Weather information tailored to the needs of the renewable energy sector

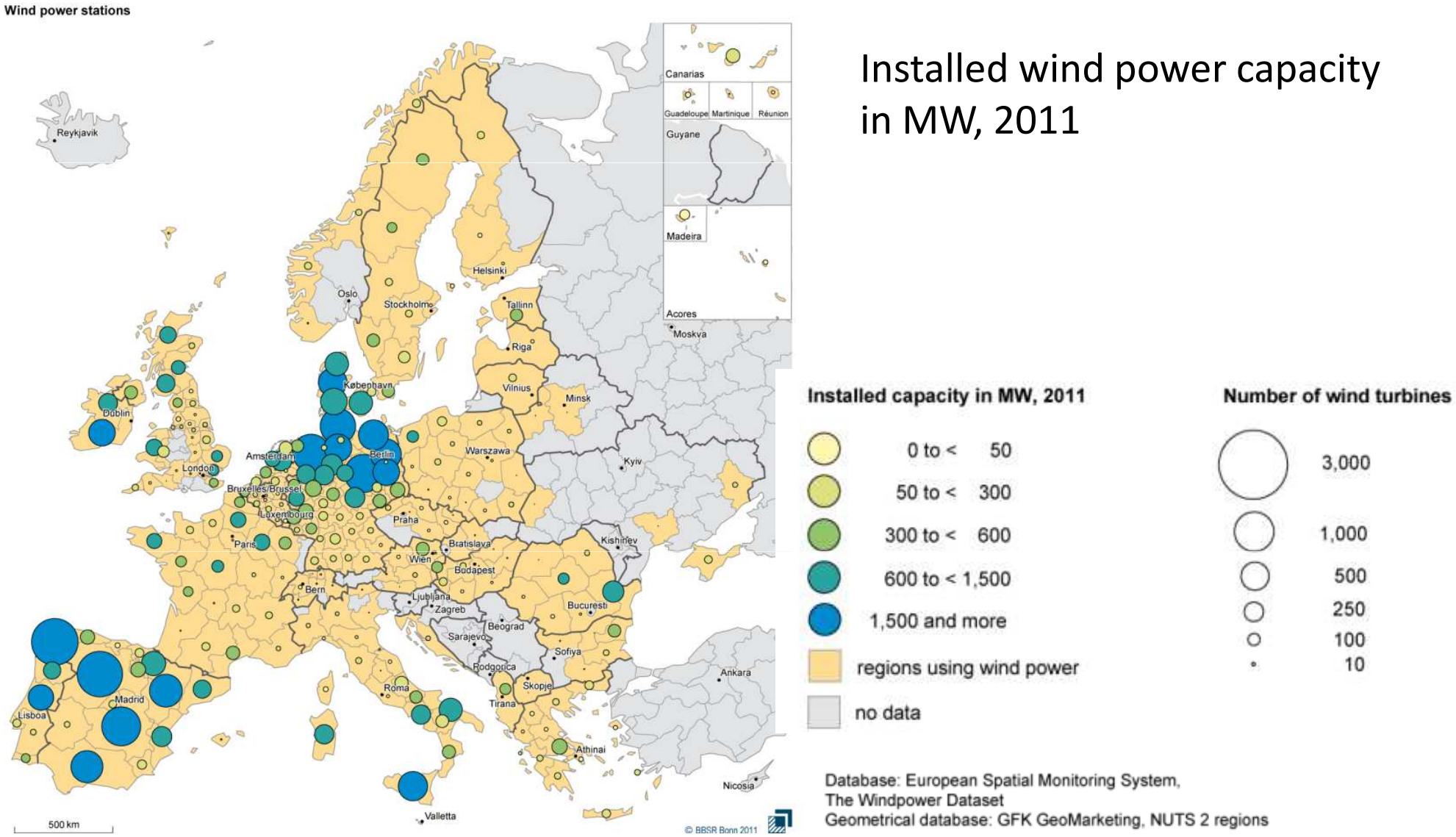
Vanessa Stauch

Product Development and Customer Relations

Deutscher Wetterdienst

Spatial distribution of wind production

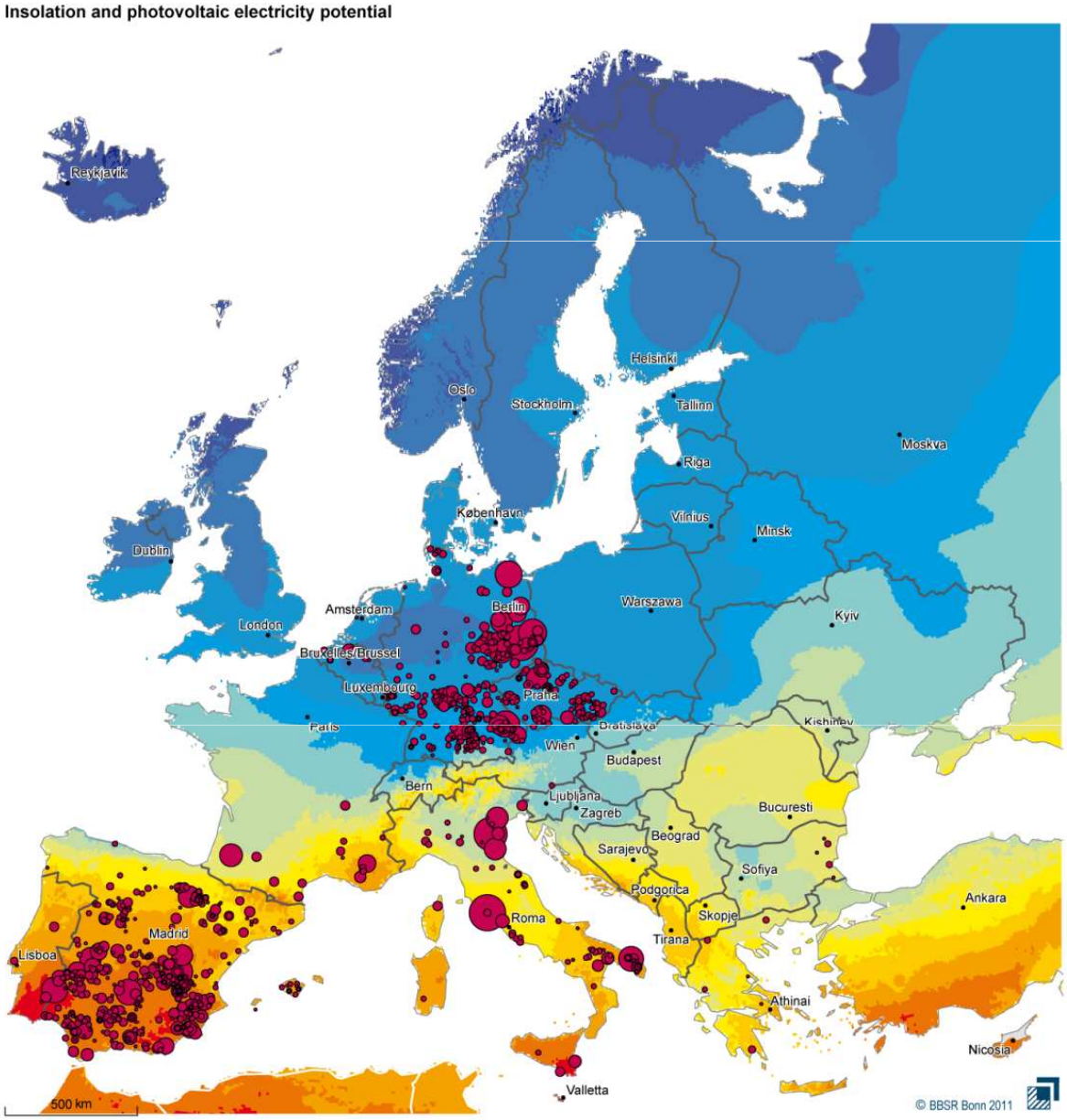
Deutscher Wetterdienst
Wetter und Klima aus einer Hand



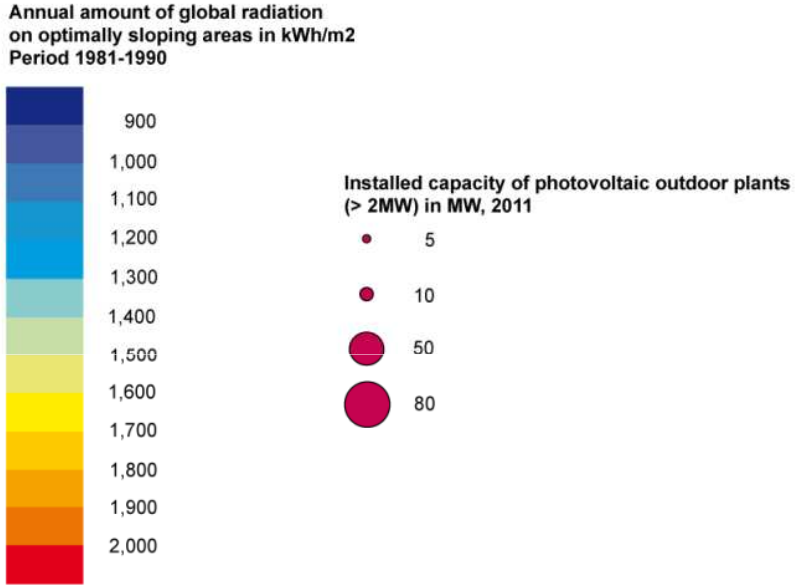
Installed wind power capacity in MW, 2011

