

# Impact of market design and public acceptance on the regional distribution of wind energy - simulation results for Germany

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Knowledge for Tomorrow



# What has DLR to do with energy system analysis?



# DLR Overview

DLR's mission:

- exploration of the Earth and the solar system
- research aimed at protecting the environment
- development of environmentally-friendly technologies to promote mobility, communication and security.

Key data:

- 8.000 employees are working at 20 sites in Germany and in offices in Brussels, Paris, Tokyo and Washington D.C.
- DLR consists of 40 research institutes and facilities



**SECURITY**

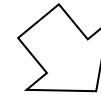
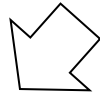
**DIGITALISATION/ Big Data**



# Current research questions

## Wind potential

- Can the local states reach there long term wind targets?



## Acceptance

- How can public acceptance be integrated into the analysis of wind investments?
- Which measures and market incentives can increase public acceptance for additional investments into wind power?

## Market design

- What incentives provides the current remuneration schemes and auction design on the regional distribution of wind energy?
- How does it compare to different auction designs?
- What regulatory measures and incentives on a German and European level could be beneficial to reach the regional targets (e.g. the states targets)?



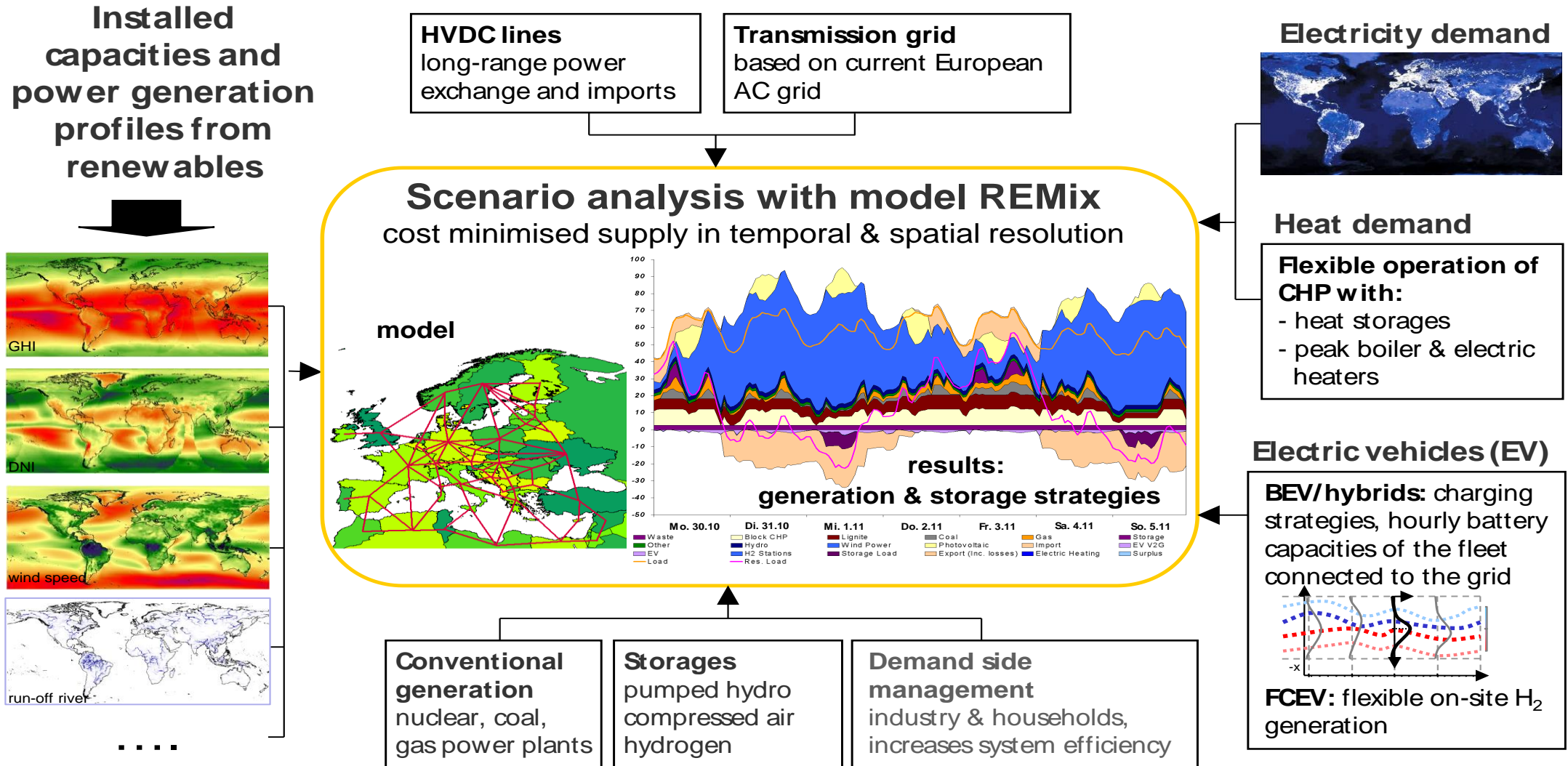
# Agenda

1. Introduction: Long term scenarios
2. Installed wind power up to 2018
3. Modelling approach
4. Regulation
  - A Regulation I: Acceptance
  - B Regulation II: Market design
5. Next steps ... and challenges



