VATTENFALL EUROPE

INTEGRATING LARGE SHARES OF FLUCTUATING POWER SOURCES INTO POWER ELECTRIC SYSTEMS

Impact on the Power System Operation

19.09.2008

Thomas Schäfer
Vattenfall Europe Transmission

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1. **Vattenfall Europe Transmission – Portrait: system and key figures**
2. Development of installed capacity of wind power
3. Forecast of wind power output
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5. Summaries

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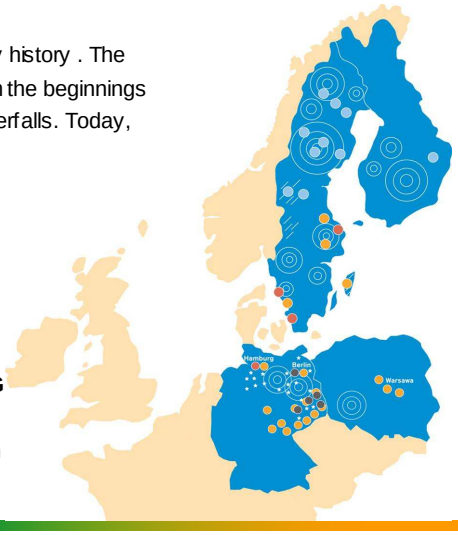
Portrait – Part of the Vattenfall Group

Vattenfall looks upon 90 years of company history . The name Vattenfall („waterfall") originates from the beginnings of power generation on North-Swedish waterfalls. Today, **Vattenfall AB** is a Swedish state-owned enterprise obliged to public good.

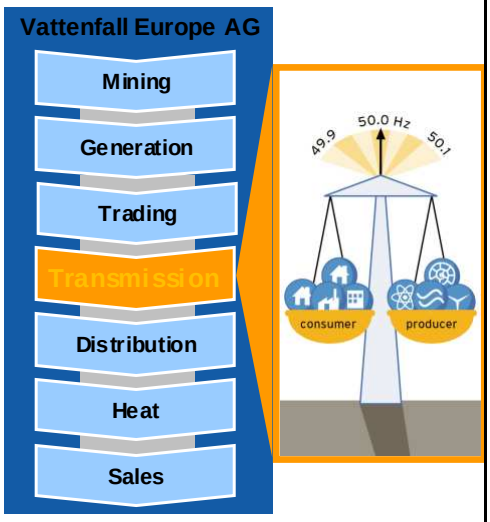
With the merger of former Bewag (Berlin), HEW (Hamburg), VEAG (Berlin) and the lignite mining company LAUBAG (Lausitz) in 2002 the German **Vattenfall Europe AG** came into existence. Today, Vattenfall Europe AG is the number 3 on the German energy market.



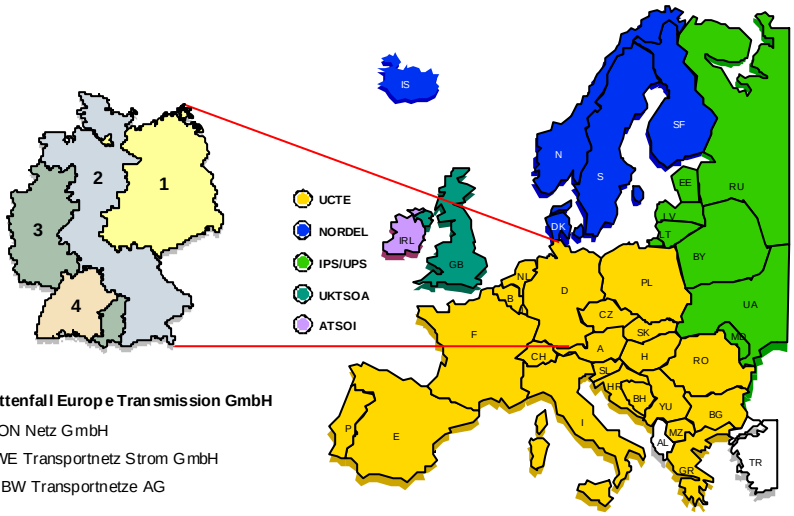
Portrait – Part of Vattenfall Europe

Within Vattenfall Europe AG, **Vattenfall Europe Transmission GmbH** is owning, operating and developing the extra high voltage grid with 380/220-kV in Eastern Germany, Berlin and Hamburg and is technically and economically independent.

In its control area the company is responsible for the balance of all feed-ins and -outs and guarantees the integration and the transport of all regenerative electricity without delay.