Spatial distribution of PV production

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

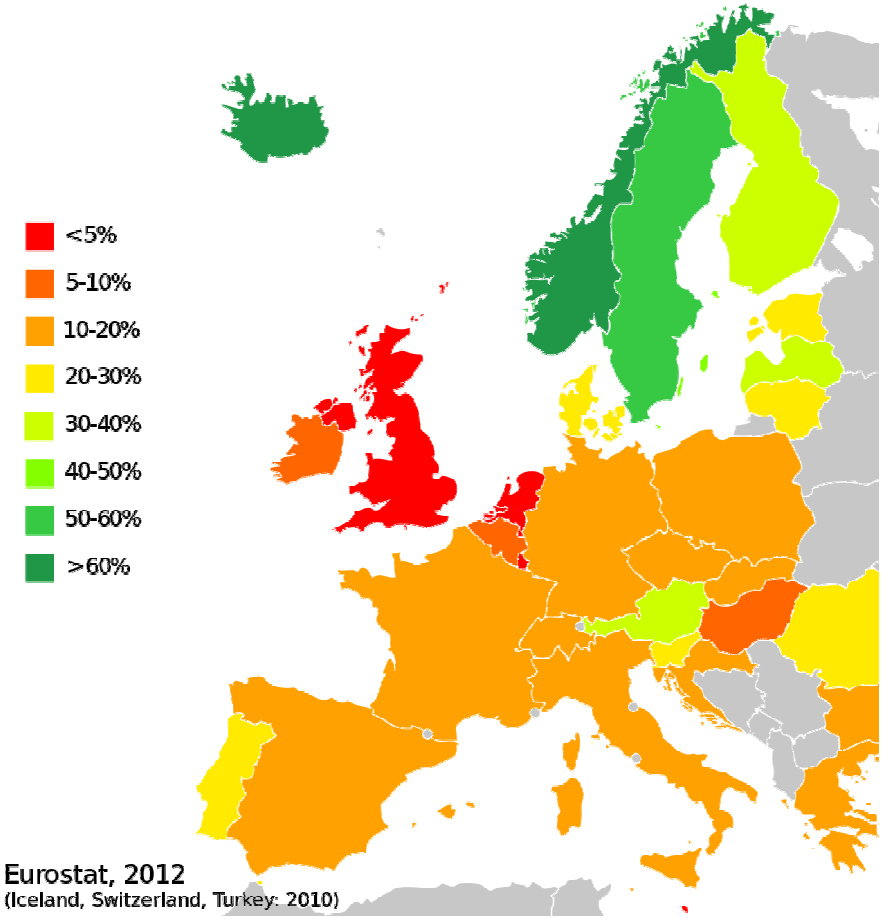


Installed solar power capacity in MW, 2011

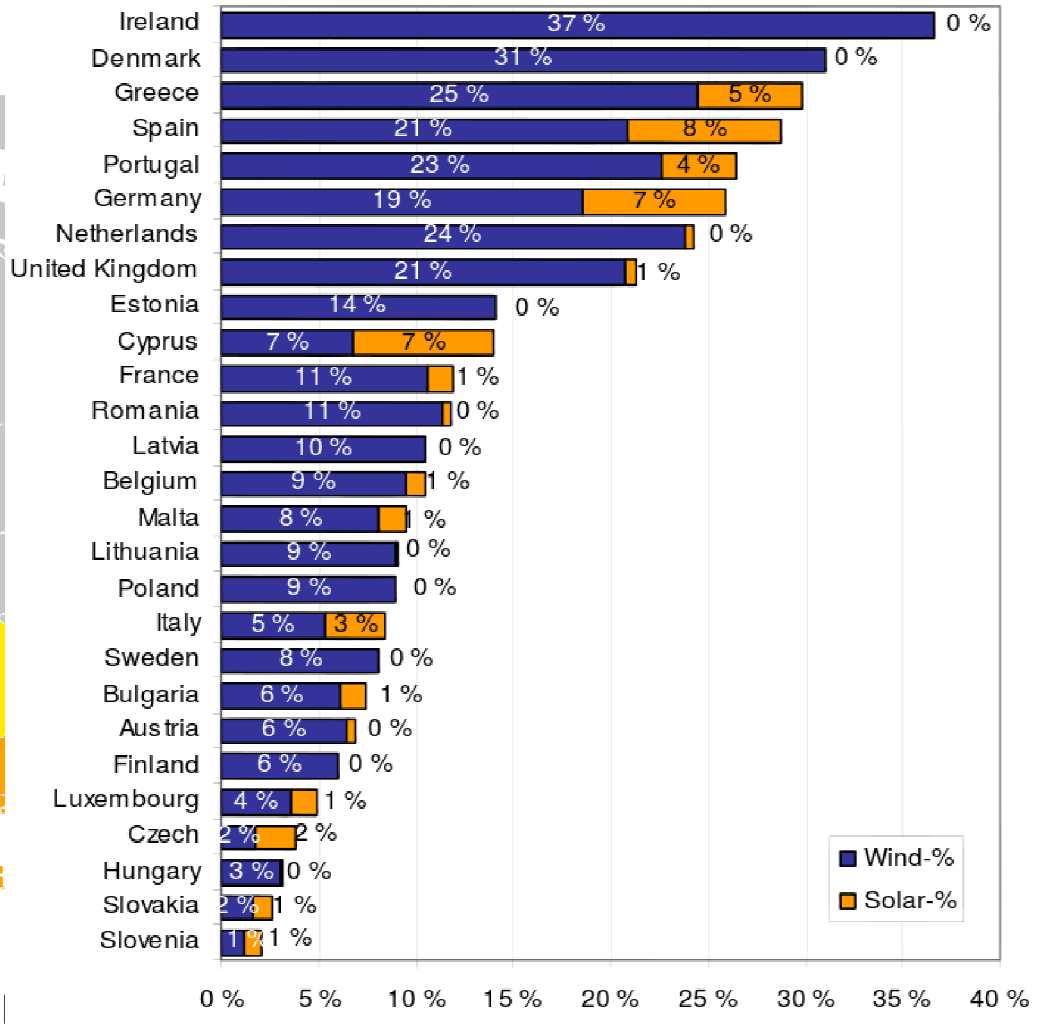


Database: European Spatial Monitoring System,
Sources: Global radiation: JRC - Photovoltaic Geographical Information System - PVGIS
© European communities, 2001 - 2008
Photovoltaic plants: PVRESOURCES
Geometrical database: GfK GeoMarketing

2020 targets of the EU



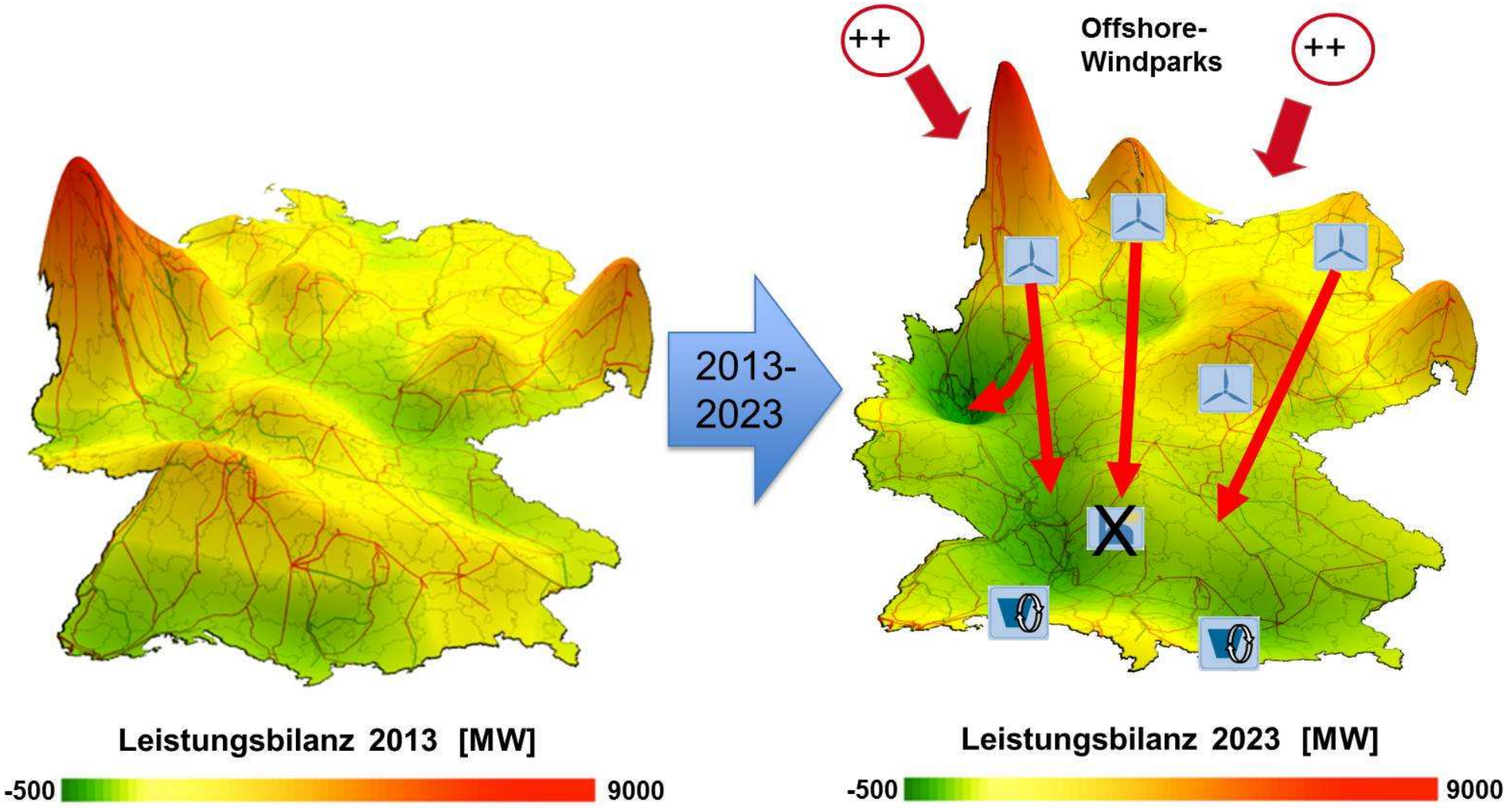
Proportion of renewable energy in the EU and
Turkey, Norway and Switzerland as percentage
energy consumption.