# 1. Introduction: Long term scenarios

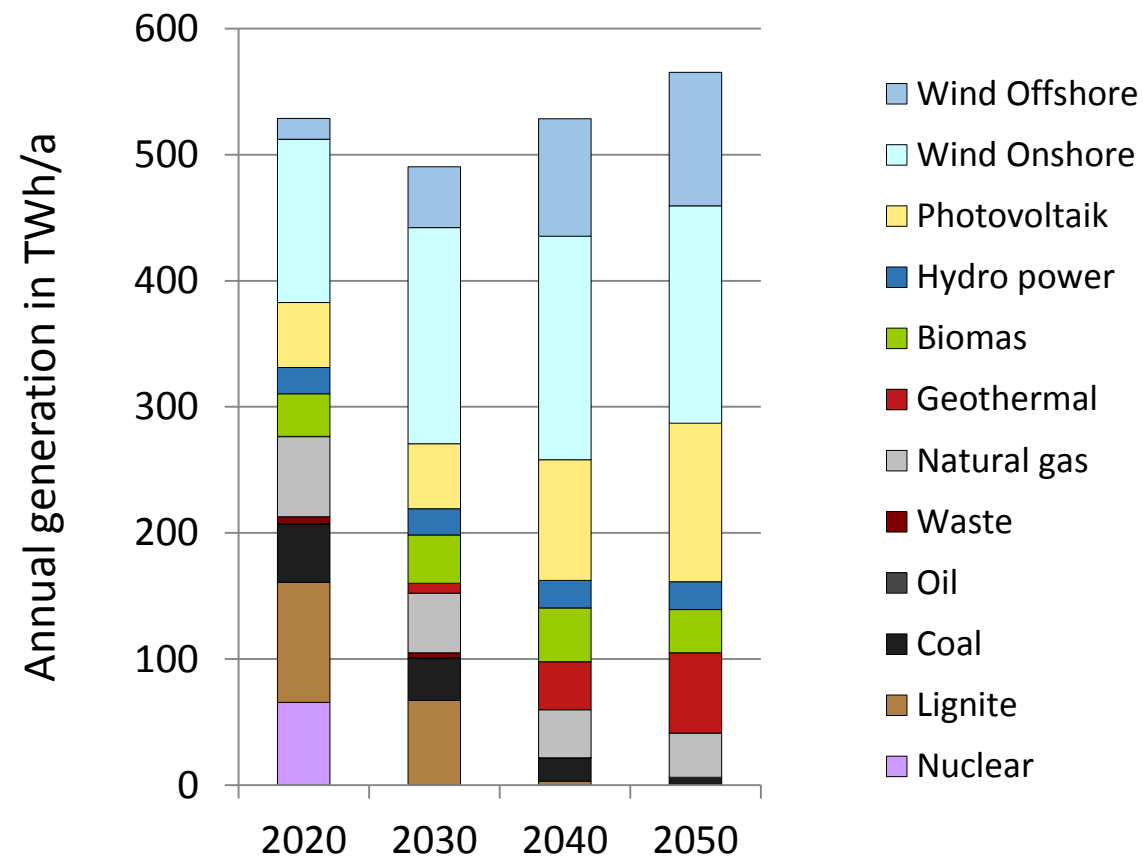
## REMix: The Energy systems model developed at DLR



