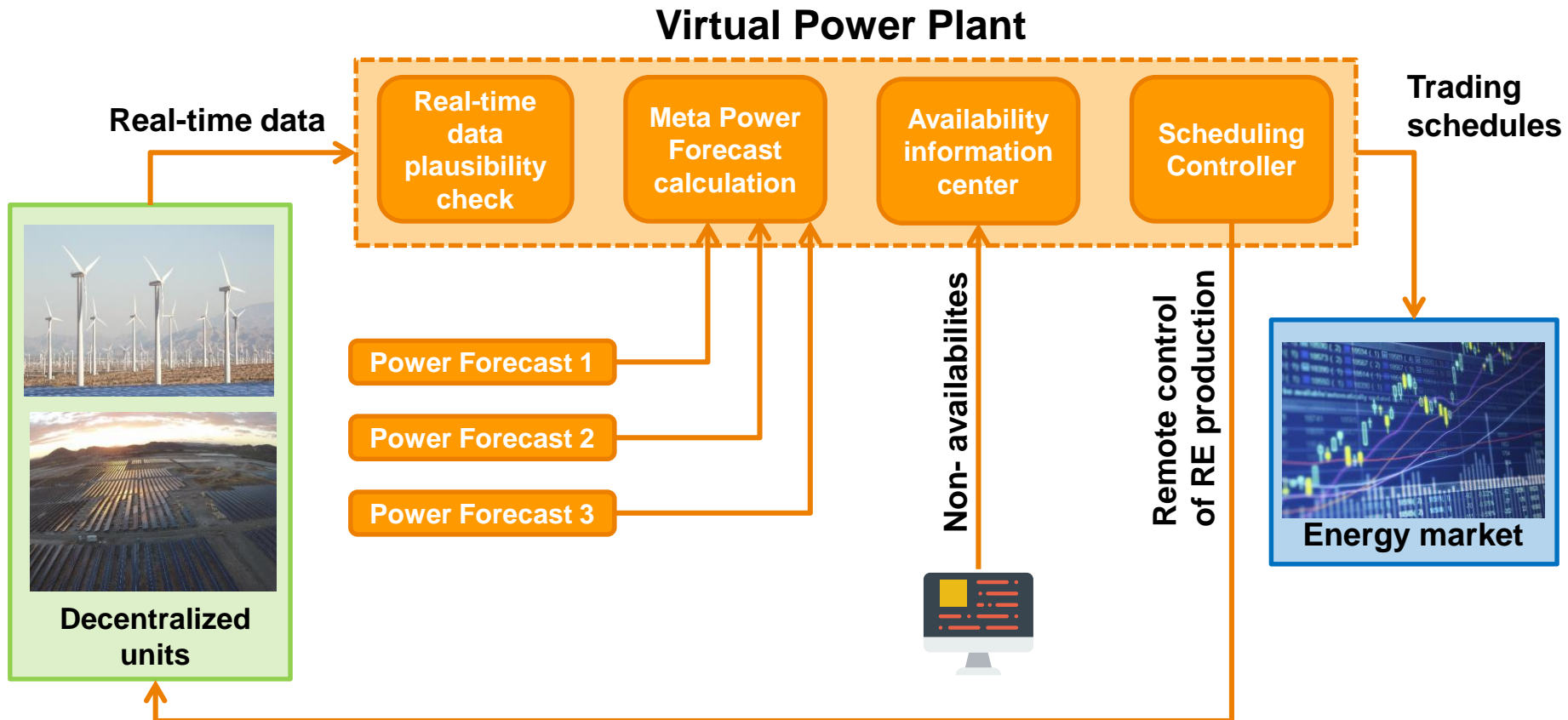
# VPP as control center for distributed generation and load



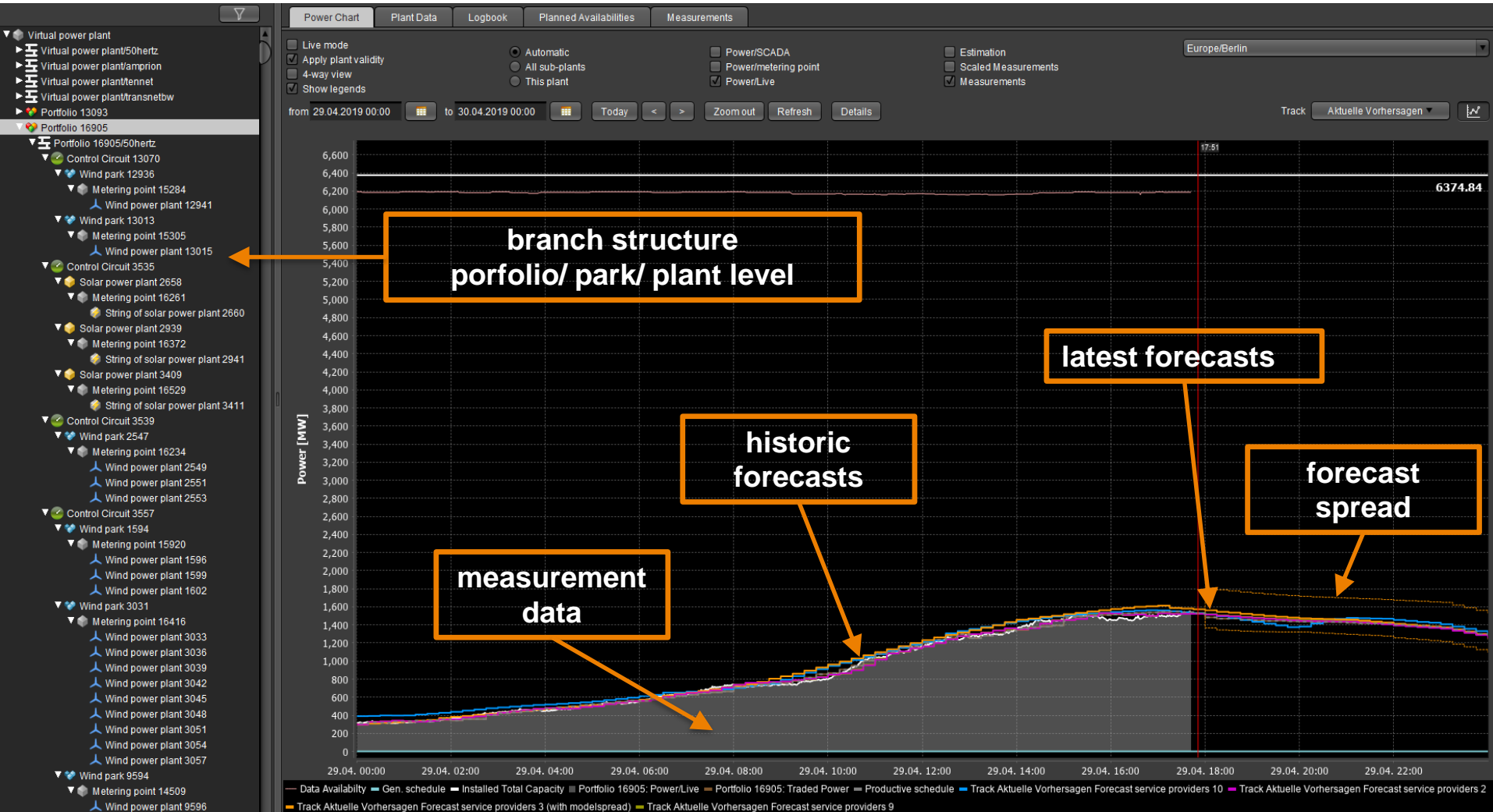
## Agenda

- Overview of our Virtual Power Plant (VPP) Solution
  - Power Trading
  - Regulation Power
  - Demand-Side-Management
  - Assistance for grid operation