VE Transmission as Part of the Electricity Systems in Europe



1 Vattenfall Europe Transmission GmbH
2 E.ON Netz GmbH
3 RWE Transportnetz Strom GmbH
4 EnBW Transportnetze AG

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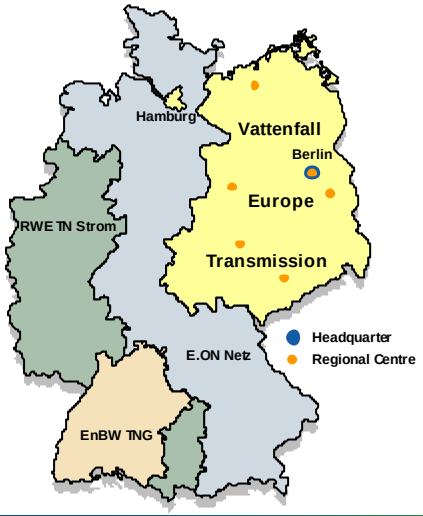
Portrait – Control Area: generation and consumption



Area: ~ 109,000 km² (~31%) *

Inhabitants: ~ 18.7 Mio. (~23%) *

Consumption: ~ 94 TWh (~18%) *

Energy from RES: ~ 21.7 TWh
thereof Wind: ~ 16.4 TWh

* Quota of Germany

Power plants and storages:

Type	Transmission Grid	Distribution Networks
Thermal	~ 12,860 MW	~ 7,100 MW
Storages	~ 2,400 MW	~ 500 MW
Wind (~41%)*	~ 690 MW	~ 8,280 MW

As of December 2007

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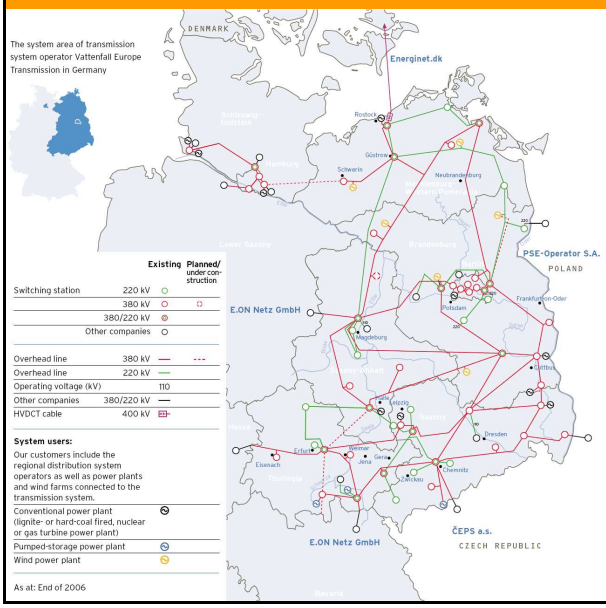
Portrait – Transmission Grid: key figures



Vertical system load:		**10,650 MW**
Electric circuit length:		**9,540 km**
thereof	**380-kV:**	**6,630 km**
	220-kV:	**2,895 km**
	HVDC:	**15 km**
Capacity of transformation level:		**28,390 MVA**
Number of substations:		**73**
Interconnections to:		**E.ON Netz, ČEPS, PSE-Operator, Energinet.dk**

As of December 2006

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Legal obligations (I)

- **Under the EU Electricity Directive**
  - Unfettered pan-European trade
  - Unhindered access to the system
  - Non-discriminatory use of the system
- **Under the Energy Industry Act*** (EnWG)
  - Electricity transport
  - Balancing of production and consumption
  - Unhindered access to the system for all network customers**
  - System stability and emergency procedures
  - Balancing group management (around 180 balancing groups)
  - Connection of offshore generation capacity to the system ("Infrastructure Planning Acceleration Act")

* EnWG, effective since 13 July 2005

** With due regard to its affiliation to the European UCTE grid, and in conformity with European and UCTE regulations

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Legal obligations (II)

- **Under the Renewable Energies Act** (EEG)
  - Priority connection of EEG generators to the system
  - Priority take-off and transport of EEG electricity
  - Prompt network extension
- **Under the Energy Security Act**
  - Special action in response to crises

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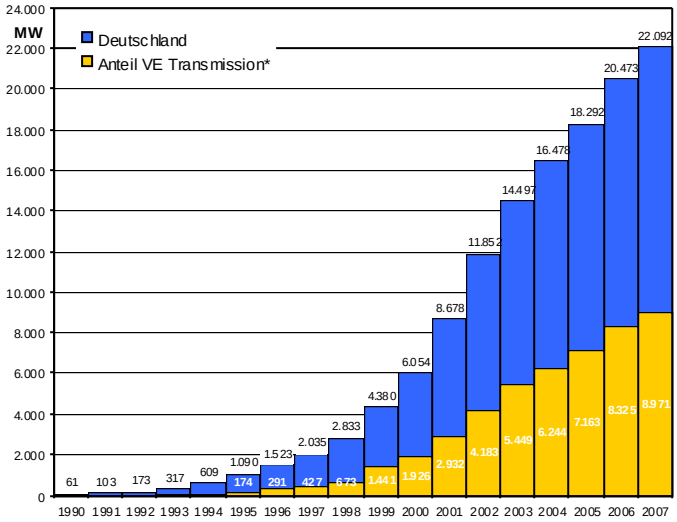
Entwicklung der installierten Leistung von Windkraftwerken Deutschland – Ende 2007