## 1. Introduction: Long term scenarios

# Long term scenarios allow to analyse consistent pathways

Electricity generation in Germany

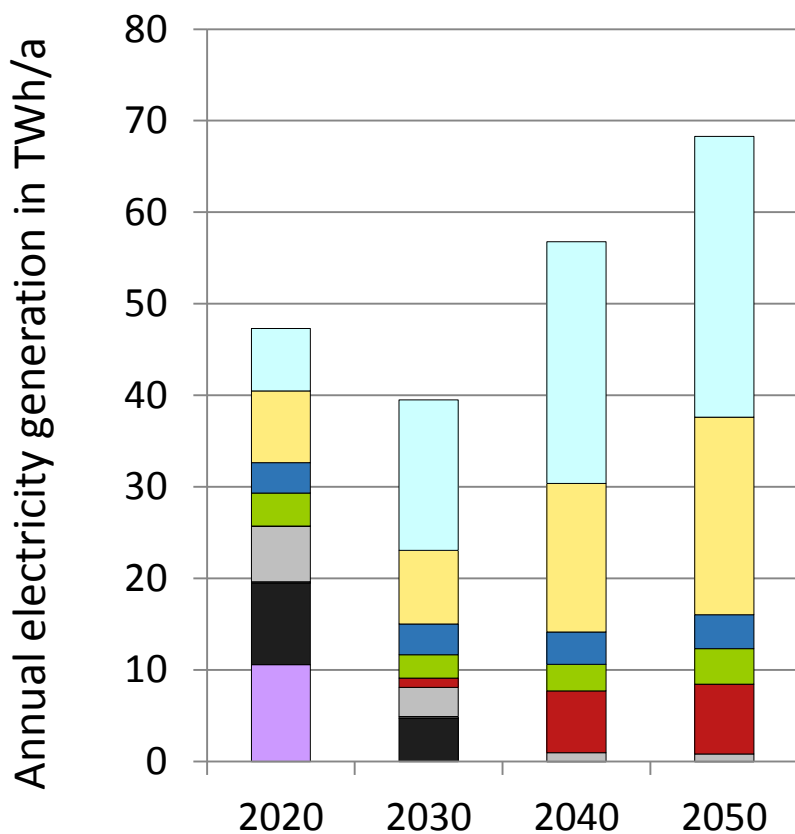


## 1. Introduction: Long term scenarios

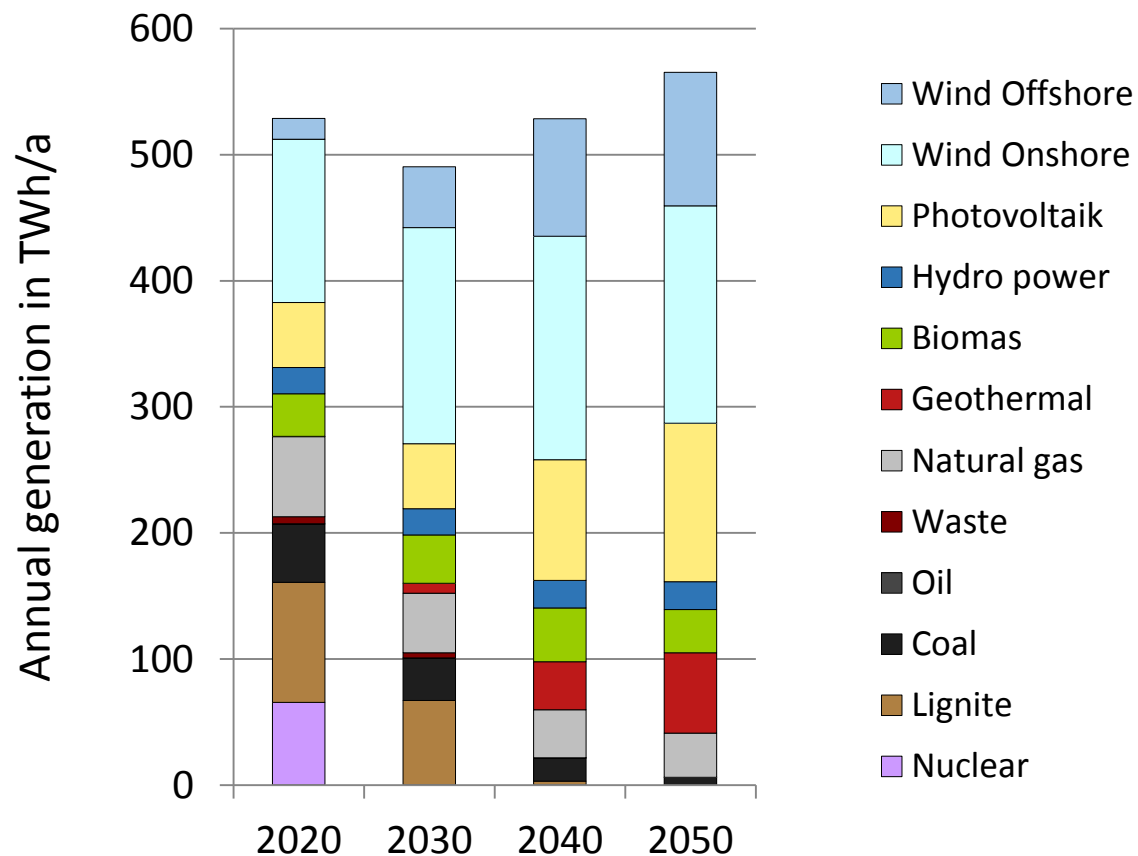
# Long term scenarios allow to analyse consistent pathways

- Wind Offshore
- Wind Onshore