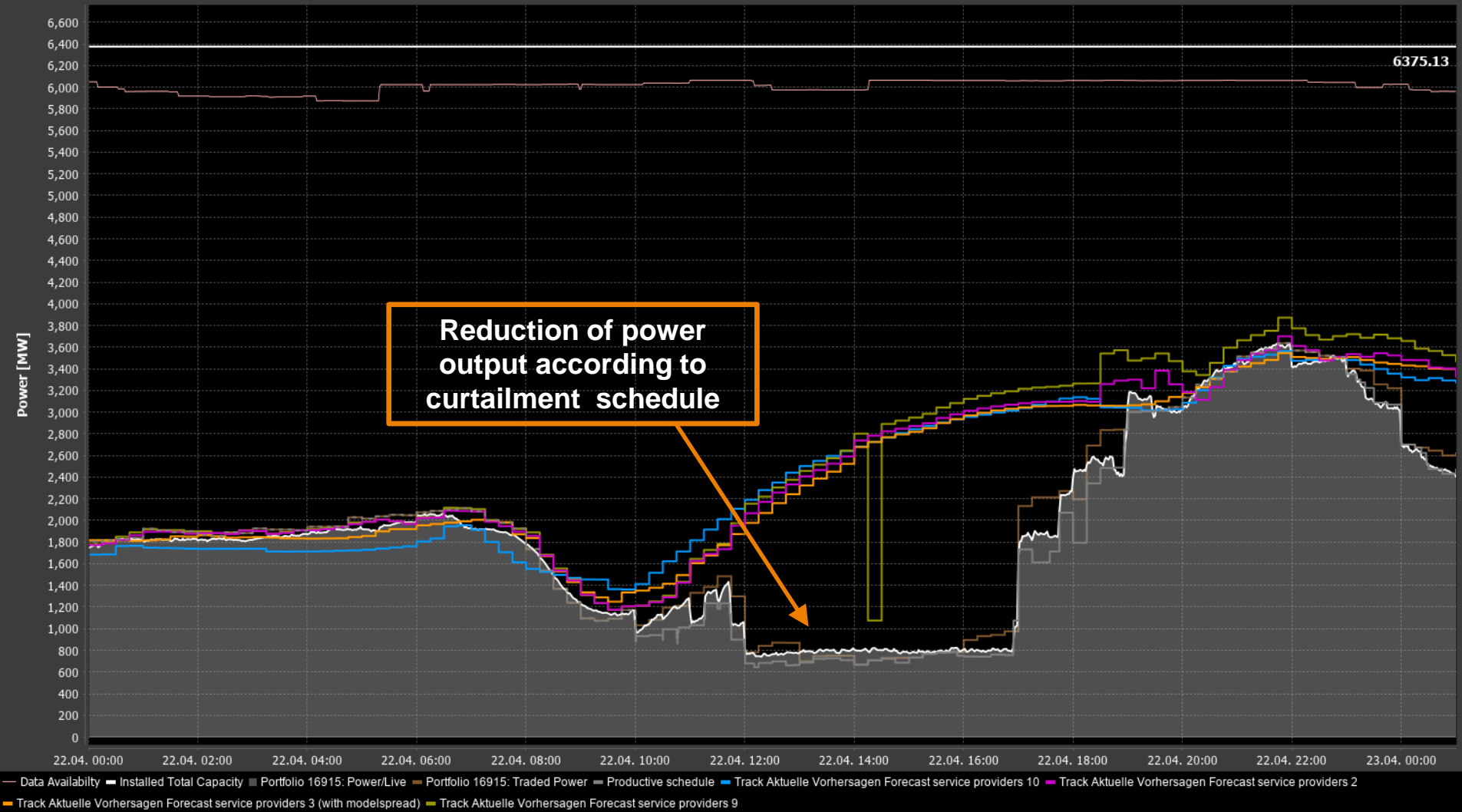
# Trading of wind and solar power: VPP and forecasting



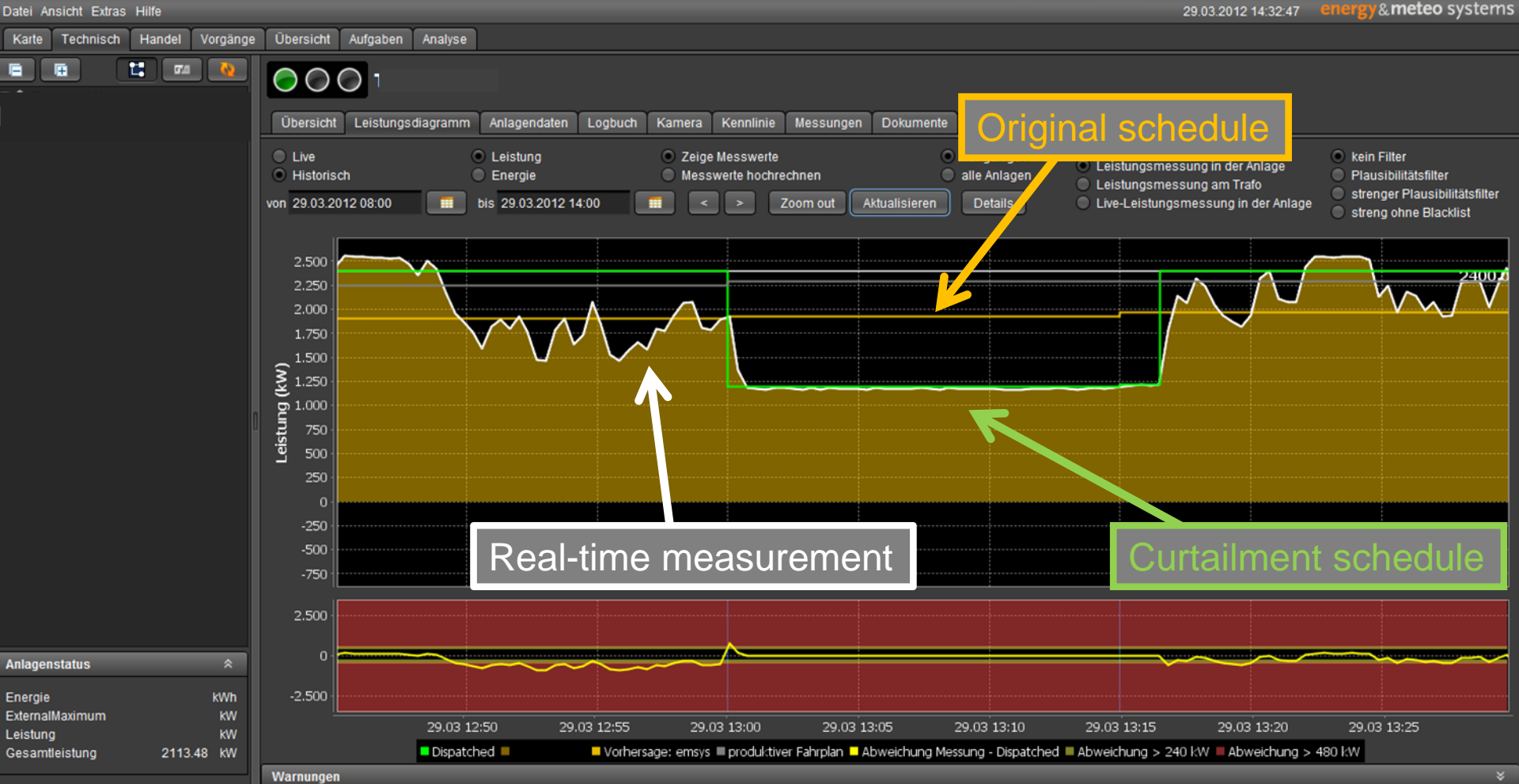
# Monitoring of decentralized units: Technical overview