* bzw. Anteil der Bundesländer Berlin, Hamburg, Mecklenburg-Vorpommern, Brandenburg, Sachsen-Anhalt, Sachsen und Thüringen

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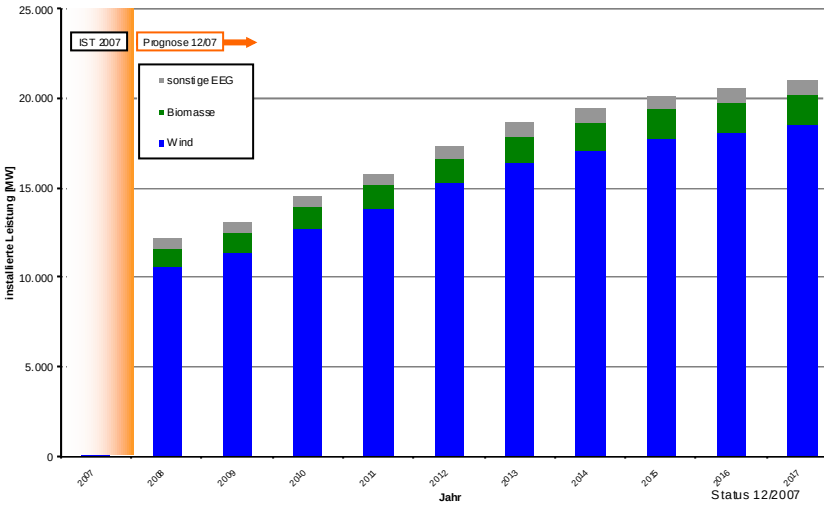
RES Integration III
Forecast of RES-Development in VE-Transmission Area



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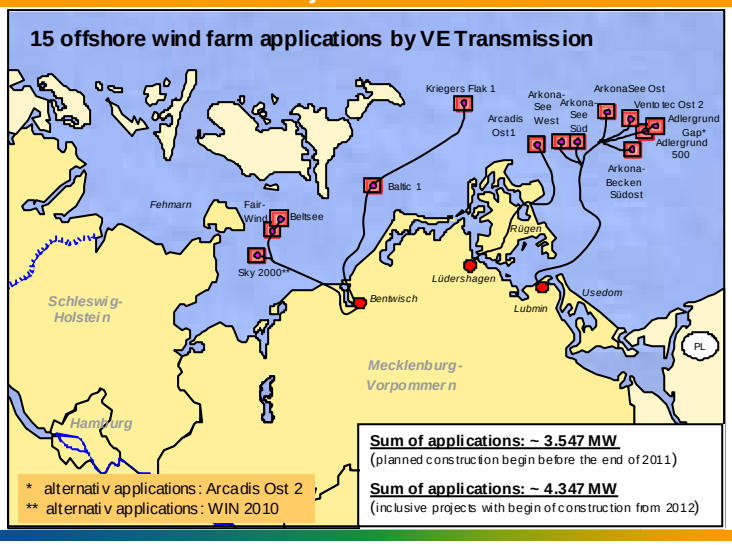
RES Integration I
State of Offshore Wind Projects in Baltic Sea



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Day-Ahead-Forecast System

	ISET	EuroWind	Previento
NWP	DWD	GFS HIRLAM	DWD ECMWF MeteoFrance
Regionalprognose	✓	✓	✓
VE-T-Prognose	✓	✓	✓
D-Prognose	✓	✓	✓
Lieferung morgens	✓	✓	✓
Lieferung abends	✓	✓	✓
Horizont	96 h	96 h	96 h

- Combination of 3 different forecast systems
- Weighted sum
- Hourly differenciated weights possible

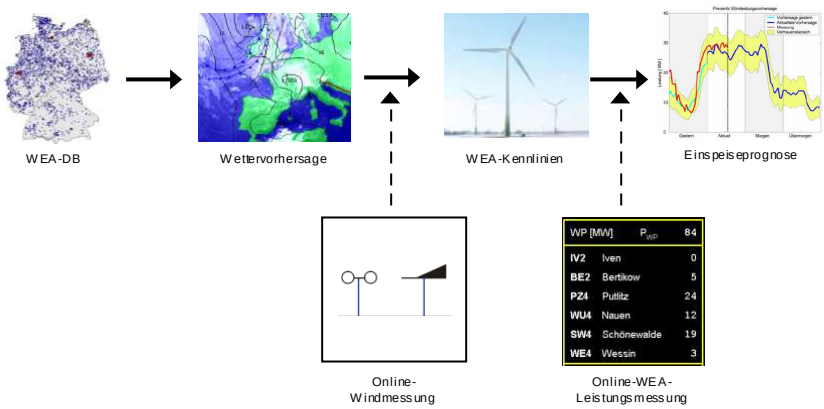
Regionen

- AVACON 1362 MW
- EDISNORD 1019 MW
- EDISSUED 2335 MW
- ENSO 344 MW
- ENVIAM 2621 MW
- TEN 622 MW
- VEH 39 MW
- WEMAG 716 MW
- gesamt VE-T 9058 MW
  (Ende Feb .2008)