- Photovoltaik
- Hydro power
- Biomass
- Geothermal
- Natural gas
- Waste
- Oil
- Coal
- Lignite
- Nuclear

Electricity generation in Baden-Württemberg



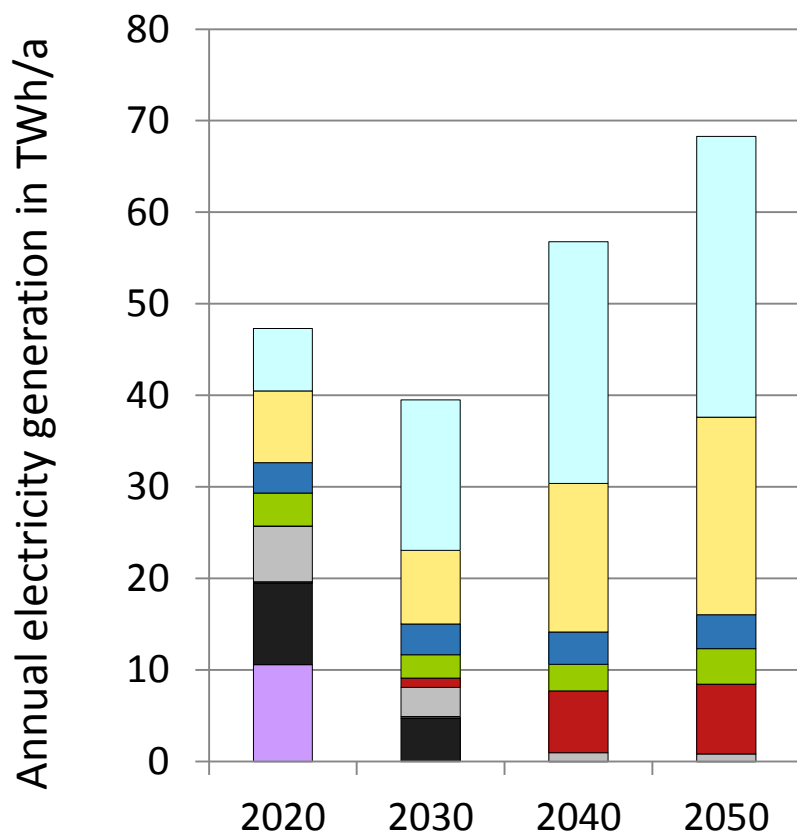
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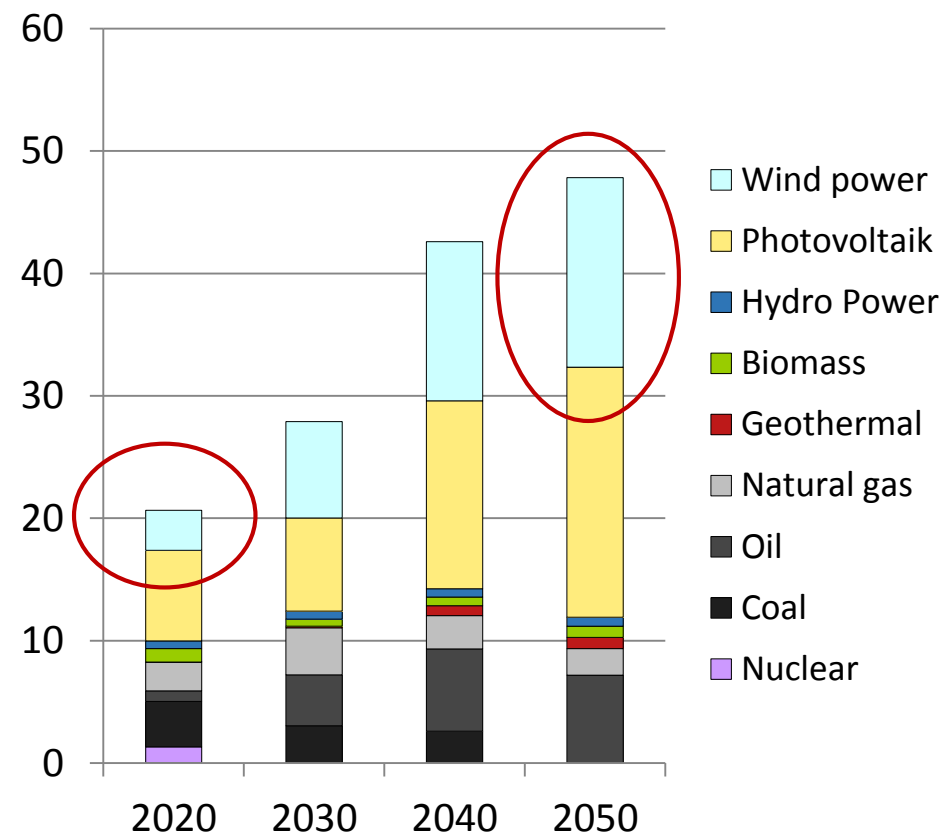
## Long term scenarios allow to analyse consistent pathways