Projected wind and solar power shares of the total projected gross final electricity consumption in 2020 following EU27 National Renewable Energy Action Plans

Consequences for the electricity supply

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



TenneT

Consequences for the electricity supply

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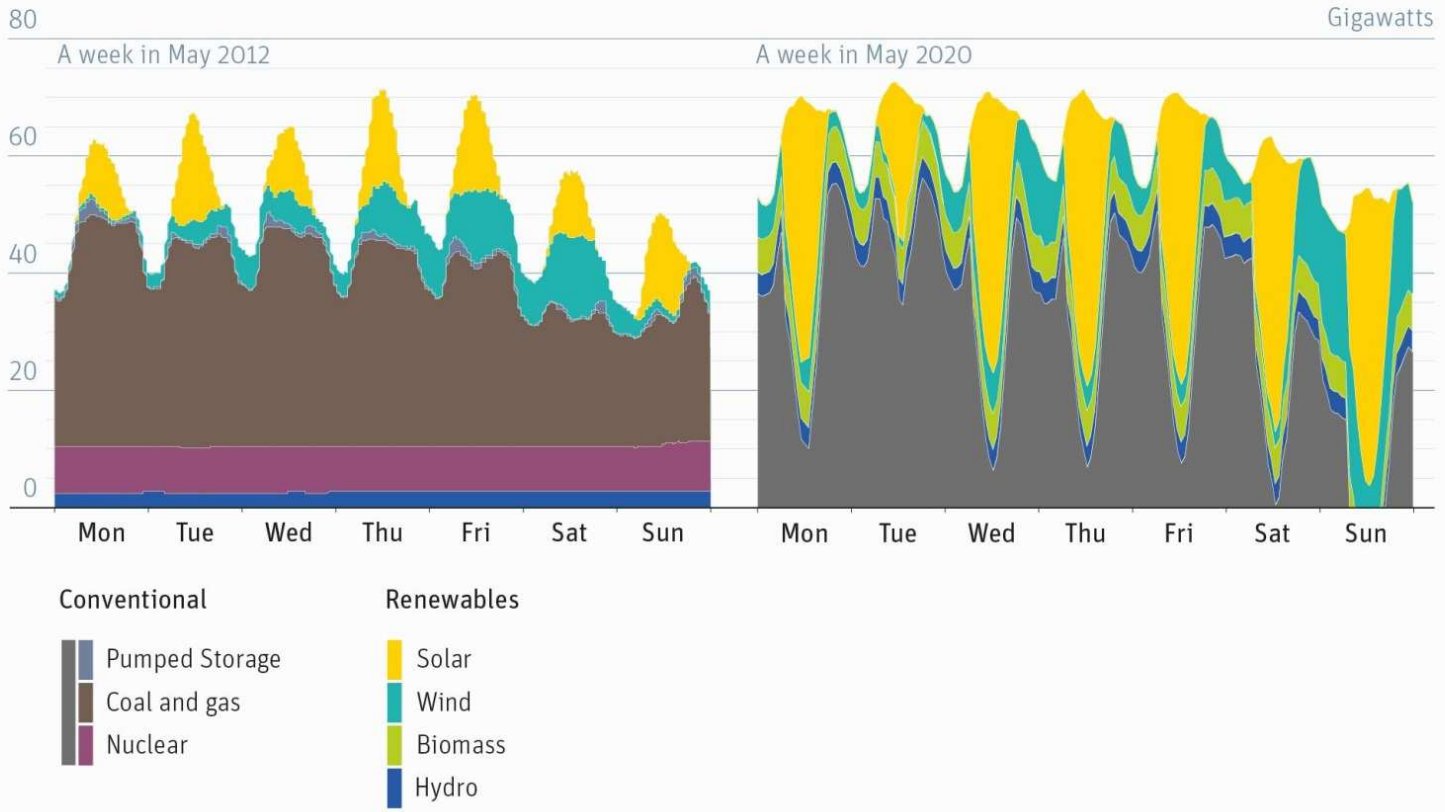
Wetter und Klima aus einer Hand

Renewables need flexible backup, not baseload

Estimated power demand over a week in 2012 and 2020, Germany

Source: Volker Quaschning, HTW Berlin



Objectives of the talk

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

» Who are the users and what are their applications?

» What kind of weather information do they need?

» What can we (weather services) do?

  » NWP model development
  » application-targeted product development

Users and their applications

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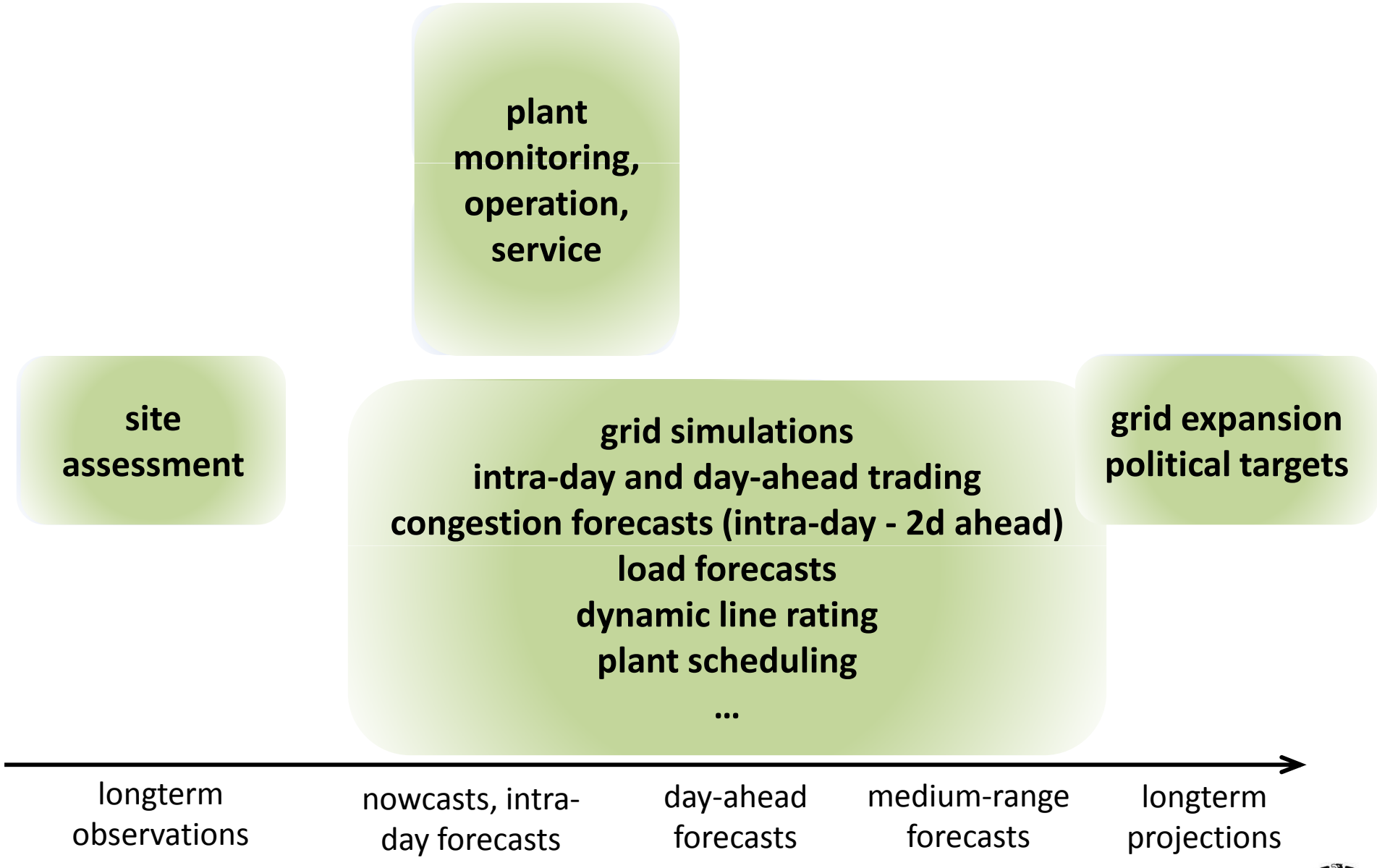
Wetter und Klima aus einer Hand



The role of the weather

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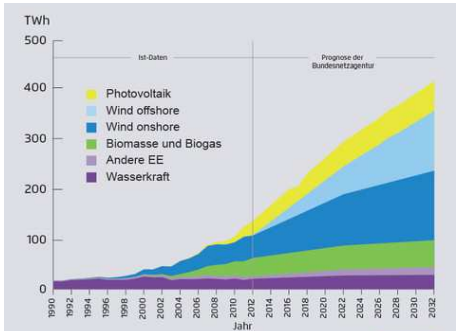
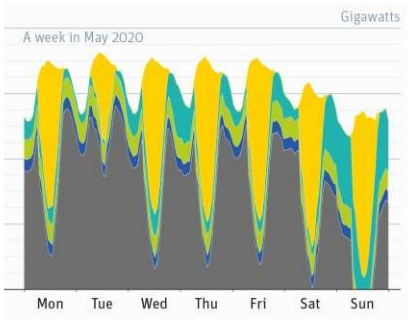
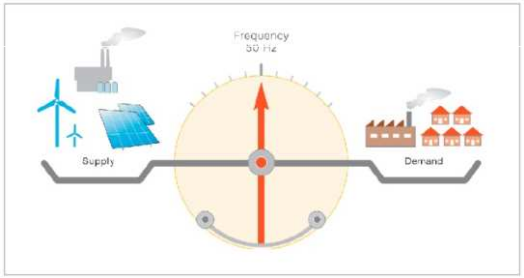
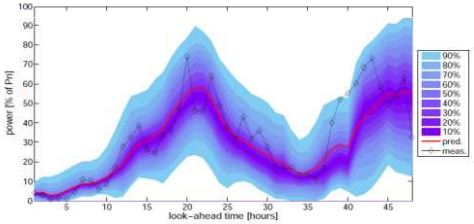
Wetter und Klima aus einer Hand









increased share of weather dependent energy sources → highly fluctuating energy production → electricity is no more generated where and when it is needed → high quality weather forecasts are needed

Weather forecasts are becoming increasingly important!