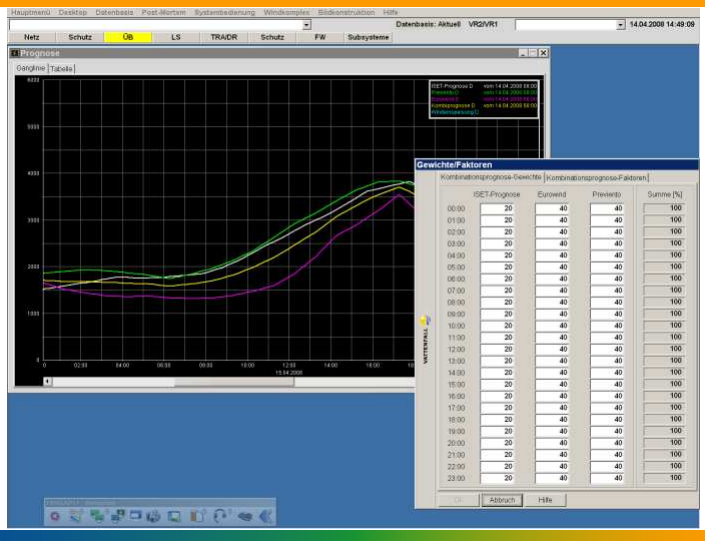
Usage of Windpower Forecasts

- Balancing of renewables
- Scheduling of network outages
- Day Ahead Congestion Forecast (DACF)
- NTC reduction
- Prediction of grid losses
- Short term prediction of emergency states

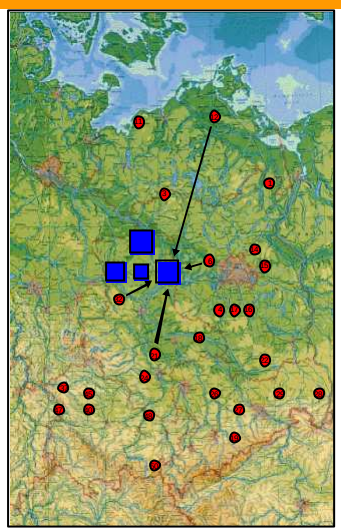
Folgetags- und Kurzfristprognosen



Day-Ahead Forecast



ISET-Online-Modell



- Aktive Referenzmessungen mit 2047 MW = 22 % von 9180 MW installierter Leistung
- Berechnung für Planflächen von 10 x 10 km
- Summierung aller Planflächen
- Im Ergebnis gewichtete Summe der Referenzmessungen

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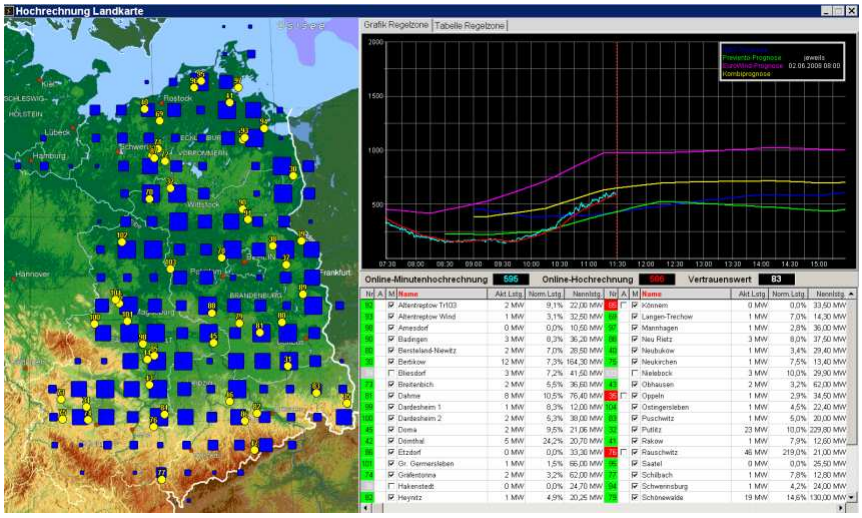
Online-Hochrechnung