# Curtailment procedure of VPP



# VPP generates curtailment schedule for individual plants

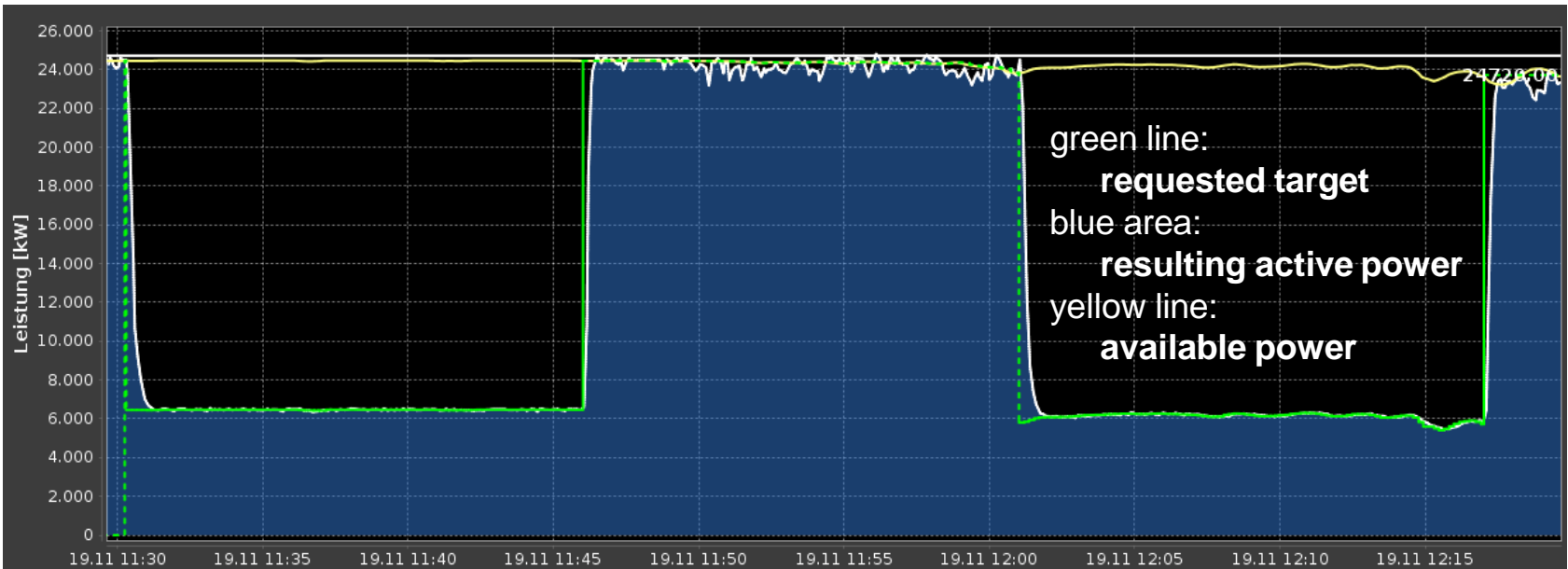


## Regulation power

- Assets connected to VPP can supply primary, secondary or tertiary reserve power
- mostly pre-qualification by grid operator required
- VPP has to cover high standards on availability and security
- wind farms often participate