What weather information is needed?

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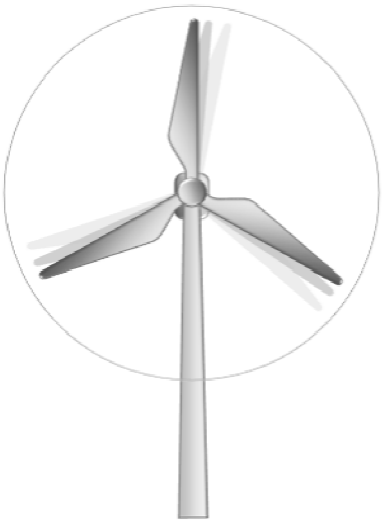
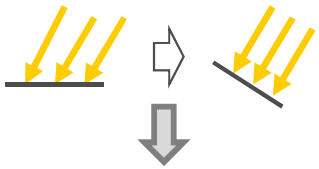
Wetter und Klima aus einer Hand

… as input for power forecast models



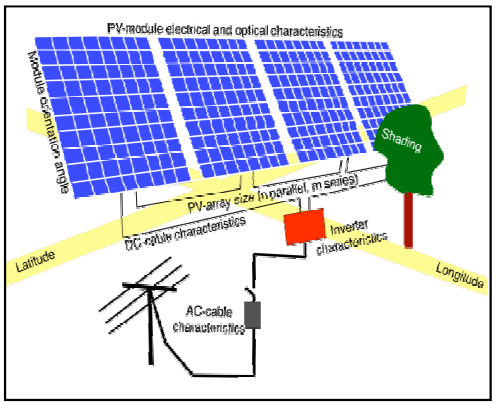
wind speed & direction
on hub height

temperature
relative humidity
pressure



direct & diffuse
shortwave radiation

temperature
albedo
wind



Forecasts for single plant sites, parks, grid nodes, control areas, countries

What weather information is needed?

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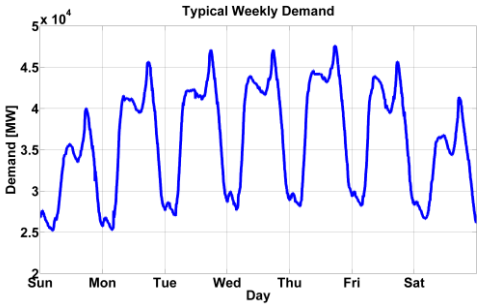
Wetter und Klima aus einer Hand

… as input for
week-ahead demand outlook



www.physics.gla.ac.uk

temperature
sunshine
precipitation

… as input for
dynamic thermal rating models

wind speed
ambient temperature
short wave radiation

www.turbosquid.com

point forecasts, regional forecasts

Forecasts along the grid

Mainly rather deterministic use of forecasts

What can we (weather services) do?

EWeLiNE & ORKA research projects

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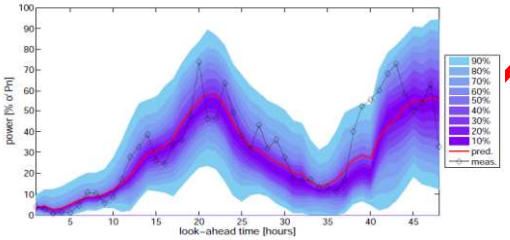
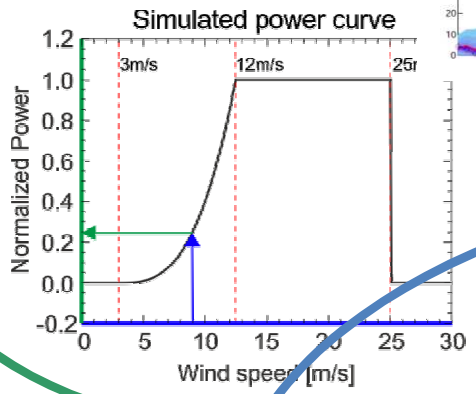
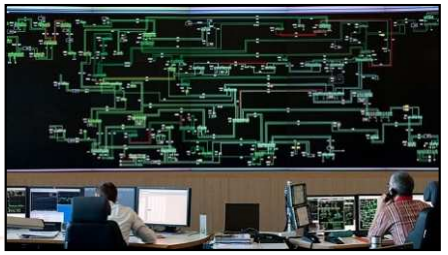
Wetter und Klima aus einer Hand

energy & meteo systems

Fraunhofer IWES







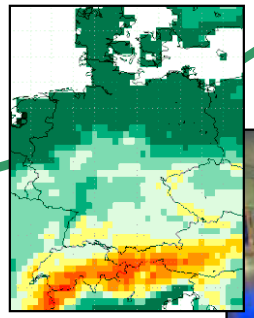
50hertz

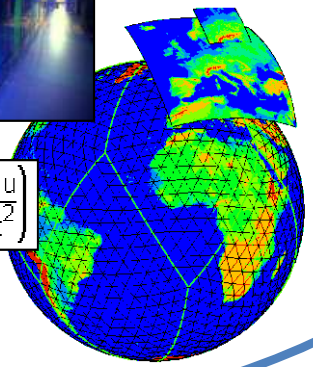
TenneT Taking power further

amprion

Thüringer Energienetze Ein Unternehmen der Thüringer Energie

avacon





$$\rho\left(\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}+w\frac{\partial u}{\partial z}\right)=\rho g_x-\frac{\partial p}{\partial x}+\mu\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}+\frac{\partial^2 u}{\partial z^2}\right)$$

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Wetter und Klima aus einer Hand

ORKA:
2012 – 2015
EWeLiNE:
2012 – 2016
www.projekt-eweline.de

Improved weather forecasts

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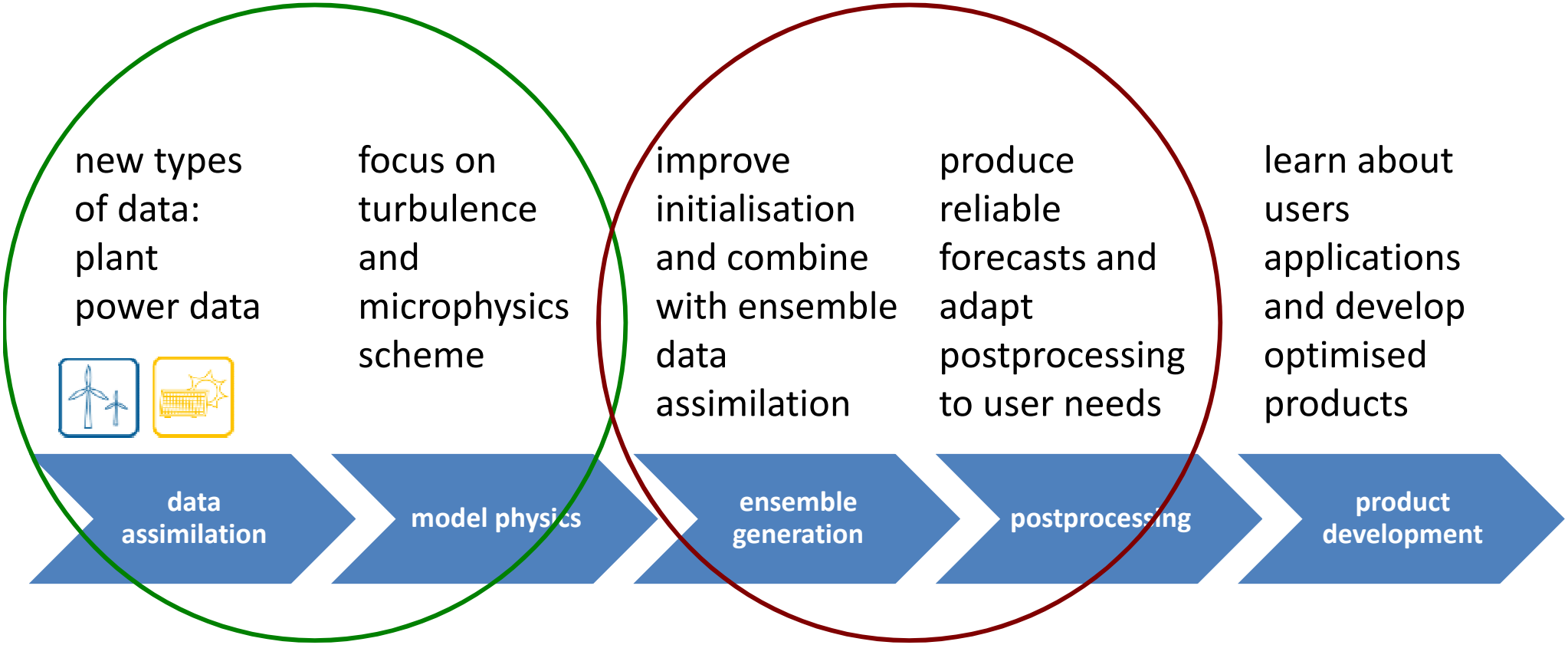
Wetter und Klima aus einer Hand