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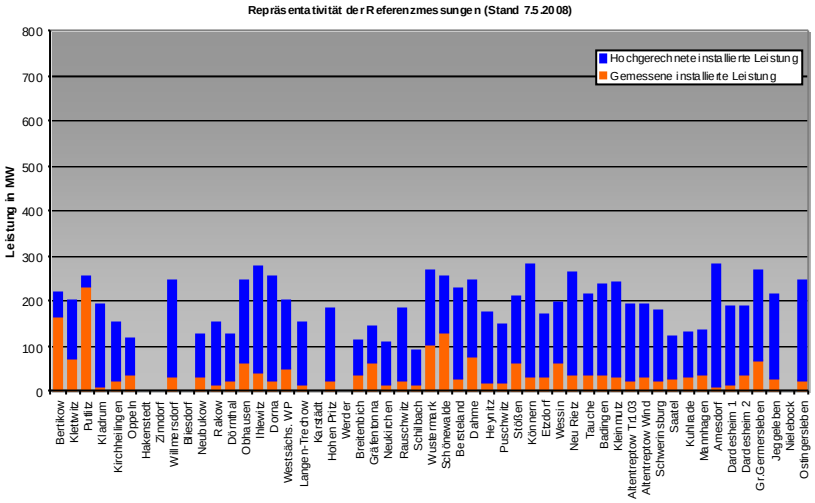
Referenzmessungen



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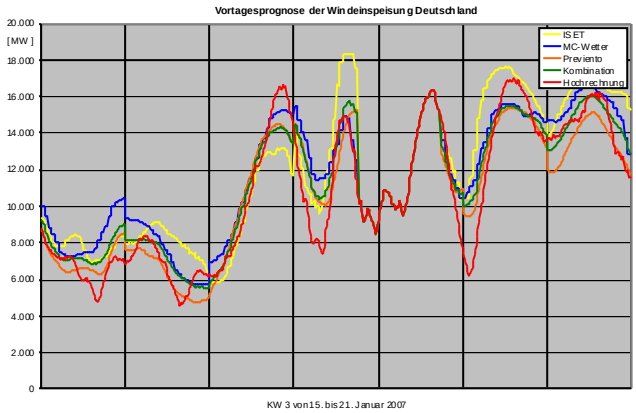
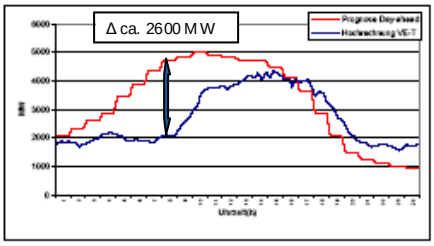
Example I



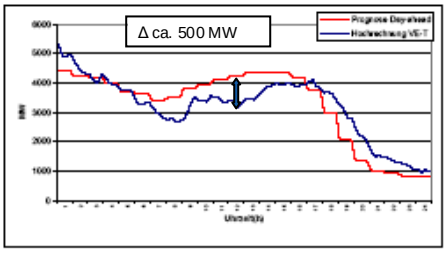
Forecast and real in feed of wind power in the control area of VE Transmission

18.4.2007



Hochrechnung	MW	Uhrzeit
Maximum	4.353	14:30
Minimum	1.566	22:45

20.4.2007



Hochrechnung	MW	Uhrzeit
Maximum	5.310	00:15
Minimum	968	23:30

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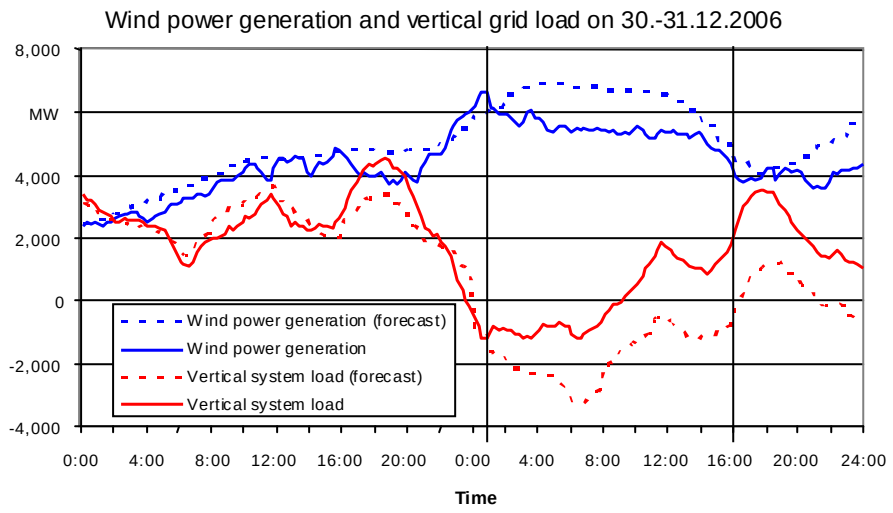
Wind Power Generation in the Control Area of VE Transmission