Electricity generation in Baden-Württemberg



Installed generation capacity in GW

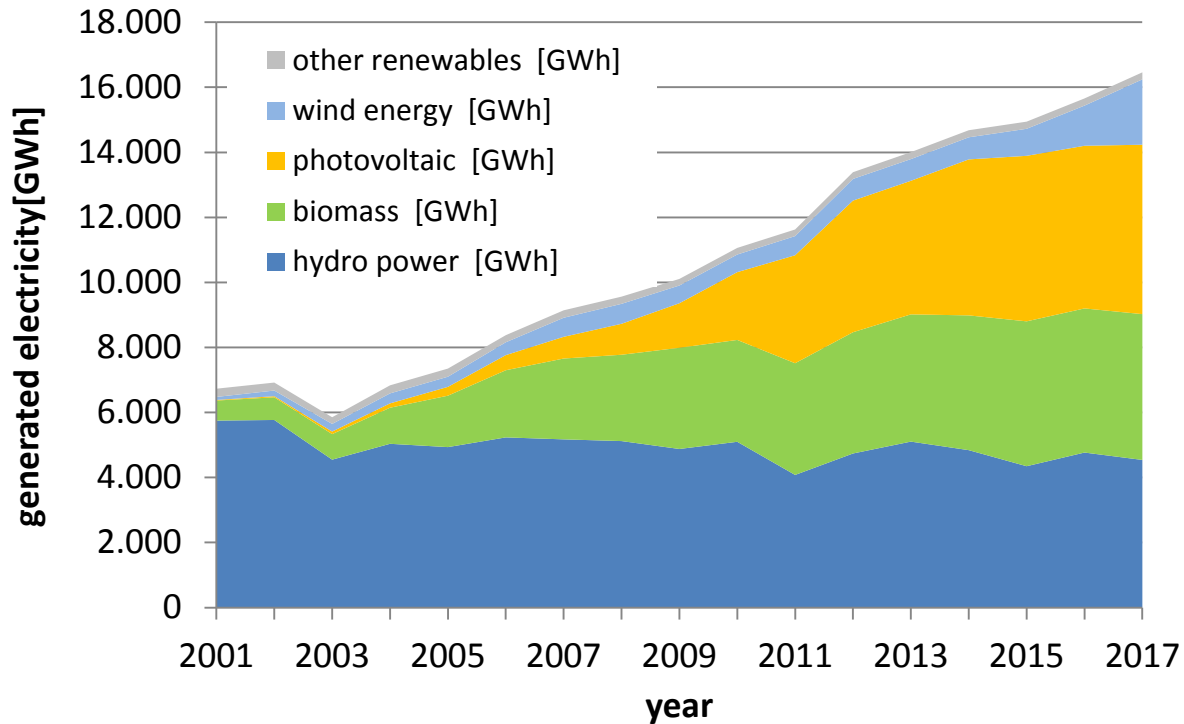
Installed capacity in BW



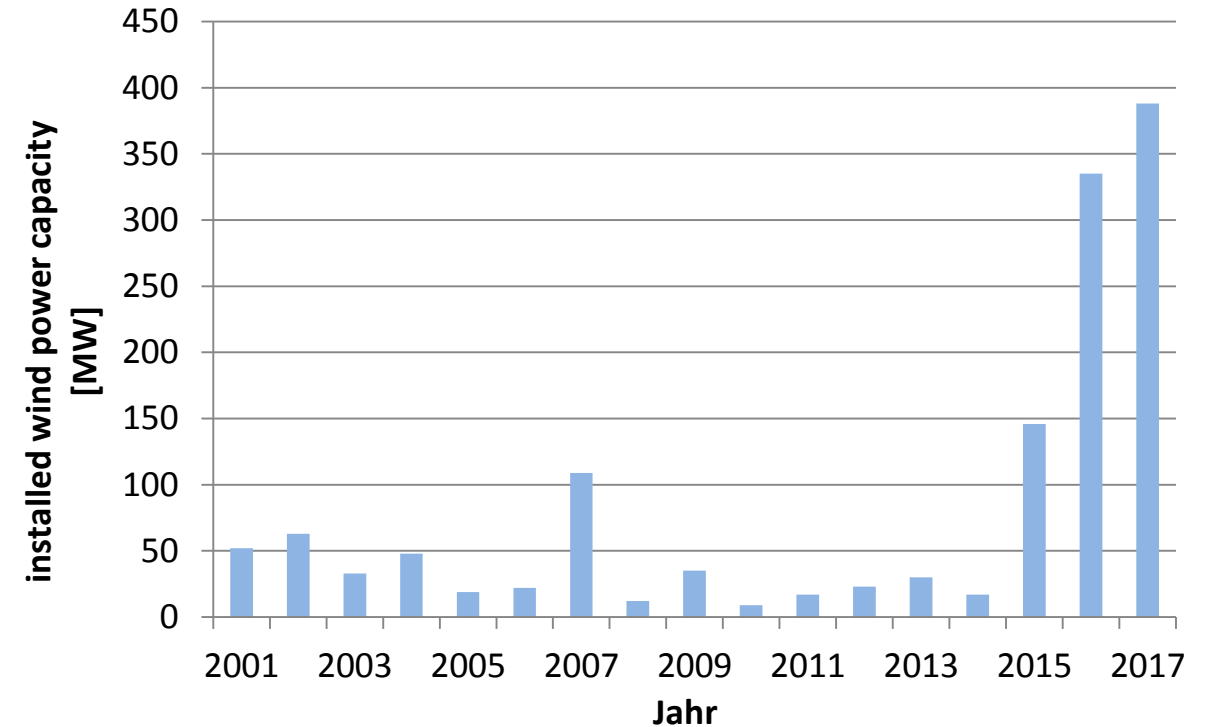
## 2. Installed wind power up to 2018

# Introduction: Installed wind capacity in the state of BW up to 2018

### Electricity generation from renewables [GWh] in Baden-Württemberg



### Installed wind capacities [MW] in Baden-Württemberg



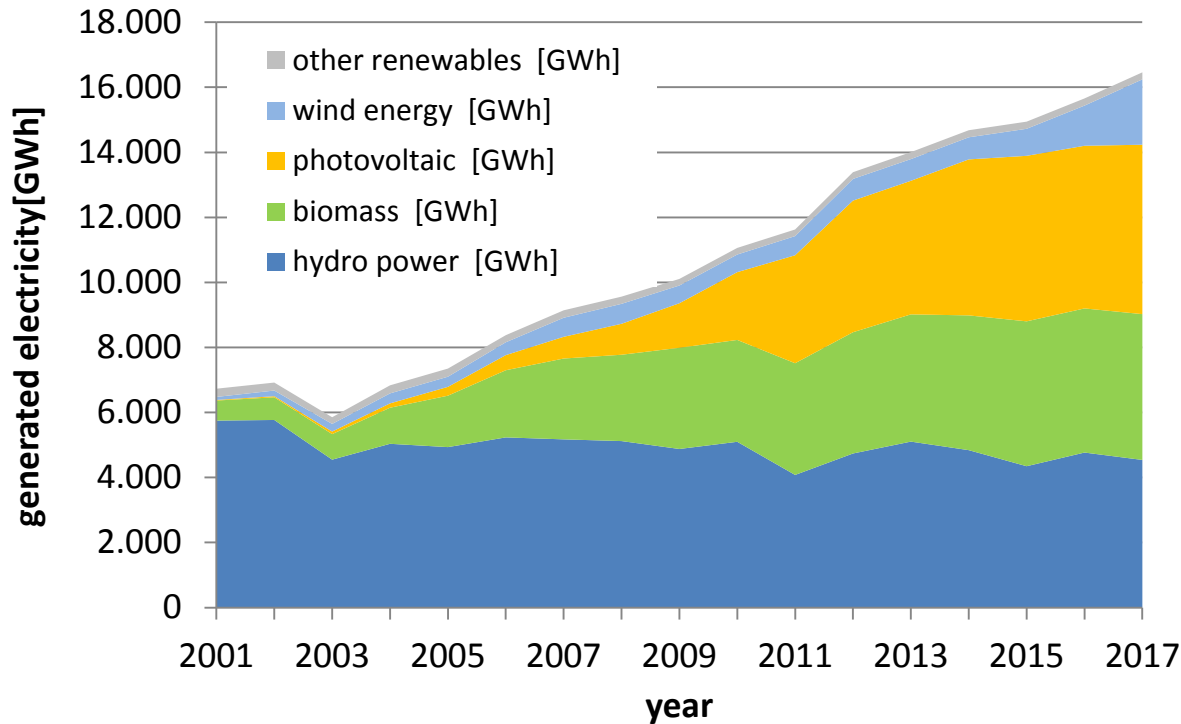
Graph: DLR based on data from UMBW (2018): „Erneuerbare Energien in Baden-Württemberg 2017, Erste Abschätzung, Stand April 2018“, Ministerium für Umwelt, Klima und Energiewirtschaft Baden-Württemberg, Stuttgart, April 2018