Talk by Carmen Köhler, Tue 10:50

Talk by Richard Keane, Tue 09:00

ORKA & EWeLiNE

Identification of user needs

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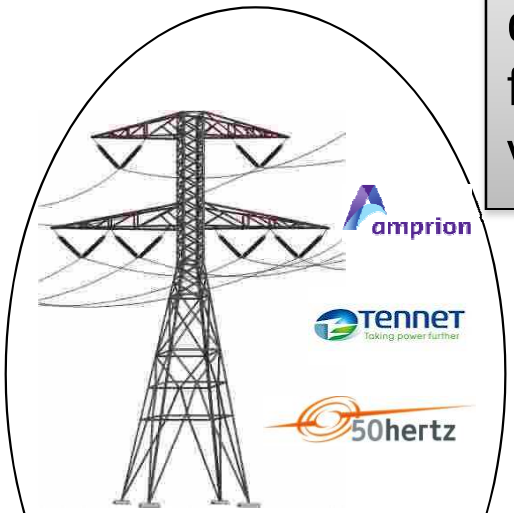
Wetter und Klima aus einer Hand

user workshop
questionnairs
frequent project meetings
visits at control rooms



user

weather

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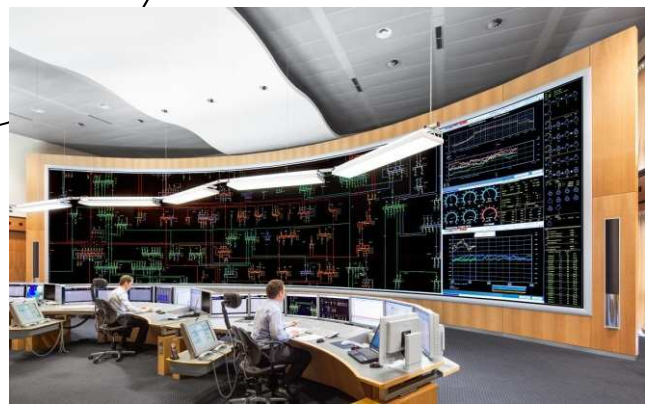
Wetter und Klima aus einer Hand

developer

power

Fraunhofer IWES



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Identified critical weather events

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Wetter und Klima aus einer Hand

	Weather phenomenon	Important for TSOs
PV	snow and icing	how long does the snow and the ice persist on the panels
	fog (all kinds)	development, partial or complete dissipation
	clouds	development of fair-weather clouds
	mineral dust	deposition on the panels
wind	sudden changes in weather regimes	- timing of the change - shutdown of wind turbine - effects on offshore production
	turbulence in the boundary layer	vertical wind reduces production
	icing	consequences on production

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Improved weather forecasts

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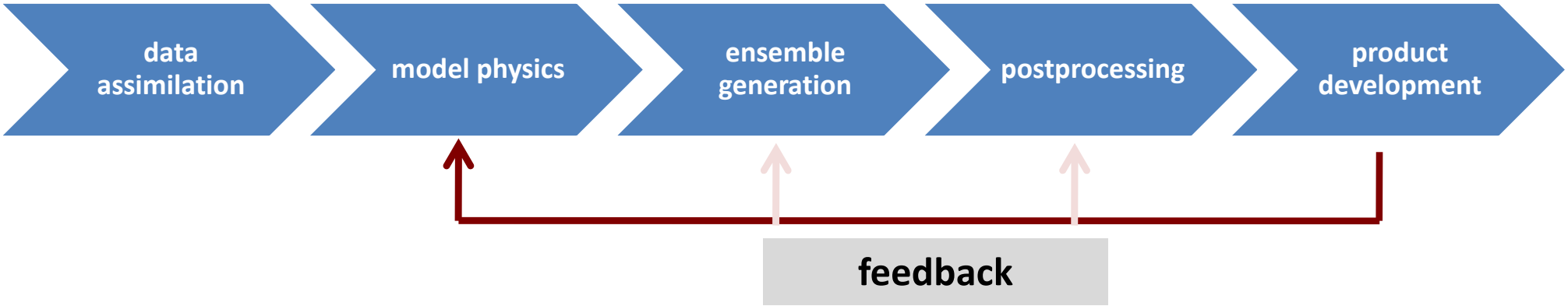
new types of data: plant power data

focus on turbulence and microphysics scheme

improve initialisation and combine with ensemble data assimilation

produce reliable forecasts and adapt postprocessing to user needs

learn about users applications and develop optimised products



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Identified forecast shortcomings

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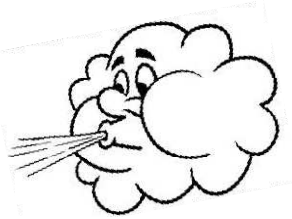
Wetter und Klima aus einer Hand

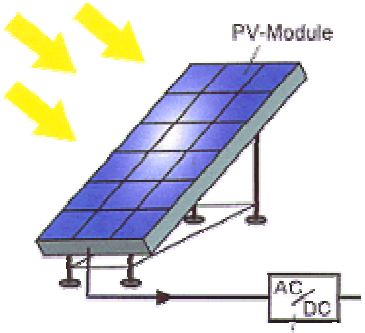
Wind



- front passages (intensity and spatiotemporal positioning)
- positive bias in stable conditions in winter
- diurnal cycle in the boundary layer (phase and amplitude)

Photovoltaic

- cloud cover after passage of cold fronts
- convection
- development and dissolution of low stratus clouds
- clear sky days (aerosol optical depth too high)



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Identification of user needs

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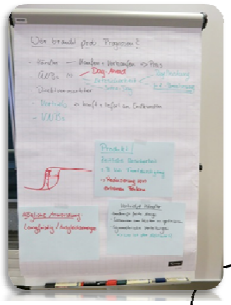

amprion

TenneT
Taking power further

50hertz

user

weather

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developer

power

Fraunhofer
IWES

Development of probabilistic forecast products to support decision making processes

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When additional information is needed…

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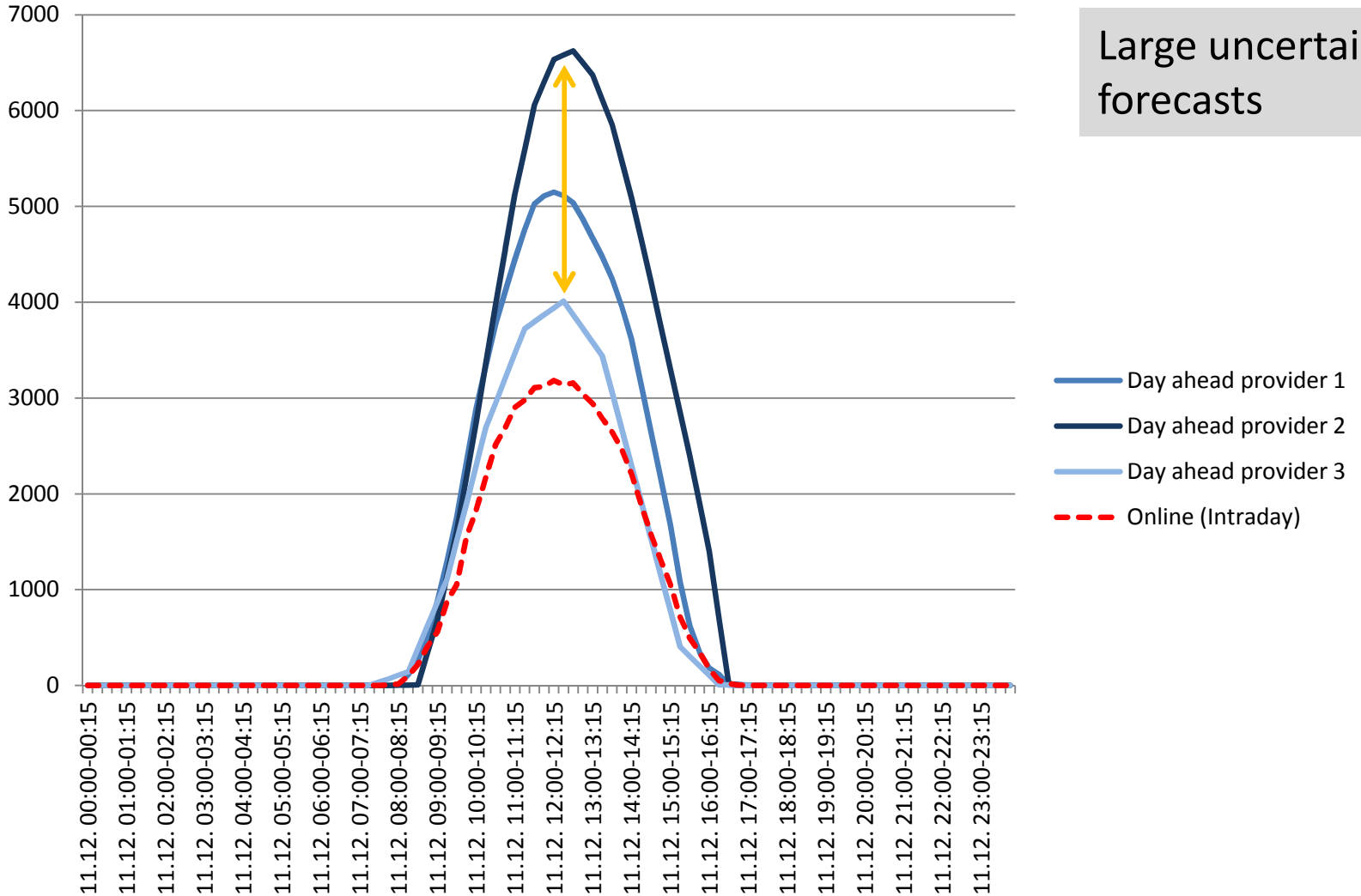

Large uncertainties in power forecasts

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Ideal use case: steep gradients