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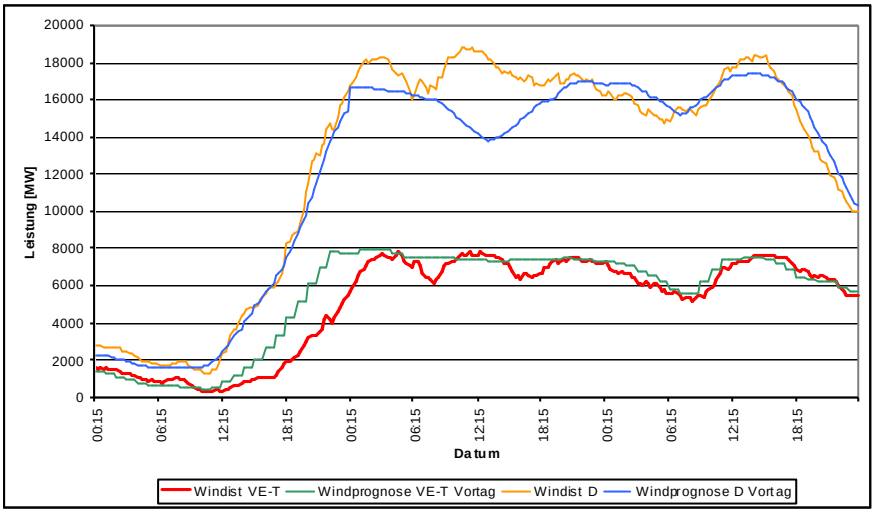
Versorgungssicherheit – Regelzone VE Transmission: Orkantief „Emma“: Windeinspeisung 29.02. – 02.03.2008



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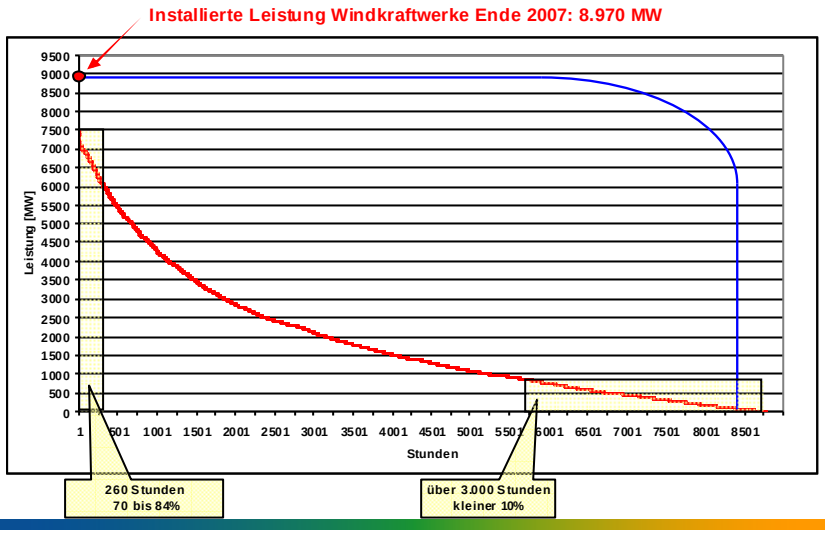
Windenergieeinspeisung 2007
Regelzone VE Transmission



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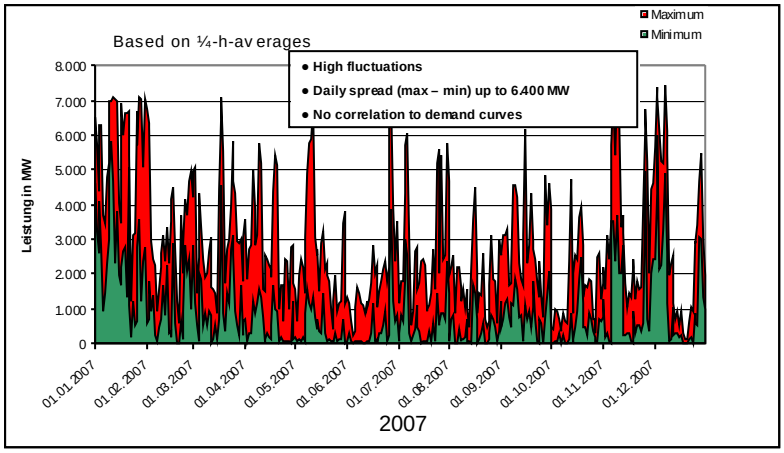
Wind Power Generation in the Control Area of VE Transmission



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Wind Power Generation in the Control Area of VE Transmission

Variation Rate of Wind Power Generation in the Control Area of VE Transmission in 2007

Maximum in-feed **Minimum in-feed**	**7.511 MW** **2 MW**
Greatest increase over 15 min **Greatest decrease over 15 min**	**638 MW** **977 MW**
Greatest increase over 60 min **Greatest decrease over 60 min**	**1.601 MW** **1.618 MW**
Greatest difference between minimum and maximum in-feed over one day	**6.398 MW**

Installed wind power in December 2007: ~ 8,970 MW

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Guarantee of Security of Supply (SoS) by the TSO in Germany

Provision and operation of the transmission grid	→	Systemprovision - § 12 (1) EnWG
Satisfy the demand concerning transmission capacity	→	Systemdesign - § 12 (3) EnWG
grid- and market related measures in the case of disturbances of the system security	→	SoS - § 13 (1) EnWG
Adjustment of all power production, transits and loads if the previous measures are not sufficient	→	SoS - § 13 (2) EnWG