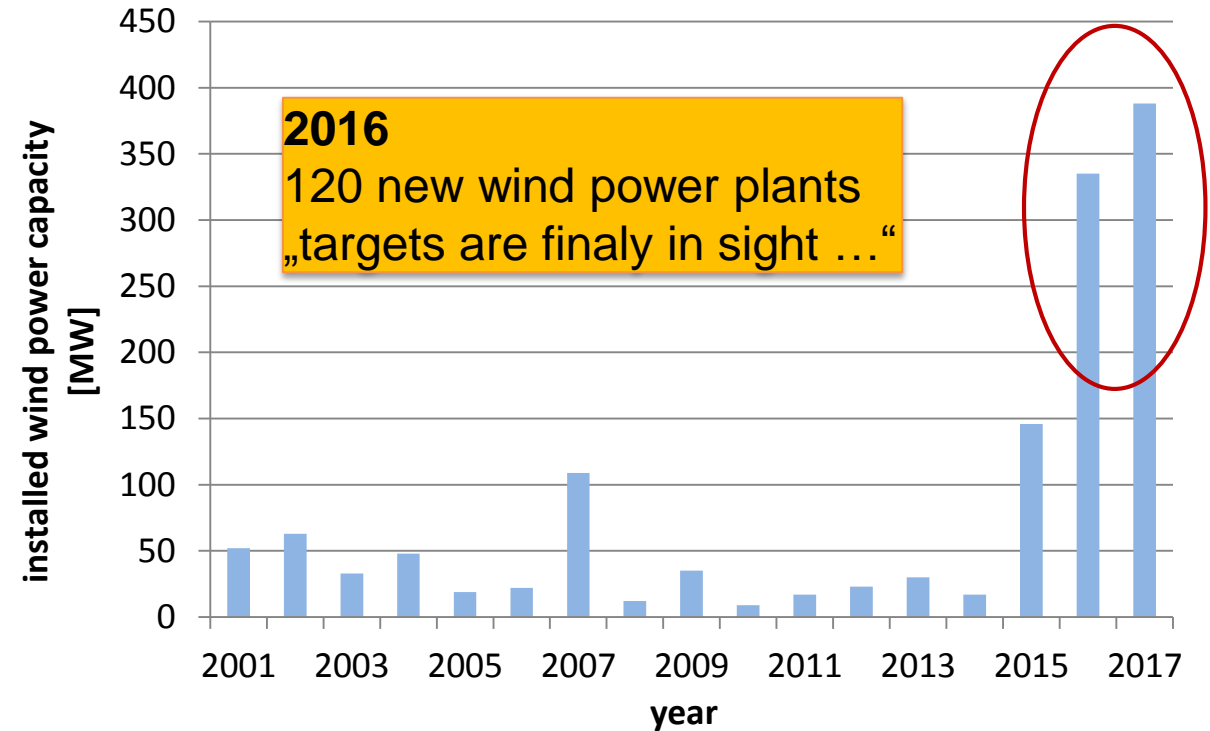
## 2. Installed wind power up to 2018

# Introduction: Installed wind capacity in the state of BW up to 2018

### Electricity generation from renewables [GWh] in Baden-Württemberg



### Installed wind capacities [MW] in Baden-Württemberg (South Germany)



Graph: DLR based on data from UMBW (2018): „Erneuerbare Energien in Baden-Württemberg 2017, Erste Abschätzung, Stand April 2018“, Ministerium für Umwelt, Klima und Energiewirtschaft Baden-Württemberg, Stuttgart, April 2018

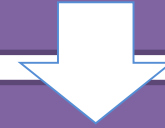


### 3. Modelling approach:

## Extending technical model with analysis of acceptance and market design

Top down:

Energy system model



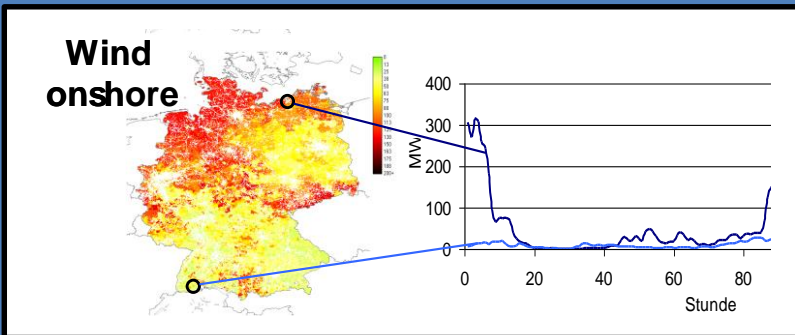
Long term target scenarios

Bottom-up:

Scenarios: Impact of market design and regional acceptance on investments of renewable energies (wind, pv)