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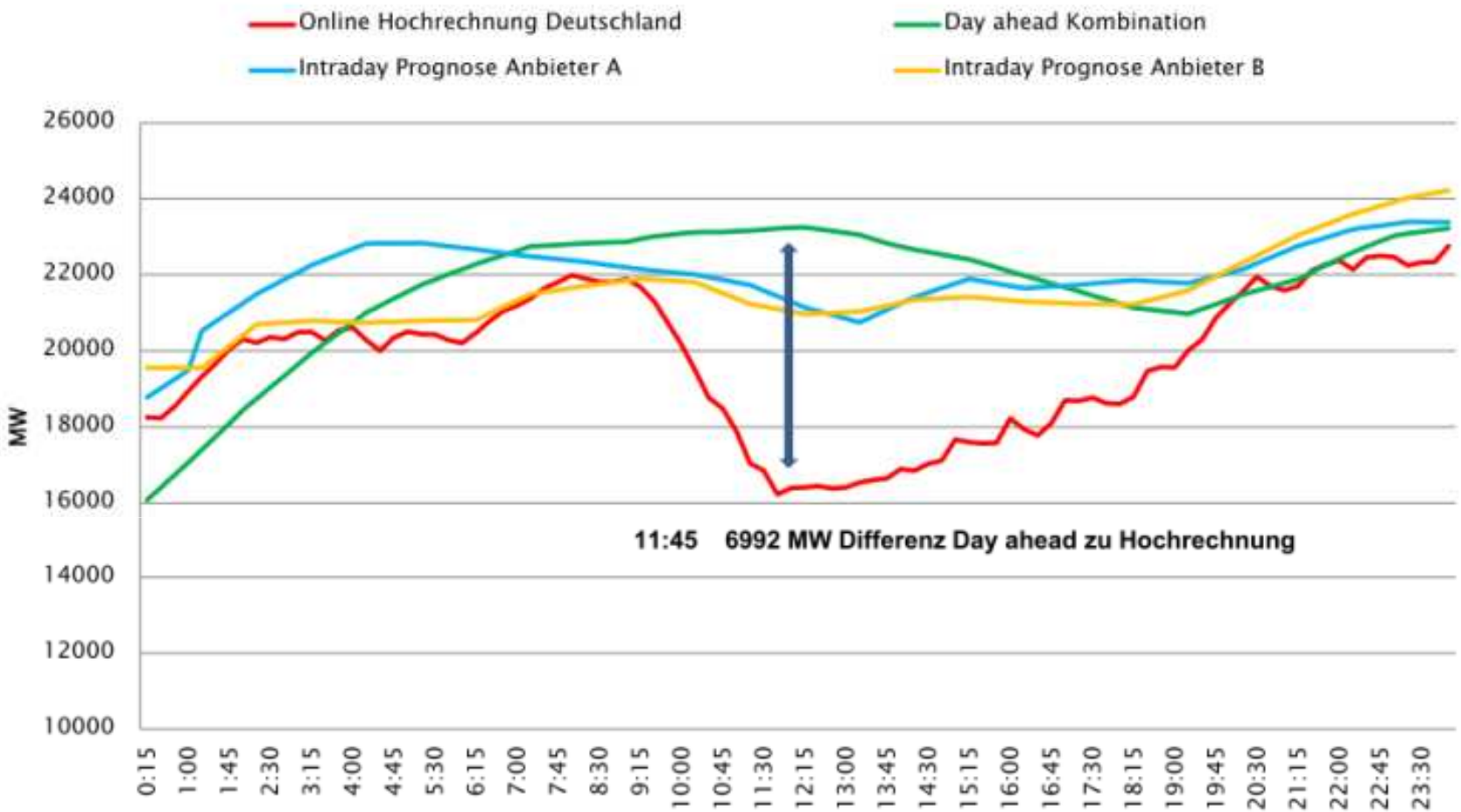
Wetter und Klima aus einer Hand

30.01.2013: quick drop-off of wind power feed-in



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Additional information through EPS

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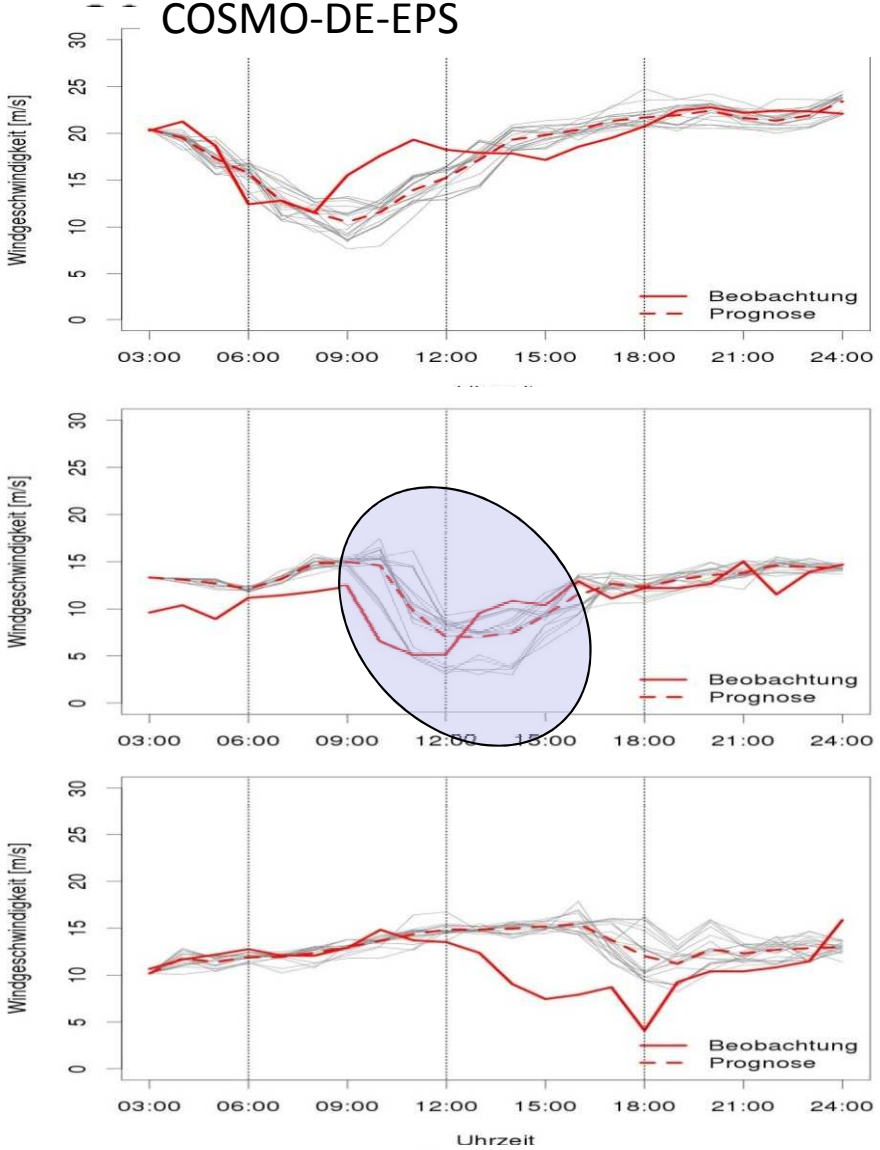
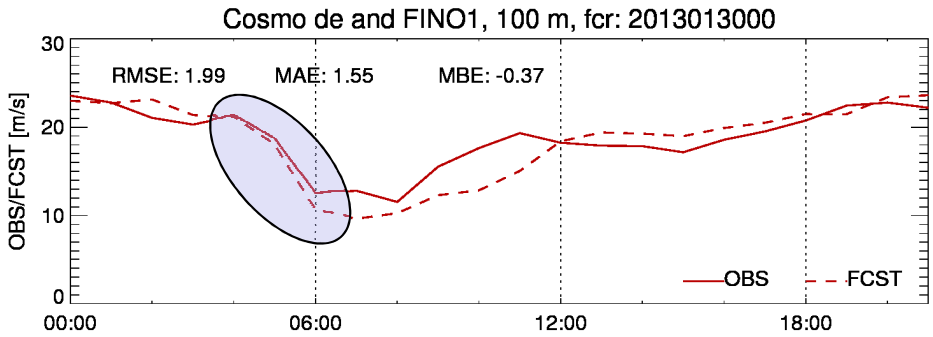
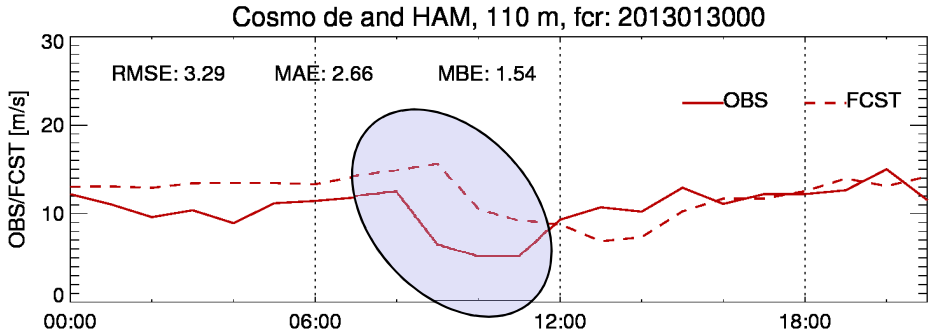
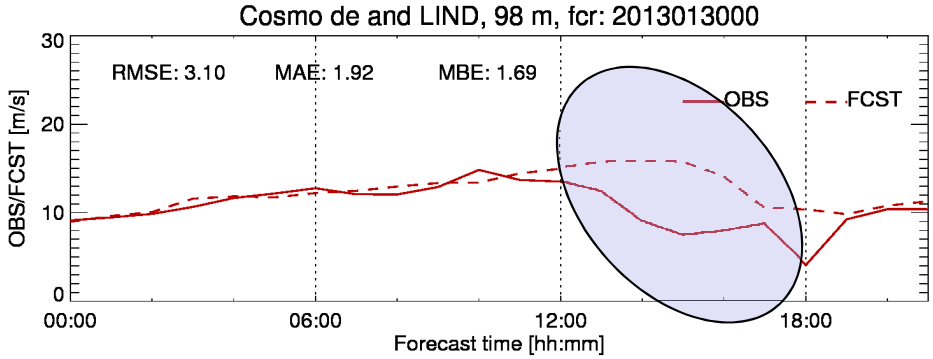
COSMO-DE-EPS