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Concept of realisation of the responsibility for SoS

Measures and applications according §13 EnWG	Grid related measures according §13 (1)	Market related measures according §13 (1)	Applications according §13 (2)
Topologic measures	x		
Use of permissible tolerances of operation (current and voltage)	x		
Use of regulation energy		x	
switchable loads		x	
Preventive congestion management		x	
Mobilisation of additional reserves by TSO		x	
Countertrading		x	
Redispatch		x	
Reduction of already accepted schedules			x
Switching out of loads, reduction of voltage in the DSO grids			x
Direct instruction of power producers (incl. EEG-power prod.- Wind power)			x

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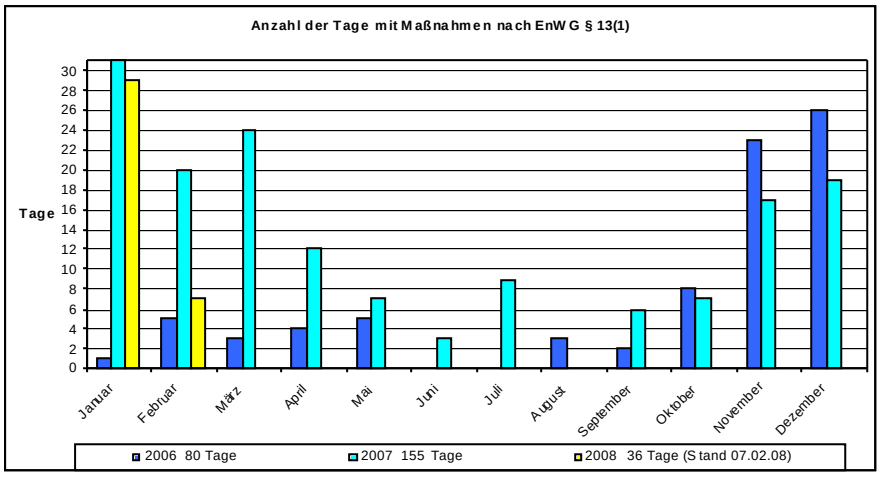
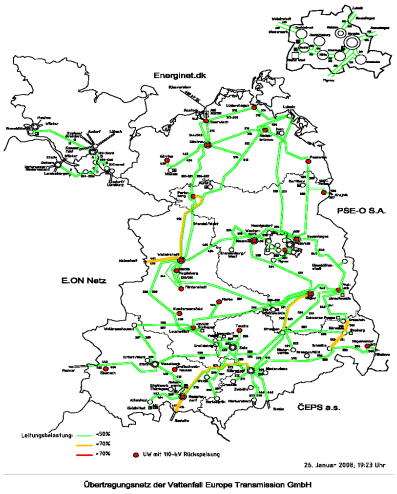
Frequency of applications of measures concerning § 13 EnWG 2006-2008



26.01.2008 19:23 p.m. max. windpower production 7870 MW



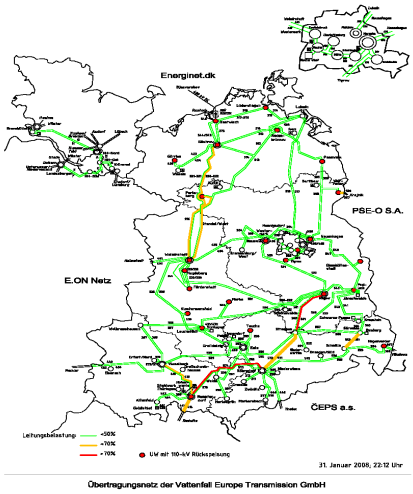
25.01.08, 15:00 p.m.
Switching on the traffic light of the CEE-Alarming System to „yellow“ (warning)

25.01.08, 15:00 p.m.
Stop of the Intraday trade

27.01.08, 16:00 p.m.
Permission of the Intraday trade

27.01.08, 16:00 p.m.
Switching on the traffic light of the CEE-Alarming System to „green“ (normal)

31.01.2008 22:12 p.m. max. windpower production 7801 MW



31.01.08, 18:00 p.m.
Switching on the traffic light of the CEE-Alarming System to „yellow“ (warning)

31.12.08, 18:00 p.m.
Stop of the Intraday trade

02.02.08, 24:00 p.m.
Permission of the Intraday trade

02.02.08, 24:00 p.m.
Switching on the traffic light of the CEE-Alarming System to „green“ (normal)

This is only the beginning – because this development is in accordance to the goals of our government…

[in MW]	December 2007	In 5a	In 10a
Onshore wind	8,970	14,100	16,100
Offshore wind	---	1,300	2,400
Other RES (biomass, photovoltaik, …)	1,170	2,100	2,700
In totaly	**10,140**	**17,500**	**21,200**

… and many applications concerning network access of new conventional power plants… (currently 15 applications with in totaly 16,000 MW)