REMix-Endat: Hourly wind potentials



Regional acceptance

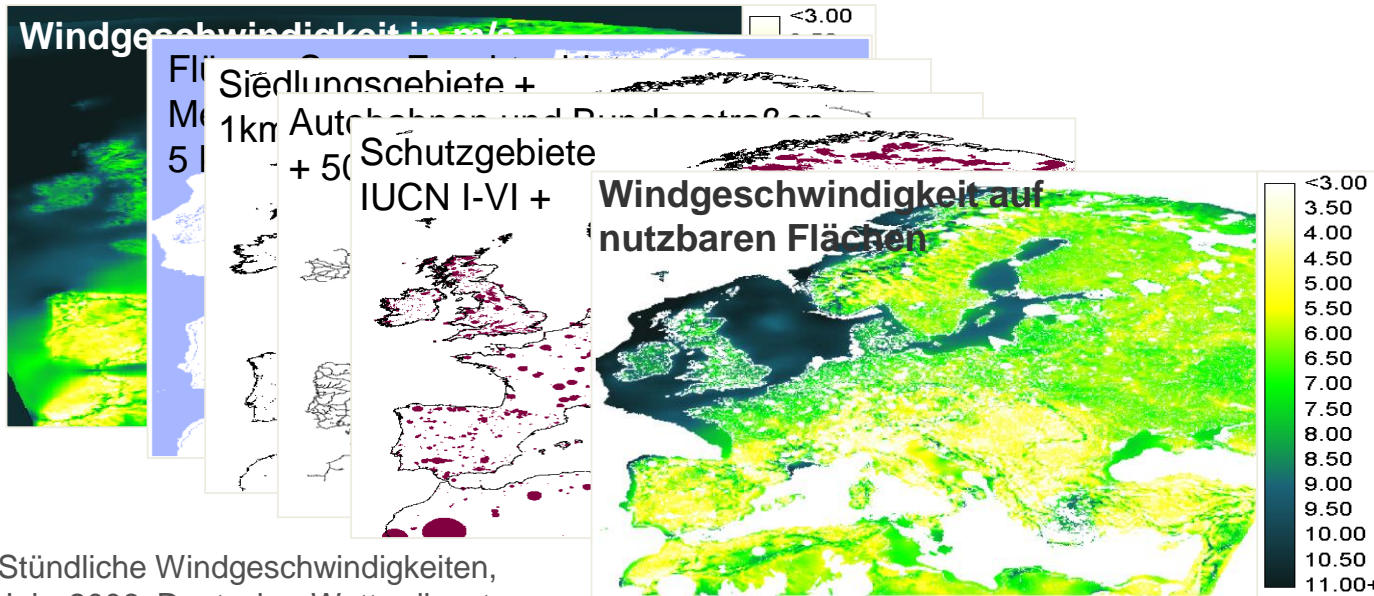


Policy framework and market design

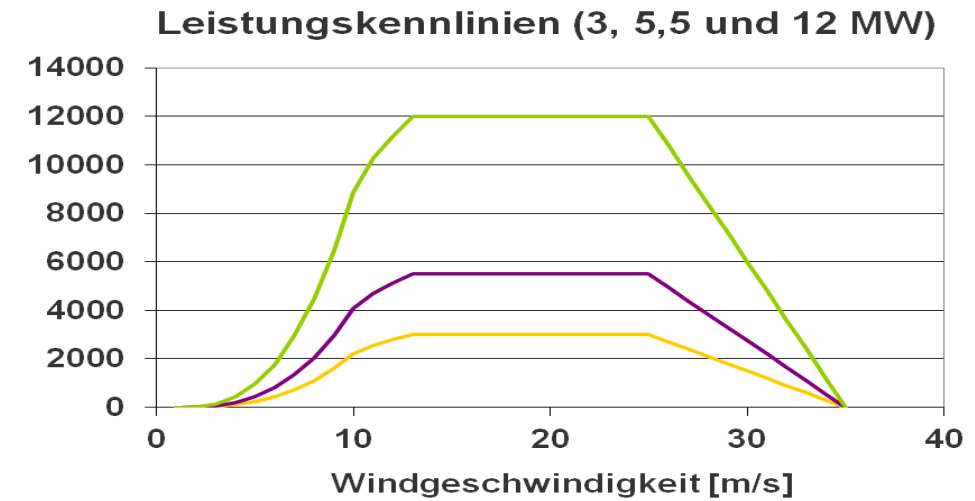
- Implementation of capacity auction
- Market and system design
- Incentives
- Feed-in component
- Regulation

# REMix EnDaT

## Renewable energy resources (example: wind energy)



Stündliche Windgeschwindigkeiten, Jahr 2006: Deutscher Wetterdienst



Leistungskennlinien auf Basis der Enercon E-82

- a) Resource: wind speed in m/s
- b) Area analysis: exclusion areas, usable area shares  
→ wind speed in m/s on usable areas
- c) Power plant model: power curve, capacity installation density, investment and operation costs, ...

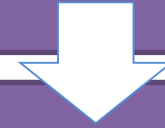


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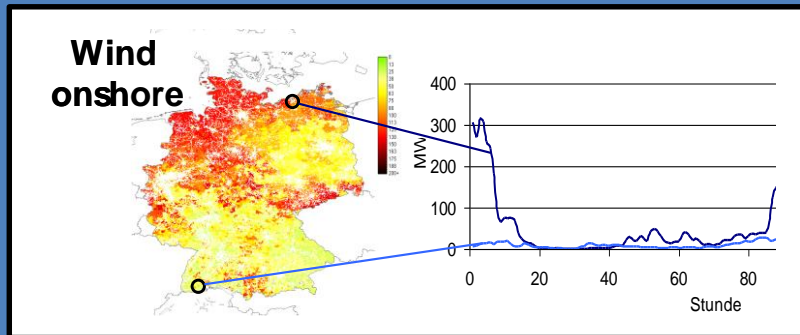
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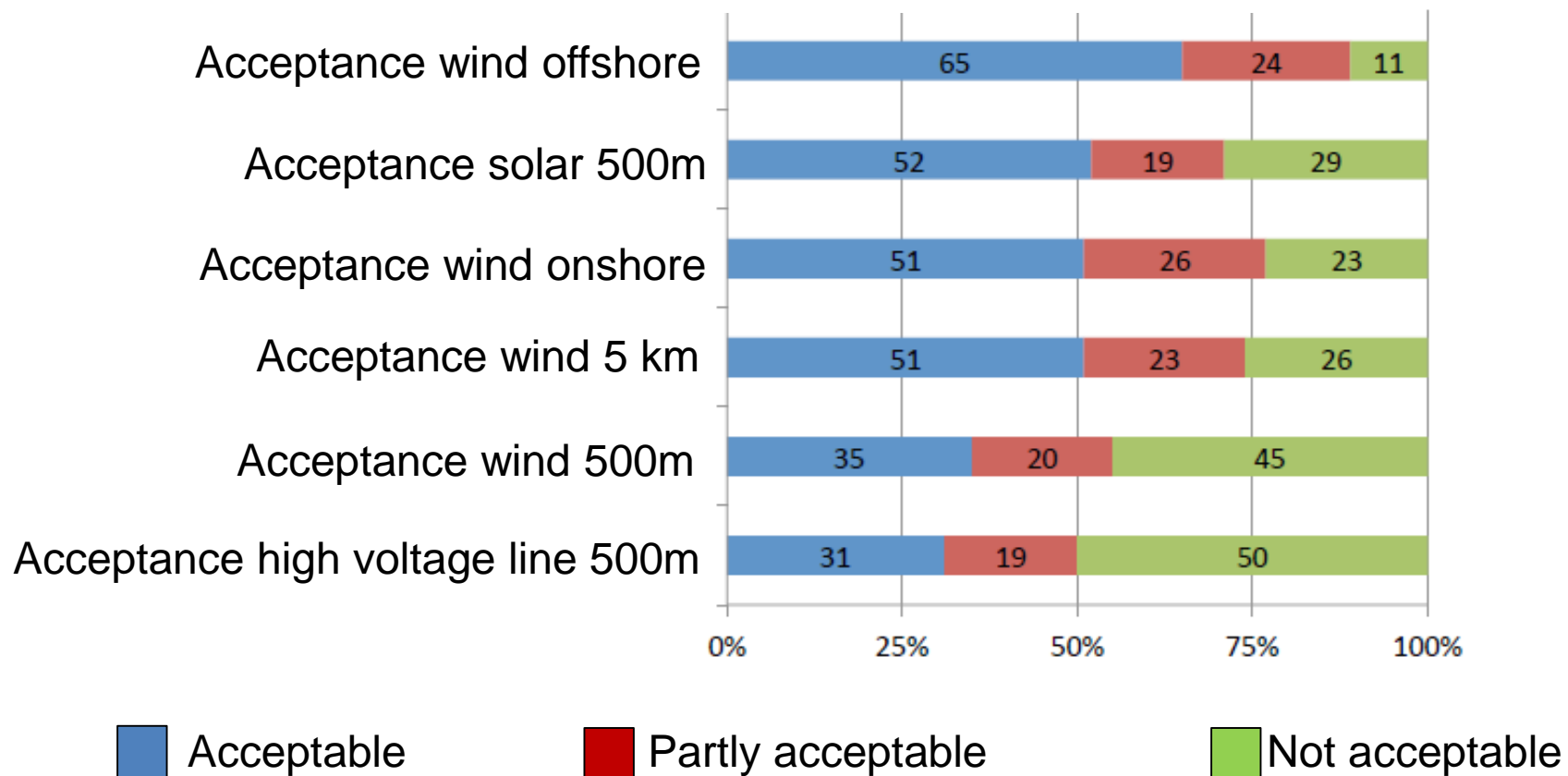
Policy framework and market design