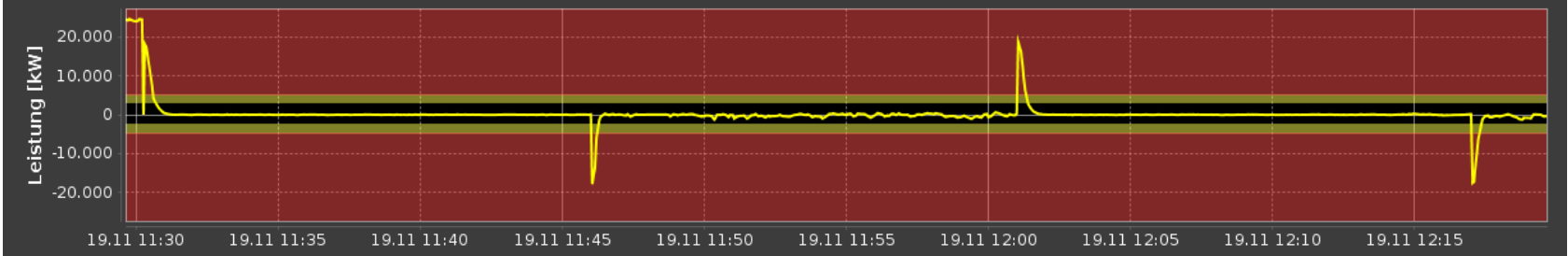


## Regulation power: tertiary reserve with wind farms

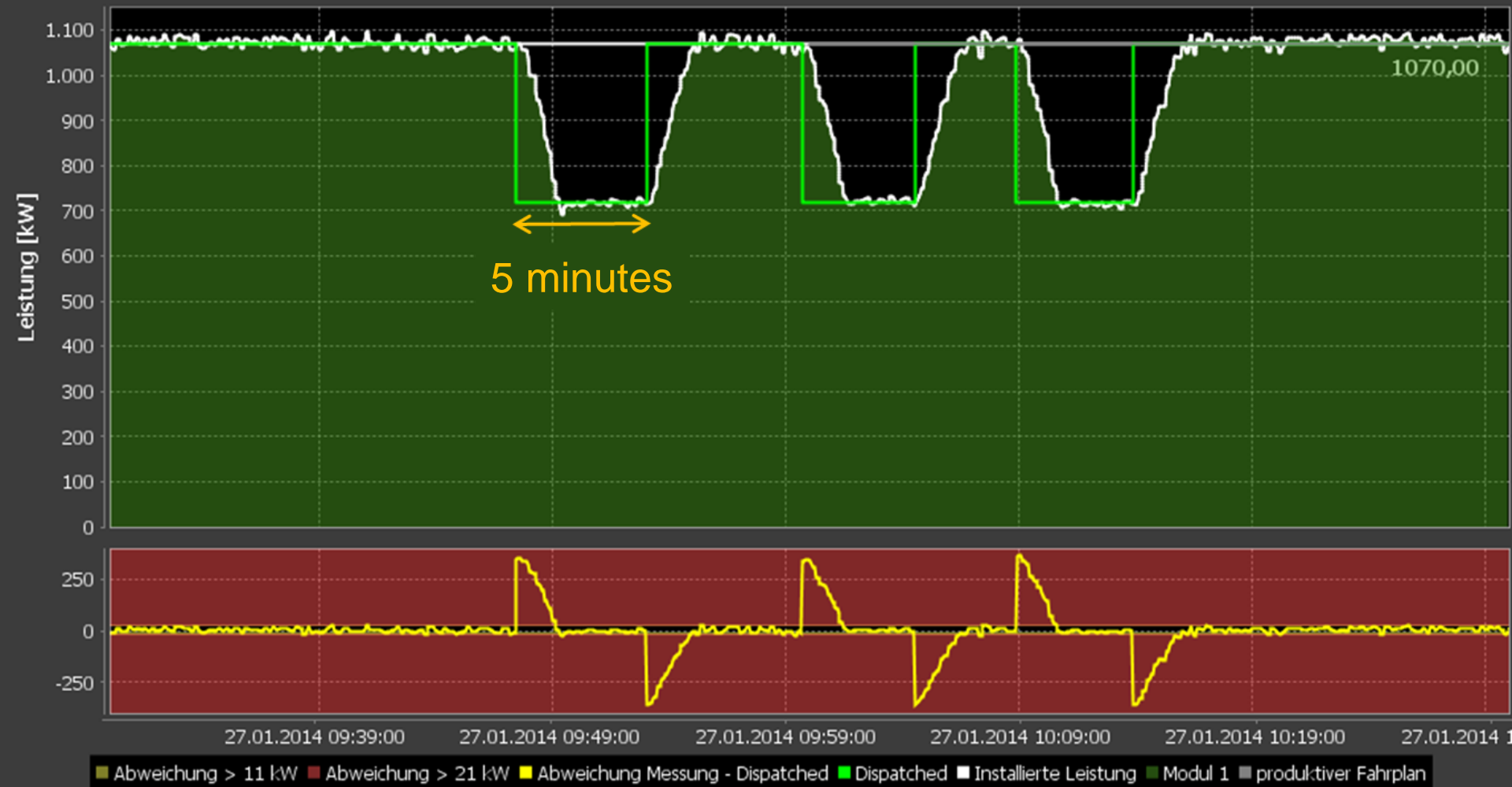


Wind farms contribute to ancillary services

Abweichung Messung - Dispatched



## Regulation power: secondary reserve with CHP units



# Regulation power: primary reserve with battery

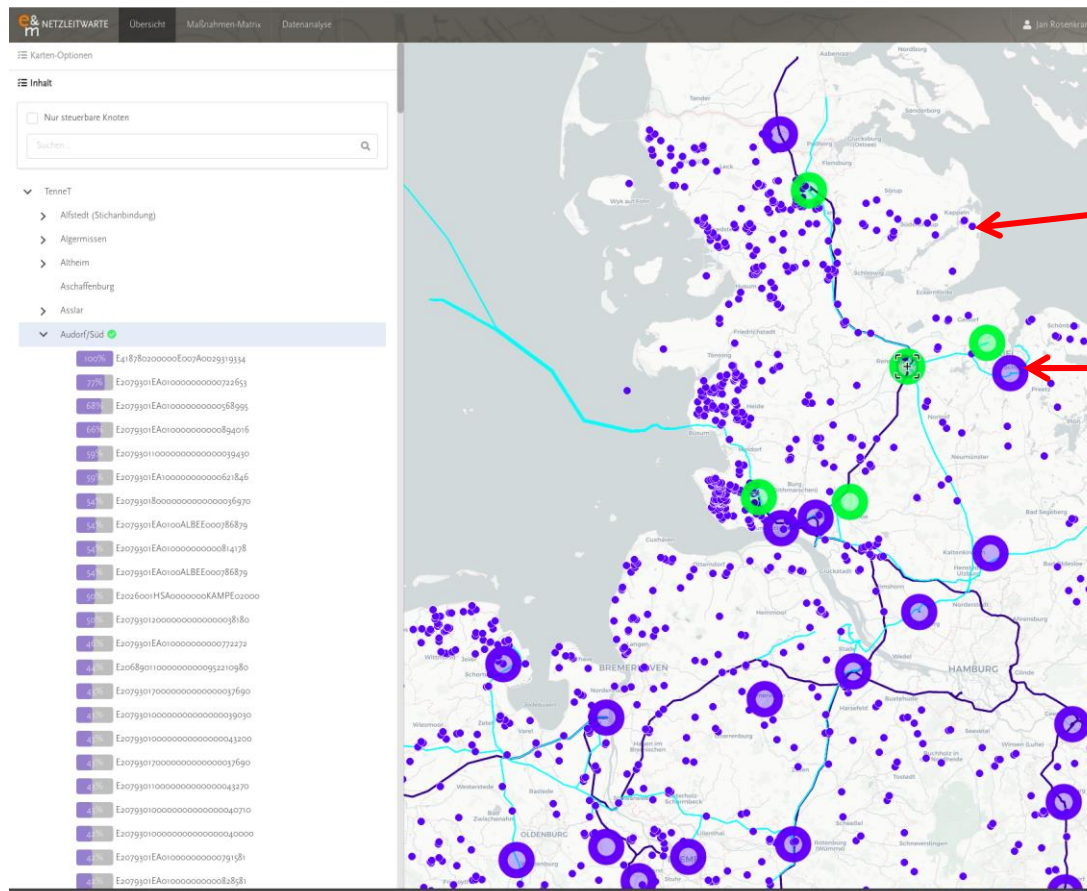


## Assistance for grid operators

- Grid Operator Control for TenneT
- Remote Controlling of wind farms on substation level

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- Remote Controlling of wind farms on substation level



Small blue dots  
= wind farms

Big blue and  
green dots  
= substations

# Planning of Redispatch Actions

**Redispatch** refers to interventions in the generation capacity of power plants in order to protect grid line sections from overload.



Redispatch actions

Potential of Redispatch

Redispatch Schedule example

Planning of a Redispatch action to curtail down a wind power plant, e.g. 5 MW down from 09:15 to 09:30, on substation level

## Implementation of virtual power plants

- Customer has to decide on different concepts
- In-house:
  - VPP software is operated on customer's server
  - Customer has to operate and maintain IT infrastructure
  - Vendor needs remote access for updates and trouble-shooting
  - No need to hand out data to third party
- Service as a Software solution:
  - VPP is used as software-as-a-service („private cloud“)
  - 24/7 support by vendor of VPP
  - No need for own IT infrastructure and operation
  - Data processed by vendor

## Lessons learned

- VPP are very successful to integrate decentralized units into market processes
- VPP is proven technology for monitoring and remote control of many thousands of plants
- VPP will play a key role in the digital energy transition
- VPP need to cover the main business and decision processes of the users
- Technology is not the problem, business models for very small scale has to be discussed
- Still many good concepts to be implemented: e.g. separate basic energy supply and flexibility in tariffs for controllable loads



# Thank you for your attention

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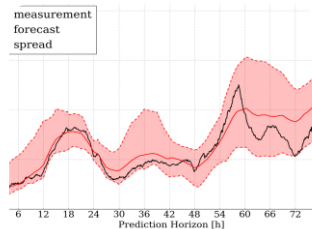
# About energy & meteo systems

## Company



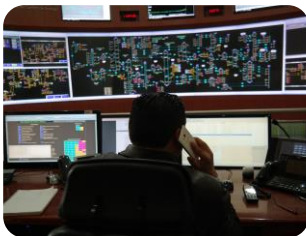
- Owner-managed since its founding in 2004
- Located in Oldenburg, Germany
- 90 employees (software developers, physicists, meteorologists and industrial engineers)

## Services



- Accurate power forecasts for solar, wind and demand
- Market-leading Virtual Power Plant (SaaS)
- Consultancy and R&D