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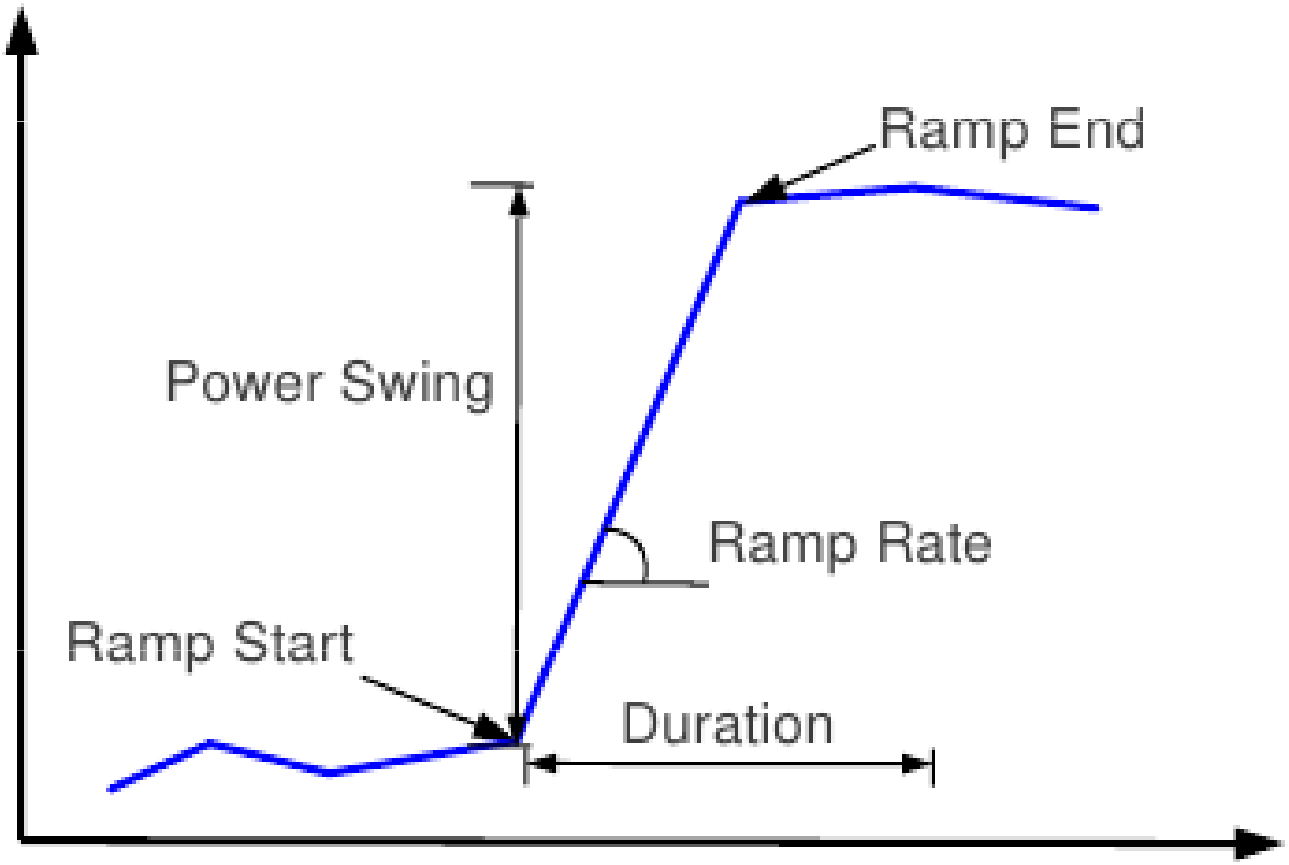
Definition of a wind ramp



Parameters: amplitude and duration

Optimised to users sensitivities

Sevlian et al. (2012)

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Probabilistic wind ramp forecast

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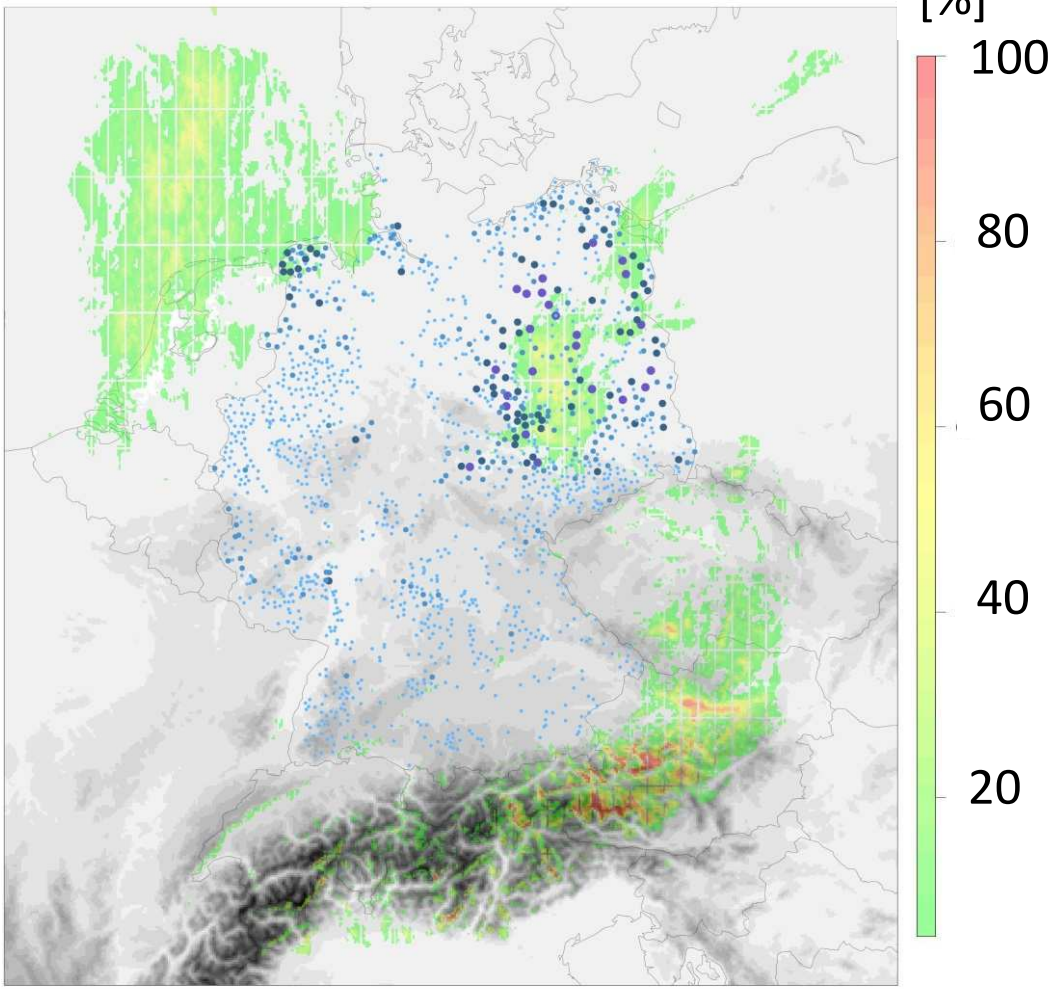
COSMO-DE-EPS 15UTC run, 05.12.2012



Vorhersage + 17h

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Probability for the occurence of an increase in wind speed of **7 m/s** within the next **3 hours**.

Combination of weather information with specific user data

- Installed capacity per postcode („Anlagestammdaten 2012“)
  < 20MW
  20-50MW
  50-100MW
  >100MW

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Conclusions

» Growing demand for meteorological information from the renewable energy sector

- needs are manifold w.r.t. spatial resolution and temporal horizon for a number of parameters
- new strategies need to be developed to integrate meteorological information into decision-making

» User dialog is needed

- consideration of user defined high-impact events
- probabilistic product development in close cooperation with the user

Thank you

Number of (n-1) critical situations

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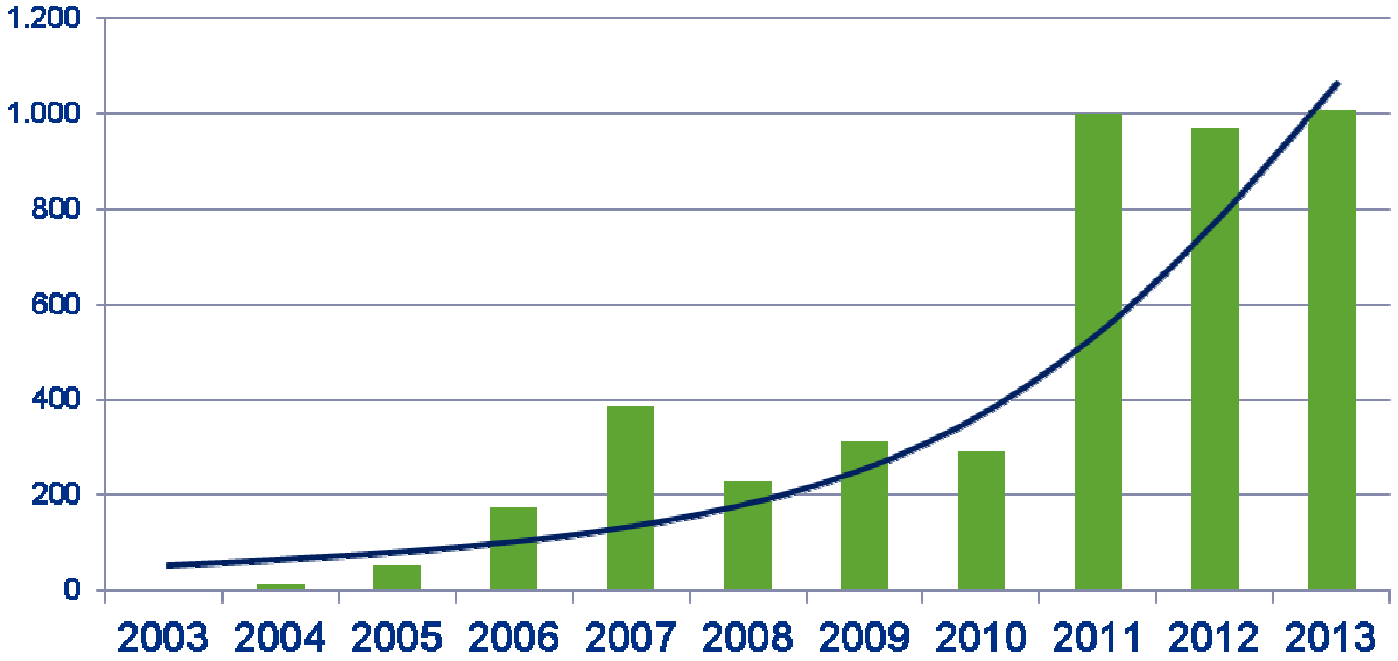
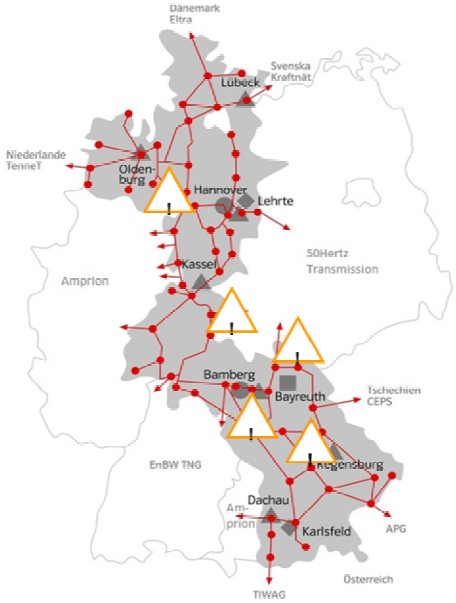
Wetter und Klima aus einer Hand