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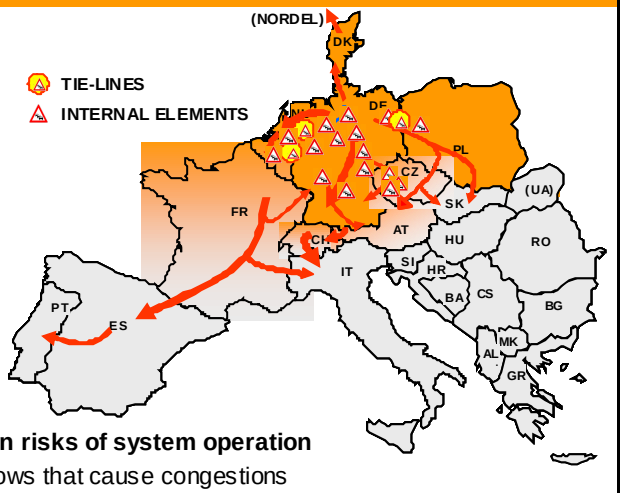
RES Integration IV
EWIS Pre-phase – Results

Detected bottlenecks during n-1 conditions
(UCTE Scenario North)



Main identified common risks of system operation

- Unscheduled transit flows that cause congestions
- Lack of ancillary services

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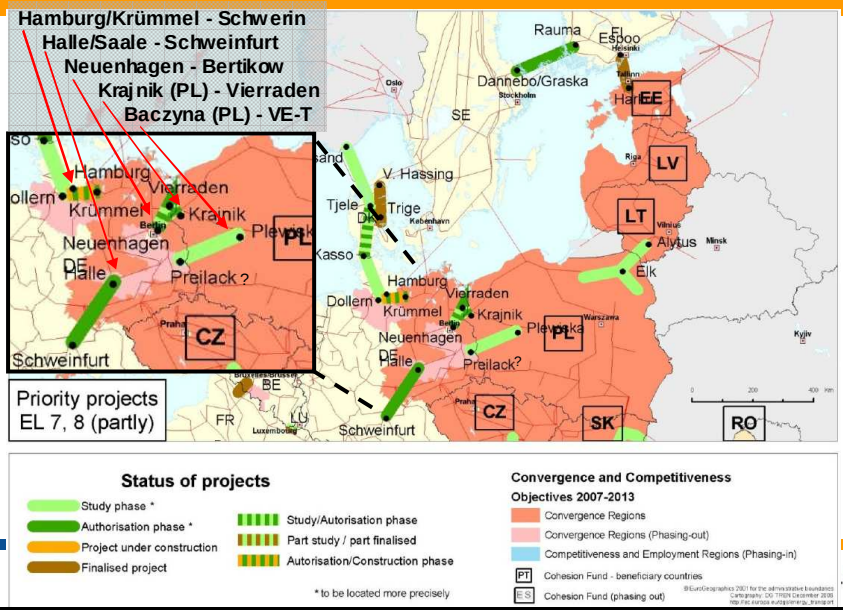
Tasks and Targets of VE Transmission in frame of TEN



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What a TSO Needs to Facilitate the Successful Integration of RES

- Stable Political environment (EU, National Government)
- Stable Financial grounds (Regulator, Shareholders)
- New Technologies for Transmission and Storage (Industry)
- New type of Staff (Universities, TSO)
- New type of Cooperation with all Stakeholders (Homework for All)
- Awareness/Trust of Public Opinion (Homework for TSO)

➡ **Cooperation and Communication are Key**

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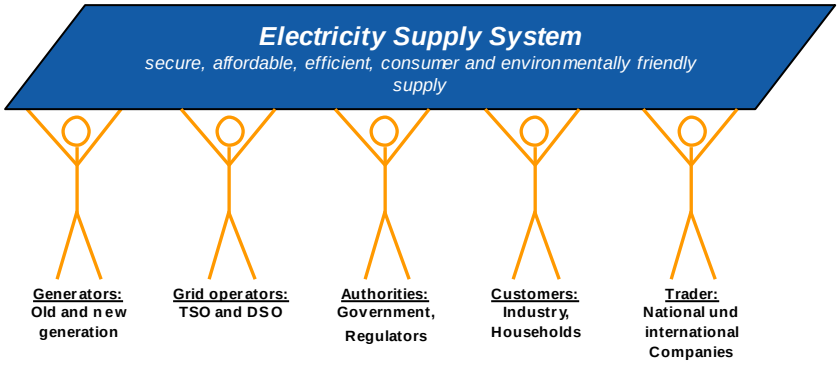
The Electricity System & The Team



Only Together we can keep a stable Electricity System

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At the End …

Together

We keep

the Lights

On!

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ERROR: syntaxerror
OFFENDING COMMAND: --nostringval--

STACK:

/Title
()
/Subject
(D:20080929154306+02’00’)
/ModDate
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/Keywords
(PDFCreator Version 0.9.5)
/Creator
(D:20080929154306+02’00’)
/CreationDate
(werner_dan)
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