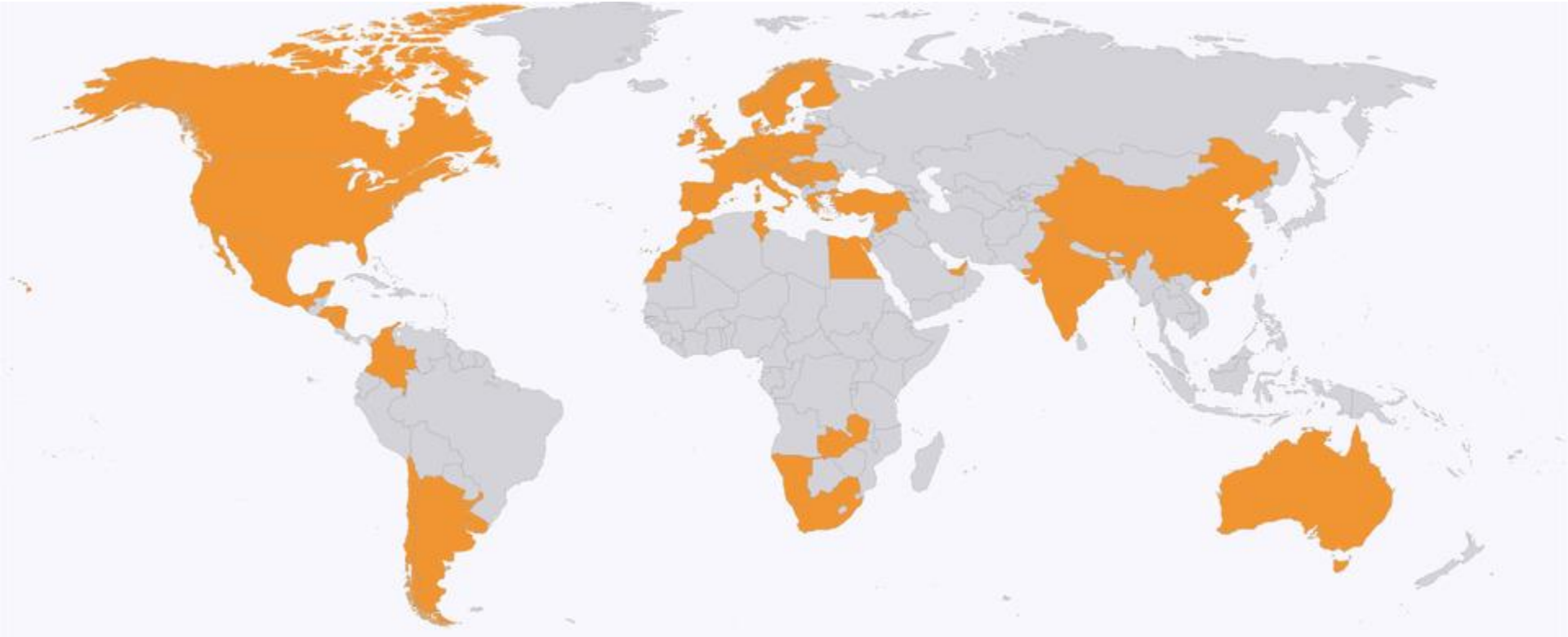
## Users



- Transmission, Distribution and Independent System Operators
- Energy trading companies
- Plant operators (IPPs, utilities etc.)

## About energy & meteo systems

### International business activities



Currently, we are forecasting about 280 GW of wind power and nearly 130 GW of solar power

## Diverse Customer Base. A Selection.

### TSOs/ISOs



### Energy generators/traders

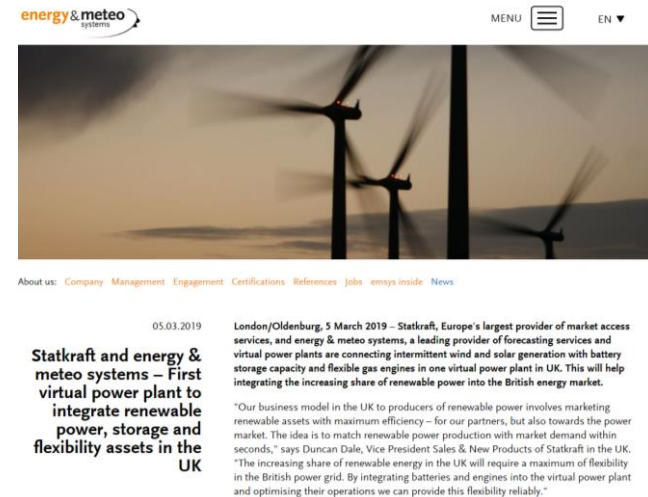


STERLING & WILSON



## Our Virtual Power Plant

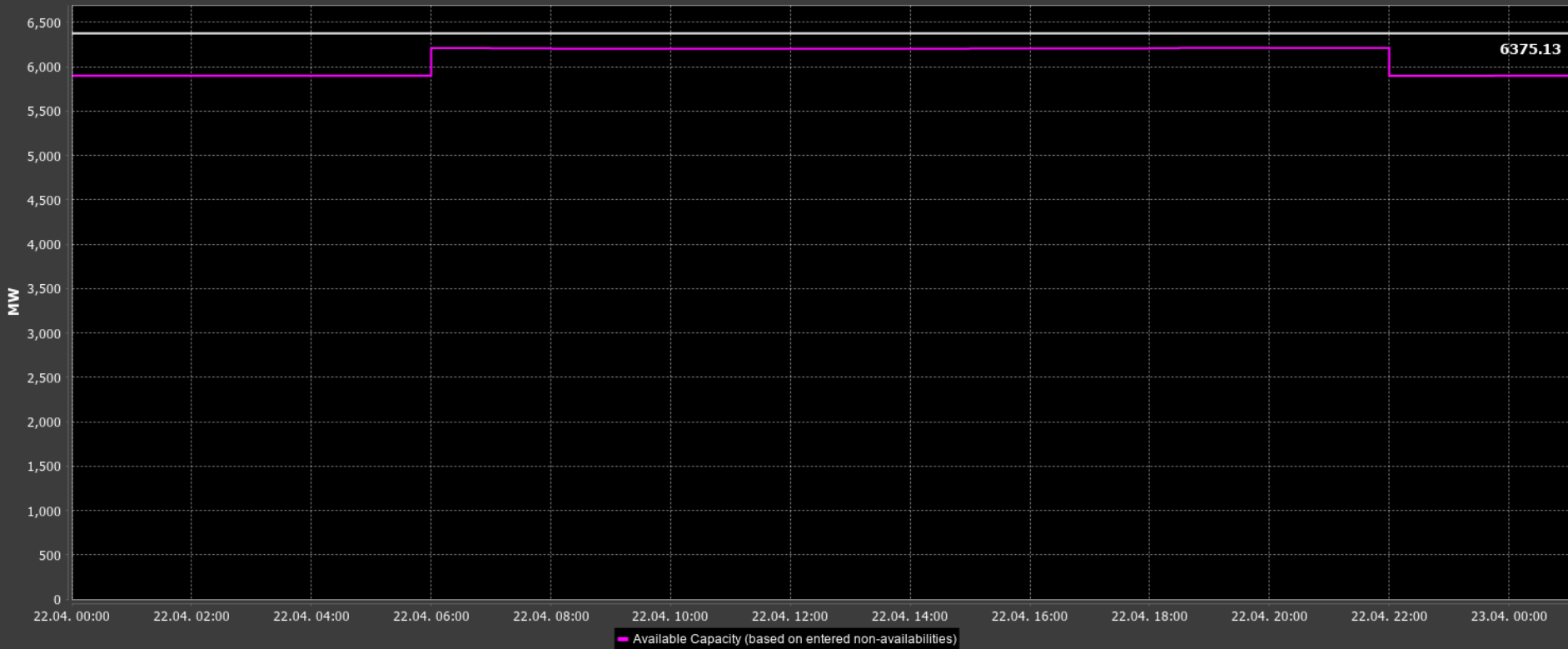
- Market-leading Virtual Power Plant solution
- Supports all standard interfaces
- Software-as-a-Service with 24/7 service
- Customized set-up of VPP by emsys
- Used by internationally leading aggregators such as Statkraft, EnBW, Vattenfall etc.
- Controls high number of assets (more than 1,000)
- More than 50 GW in Germany, Austria, France, UK, Ireland, Netherlands, Belgium, Turkey, Finland, Denmark etc.