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Events*	2	15	51	172	387	228	312	290	998	970	1009
Days	2	14	51	105	185	144	156	161	308	344	356





* Ereignisse, in deren Folge Maßnahmen nach § 13 EnWG und § 11 EEG ergriffen wurden; ohne Spannungsprobleme

Daily cycle in the boundary layer

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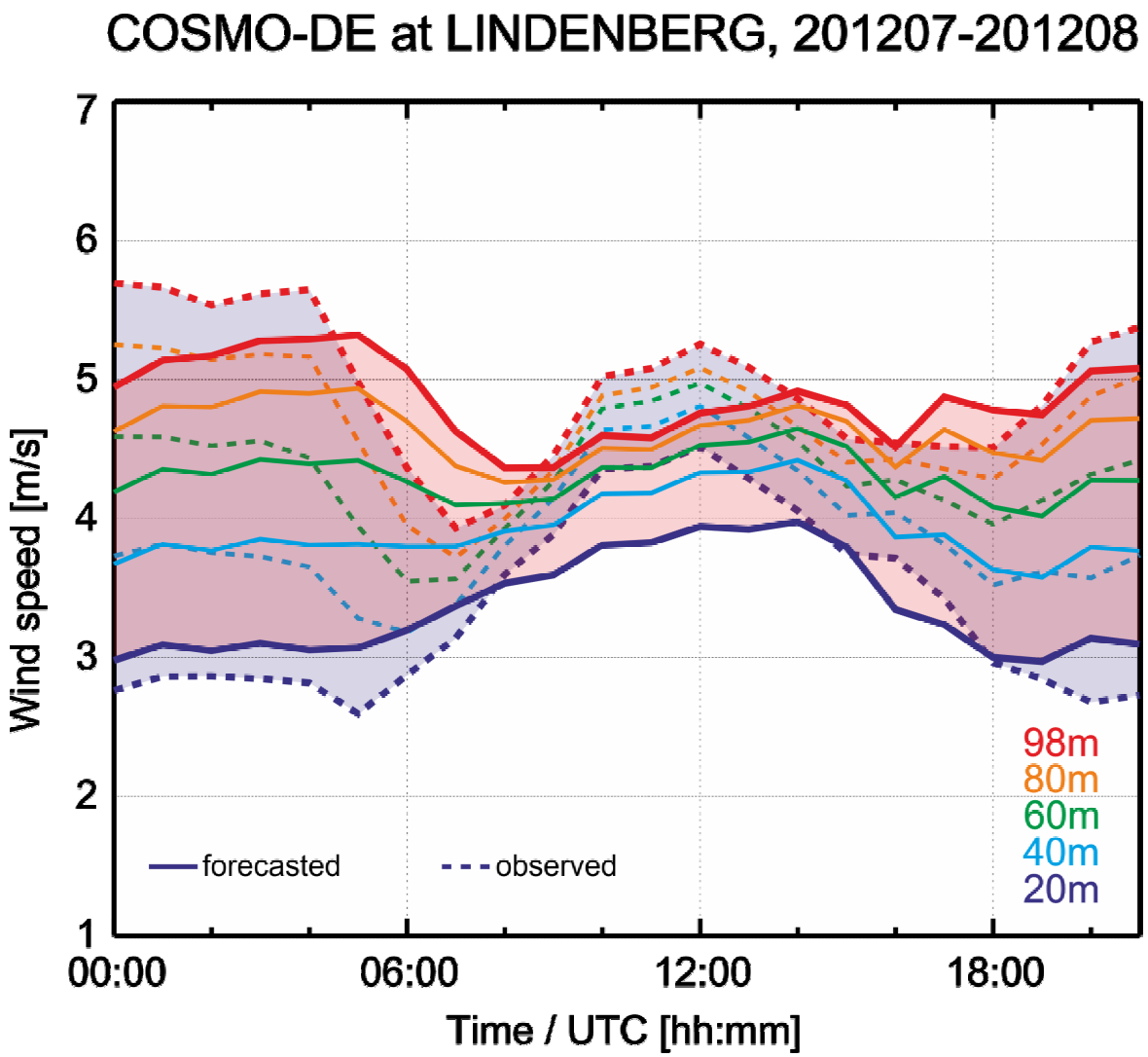
➔ Low Level Jets

- underestimation of the amplitude, in particular for LLJs
- timing error/temporal inertia:
  transition from mixed conditions (day) to stabil conditions (night) and vice versa too slow

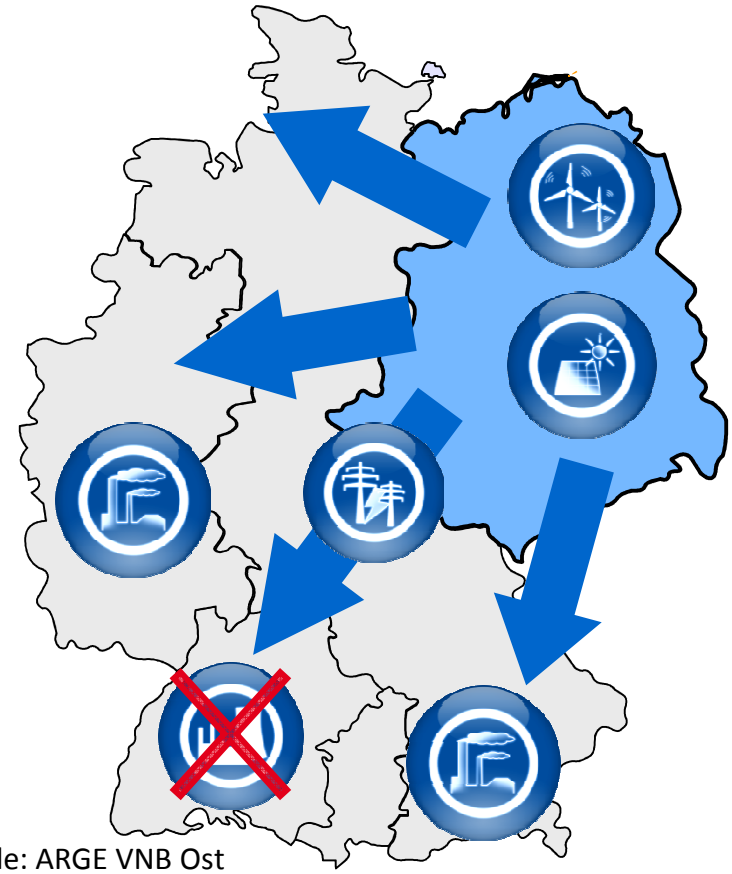


Andrea Steiner, DWD

ORKA & EWeLiNE

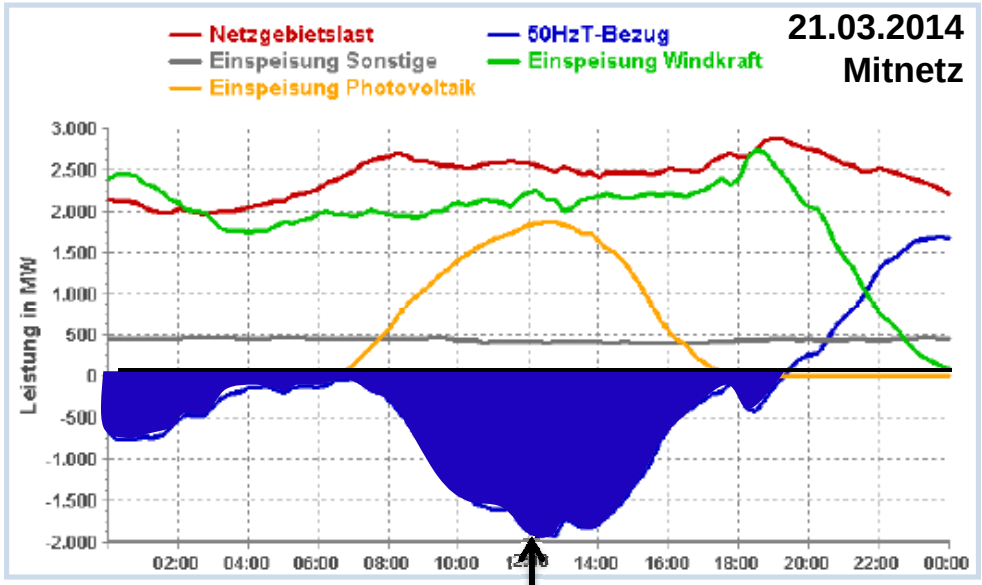
Die Veränderungen der Energiewende werden im Norden und Osten Deutschlands schon heute sichtbar.

Örtliches Ungleichgewicht



Quelle: ARGE VNB Ost

Zeitliches Ungleichgewicht zwischen Bedarf und Erzeugung



Rückspeisung in Höhe der eigenen Last