# Managing non-availabilities in VPP

Parent element	Related to	Type of outage	Available capacity	Installed capacity	Valid from	Valid to	reason	Source	Last changed
Wind park 216	Wind park 216	Curtailement	9500	10500	15.03.2019 00:00:00	16.03.2023 00:00:00	Maintanance	VPP client	14.03.2019 15:03:45
Solar power plant 404	Solar power plant 404	Partial shutdown of park or plant	636.53	879	29.08.2018 18:00:00	01.01.2020 00:00:00	Maintanance	VPP client	29.04.2019 17:10:32
Solar power plant 595	Solar power plant 595	Grid or plant shutdown (completely)	0	557	20.06.2018 00:00:00	25.04.2019 15:00:00	Maintanance	Import	25.04.2019 13:50:55
Solar power plant 621	Solar power plant 621	Grid or plant shutdown (completely)	0	600	21.07.2018 00:00:00	03.05.2019 12:00:00	Maintanance	Import	03.05.2019 09:53:29
Solar power plant 673	Solar power plant 673	Grid or plant shutdown (completely)	0	750	21.07.2018 00:00:00	01.01.2020 00:00:00	Maintanance	Import	29.03.2019 10:35:08
Solar power plant 688	Solar power plant 688	Grid or plant shutdown (completely)	0	730	21.07.2018 00:00:00	01.01.2020 00:00:00	Maintanance	Import	29.03.2019 10:32:27
Wind park 744	Wind park 744	Partial shutdown of park or plant	2600	3200	13.03.2019 00:00:00	14.03.2023 00:00:00	Maintanance	VPP client	12.03.2019 17:20:59
Wind park 902	Wind park 902	Curtailement	1300	1500	13.03.2019 00:00:00	14.03.2023 00:00:00	Maintanance	VPP client	12.03.2019 16:21:02
Wind park 1649	Wind park 1649	Partial shutdown of park or plant	1000	3000	05.03.2019 00:00:00	01.01.2020 00:00:00	Maintanance	VPP client	05.03.2019 16:53:04
Solar power plant 1779	Solar power plant 1779	Grid or plant shutdown (completely)	0	165	29.12.2018 00:00:00	01.10.2019 00:00:00	Maintanance	VPP client	28.12.2018 17:06:05
Wind park 2097	Wind park 2097	Curtailement	2000	2400	06.03.2019 00:00:00	01.01.2020 00:00:00	Maintanance	VPP client	05.03.2019 15:19:03
Wind park 2173	Wind park 2173	Curtailement	8200	10000	06.03.2019 00:00:00	01.01.2020 00:00:00	Maintanance	VPP client	05.03.2019 17:02:14
Solar power plant 2244	Solar power plant 2244	Grid or plant shutdown (completely)	0	749.88	28.02.2019 00:00:00	01.01.2020 00:00:00	Maintanance	VPP client	27.02.2019 10:33:17

View

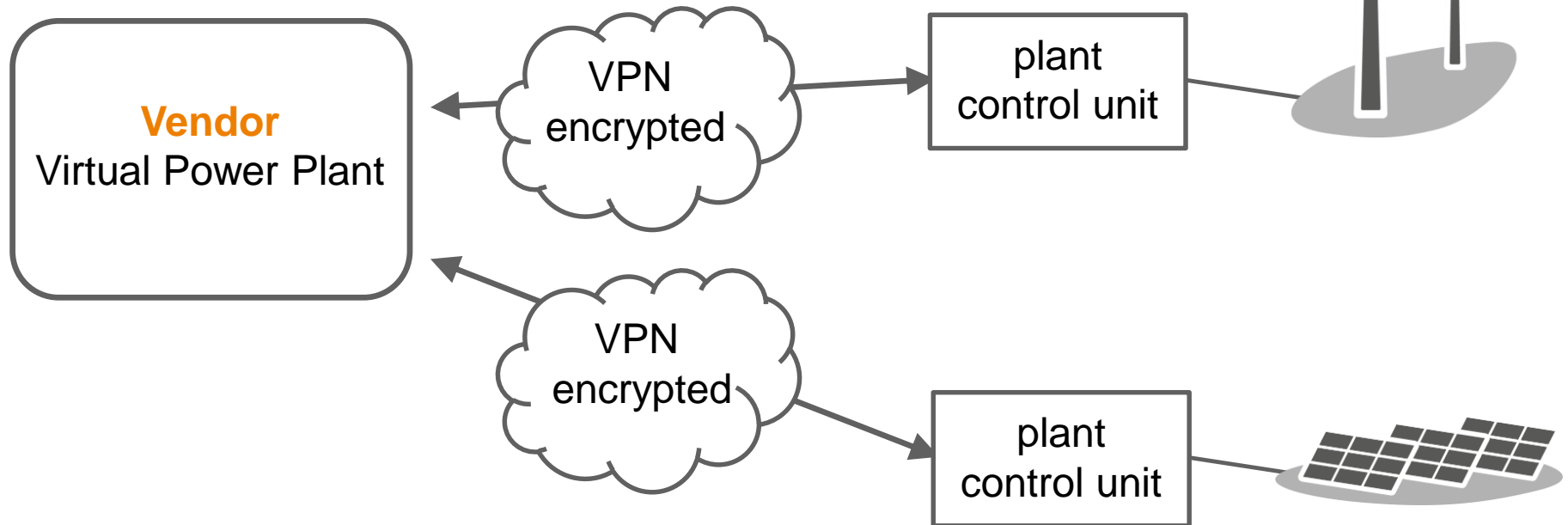


## IT security

- As soon as relevant share of wind or solar plants is connected, VPP has to be considered as critical infrastructure
- Rules on cyber security are made by national bodies
  - best-practice in IT-security in energy systems with specific requirements
  - but converge to international standards, e.g. between U.S. and Europe
- Key role:
  - Information security management system (ISMS) as framework to establish, monitor and improve processes on cyber security
  - ISMS standards: e.g. ISO27001 or ISO27019
- Growing importance for VPP and stricter rules to be expected!

## VPP – communication with assets

Exchange of measurement data and schedules between VPP and plant control unit through secure VPN connection





# Grid Operator Control Room

## View of Vertical Grid Load components



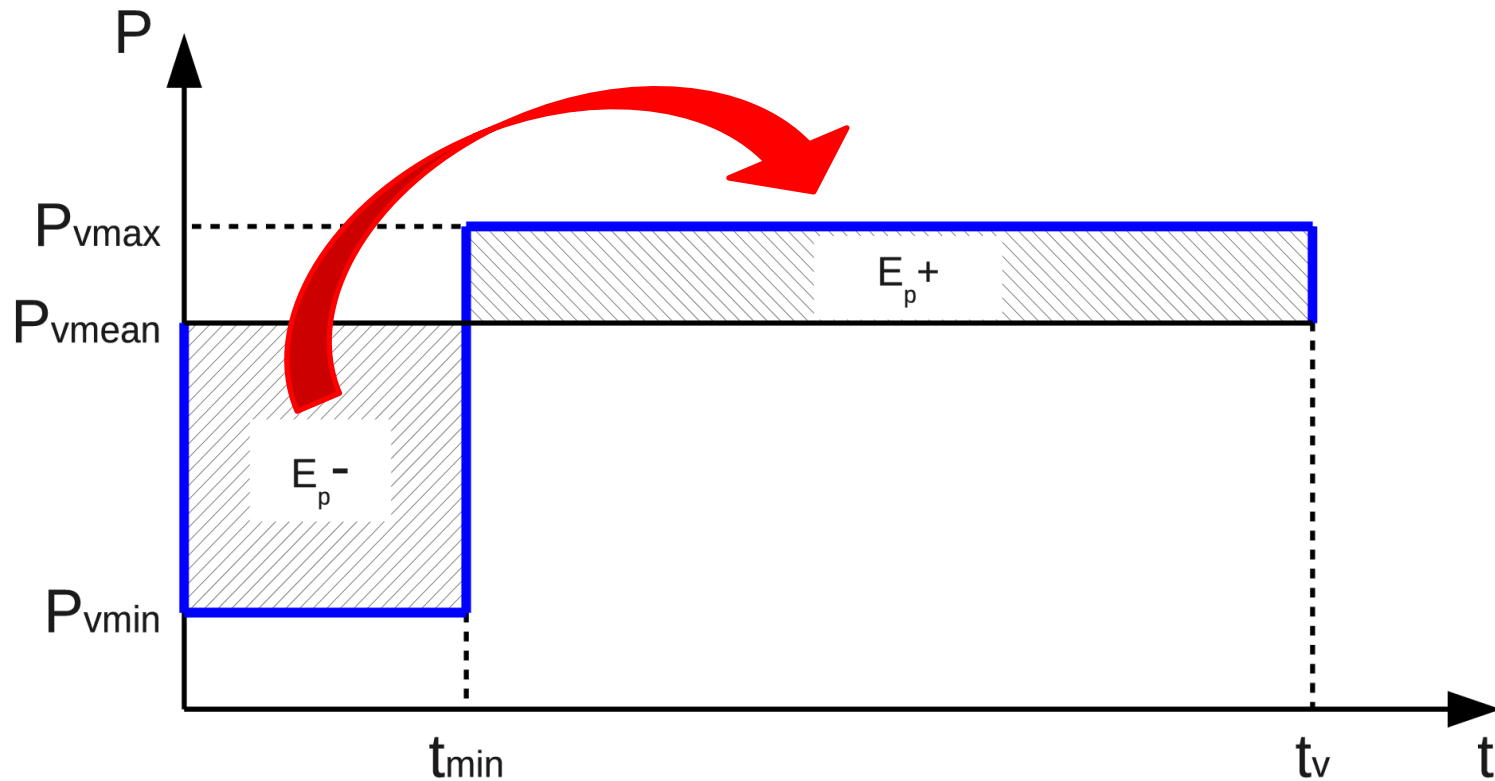
Selected controllable substation

## Controllable loads / demand side management

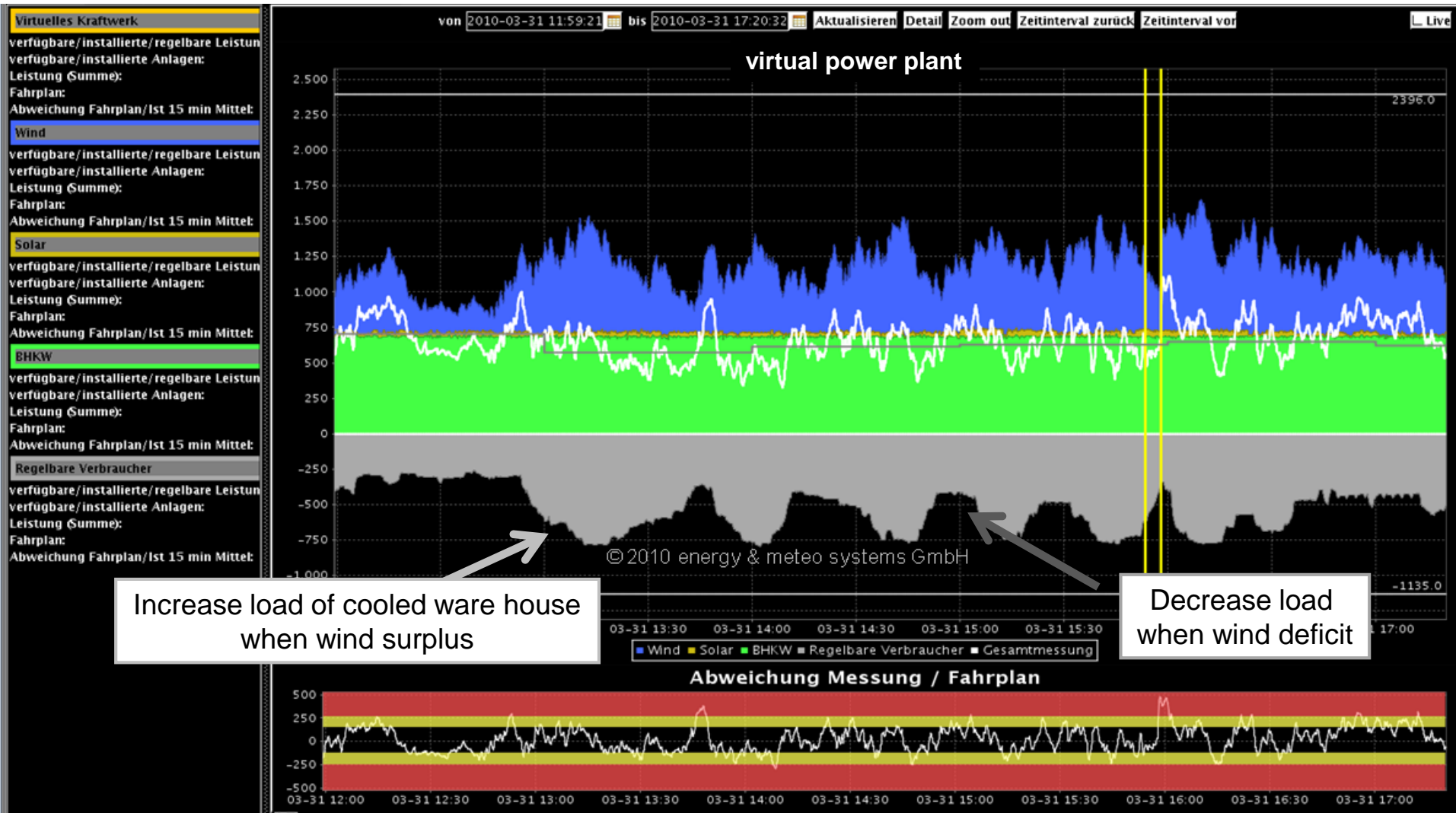
- Cooled warehouse(s) connected to VPP as controllable load
- Load acts as storage
- VPP used to optimize energy supply and purchase via spot market and regulation market
- Production units such as wind farms and solar plants added
- Also used to minimize impact of forecasting errors

## Cooled ware house (demand side management)

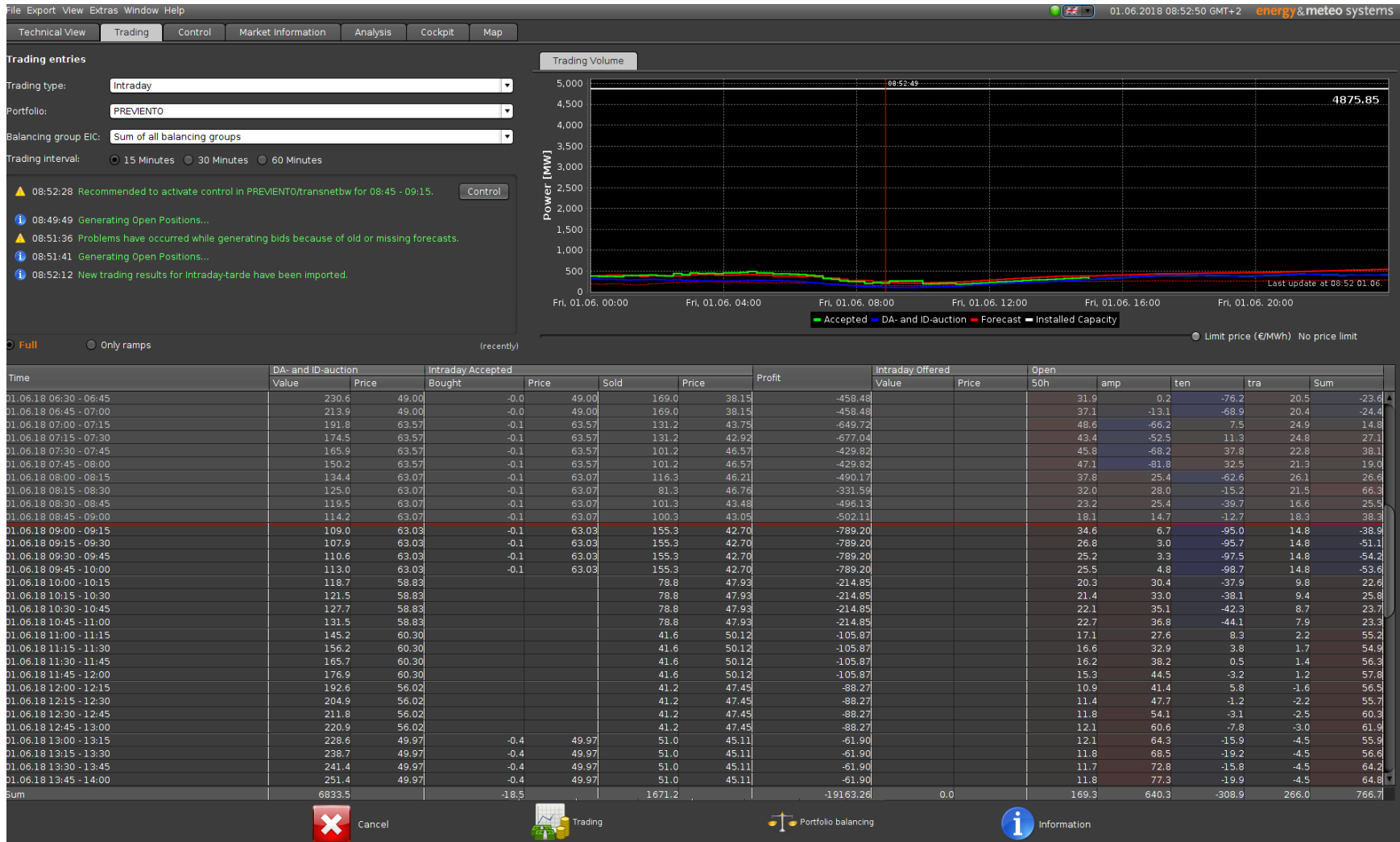
Basic idea: load shifting



# Load control: balancing forecasting errors



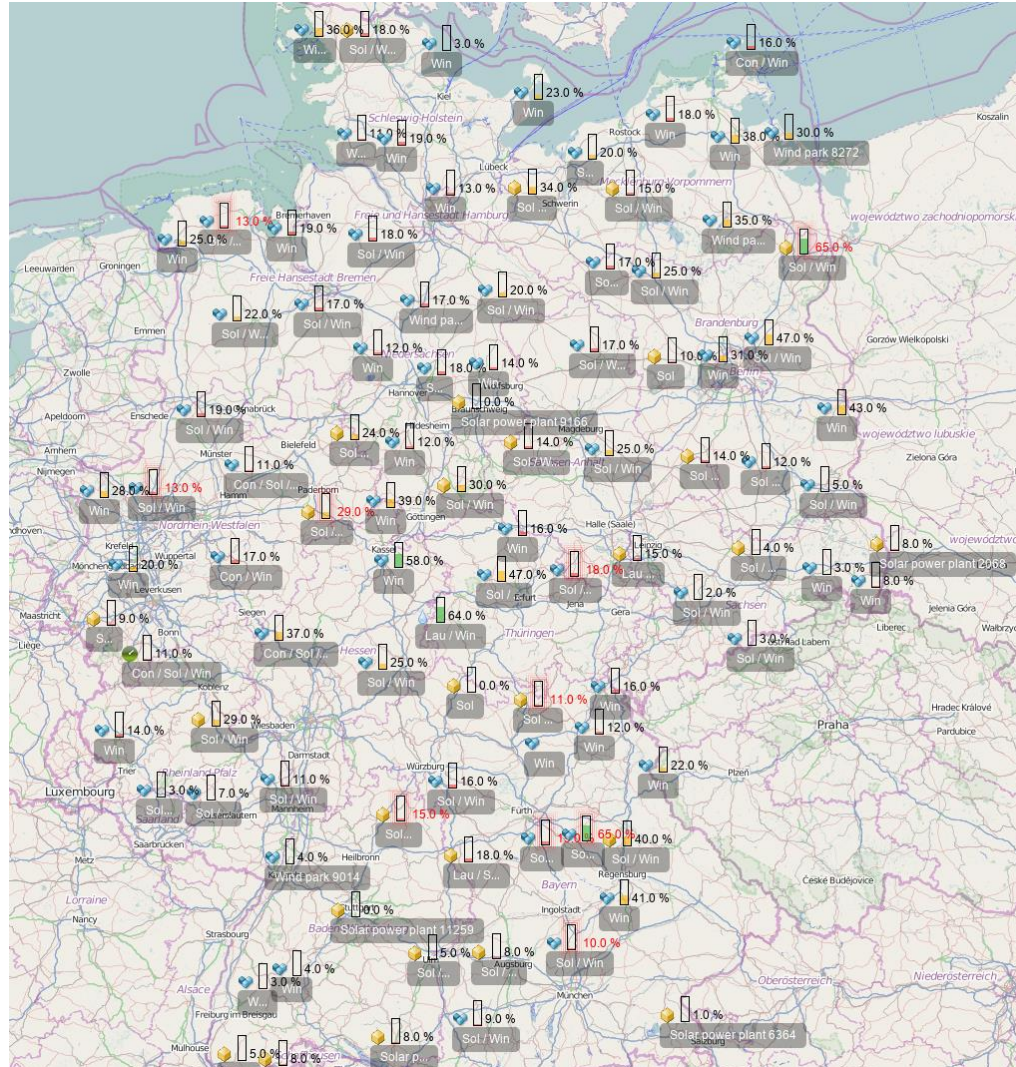
# Calculation of trading's open positions in real time mode



# Plant control visualization



# Monitoring of decentralized units: Map overview

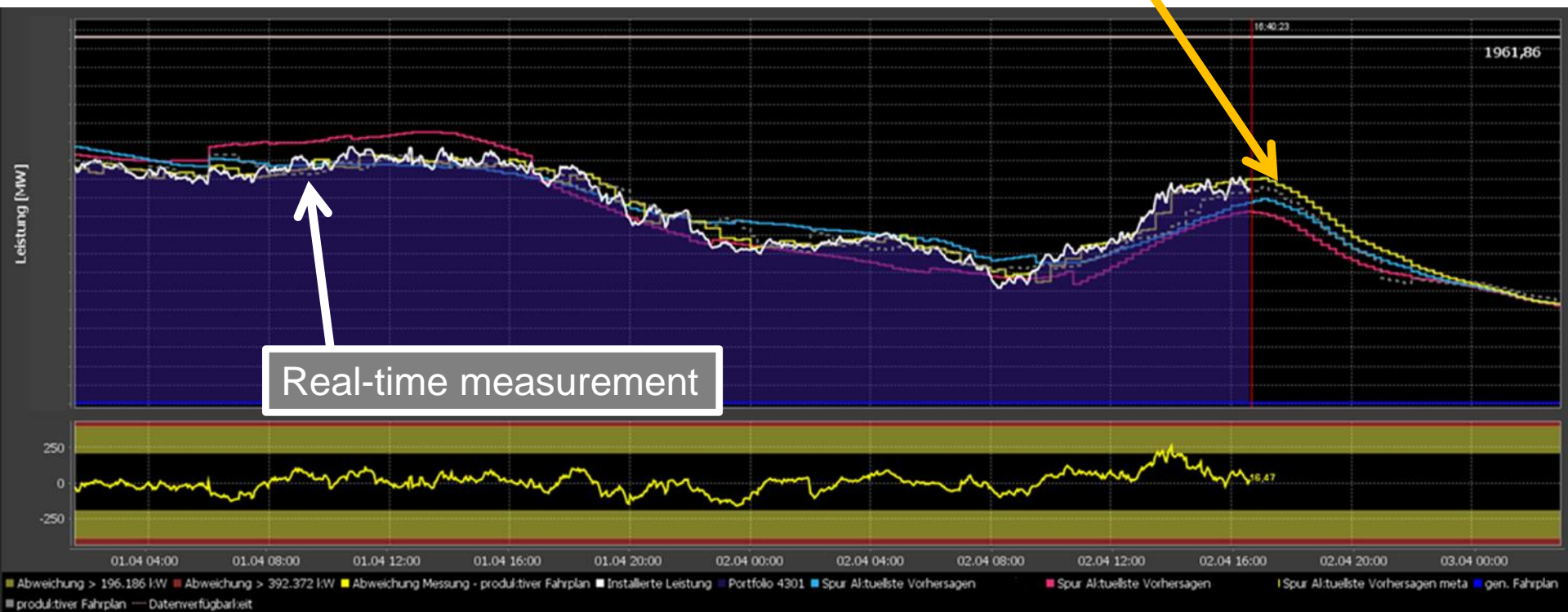


## Trading of wind and solar power: VPP and forecasting

Deviations of forecast can be settled on intraday market to reduce balancing costs.

Shortest-term meta forecasts

Real-time measurement





# Overview availability of measurement data