- Implementation of capacity auction
- Market and system design
- Incentives
- Feed-in component
- Regulation

## 4A Regulation I: Acceptance

# Results from Acceptance of wind power highly depends on distance

## Acceptance of energy technology



## 4A Regulation I: Acceptance

# Local governments implement „distance to settlement“ to reach acceptance

Germany /state	Implemented setback distance	Status
Noise protection (Germany)	<b>400 - 600 meter</b>	
Baden-Württemberg	<b>700 meter</b>	Individual decisions recommended
Hessen	<b>1000 meter</b>	Jurisdiction
North Rhine-Westphalia	<b>1500 meter</b>	Implemented by local law
Bavaria	<b>10 h =&gt; 2000 meter and more</b>	Implemented by local law

- In order to increase acceptance of wind power states implement individual minimum distances for wind turbines from settlements
- State of Baden-Württemberg is not as strict as other states

### Problems:

- implemented setback distances differ significantly between states
- Approach is very broad – no distinction between types of settlements

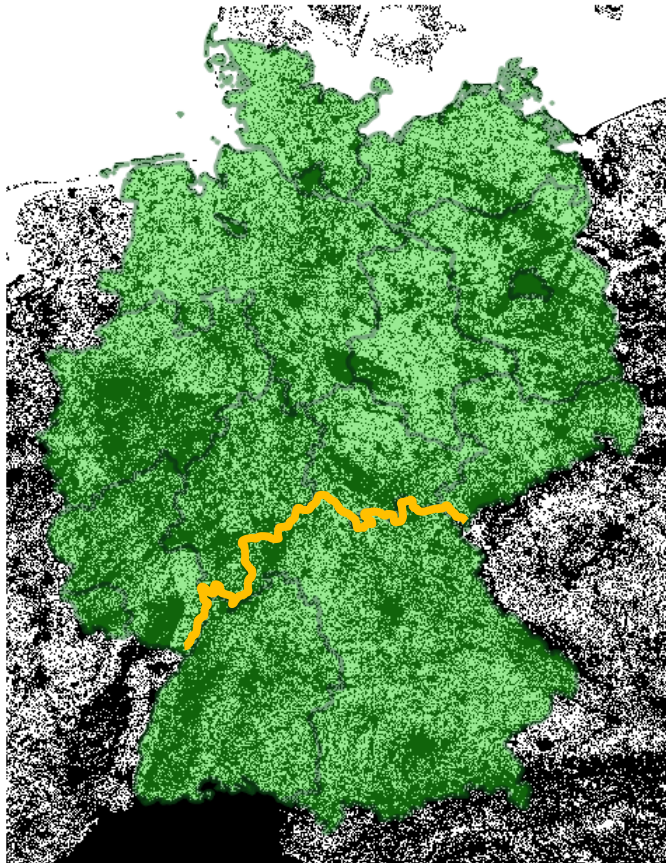


## 4A Regulation I: Acceptance

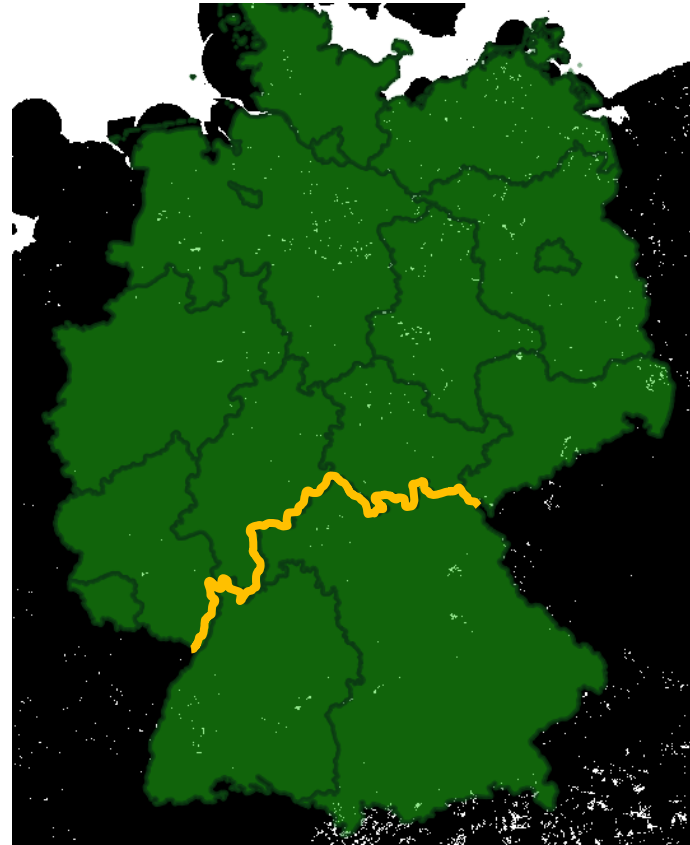
# Increasing distance of wind turbines to settlements eliminates potentials

Possible wind locations – depending on setback from settlements

*setback 120 meter*



*setback 2.000 meter*



- In order to increase acceptance of wind power states implement individual minimum distances for wind turbines from settlements
- State of Baden-Württemberg is not as strict as other states

### Problems:

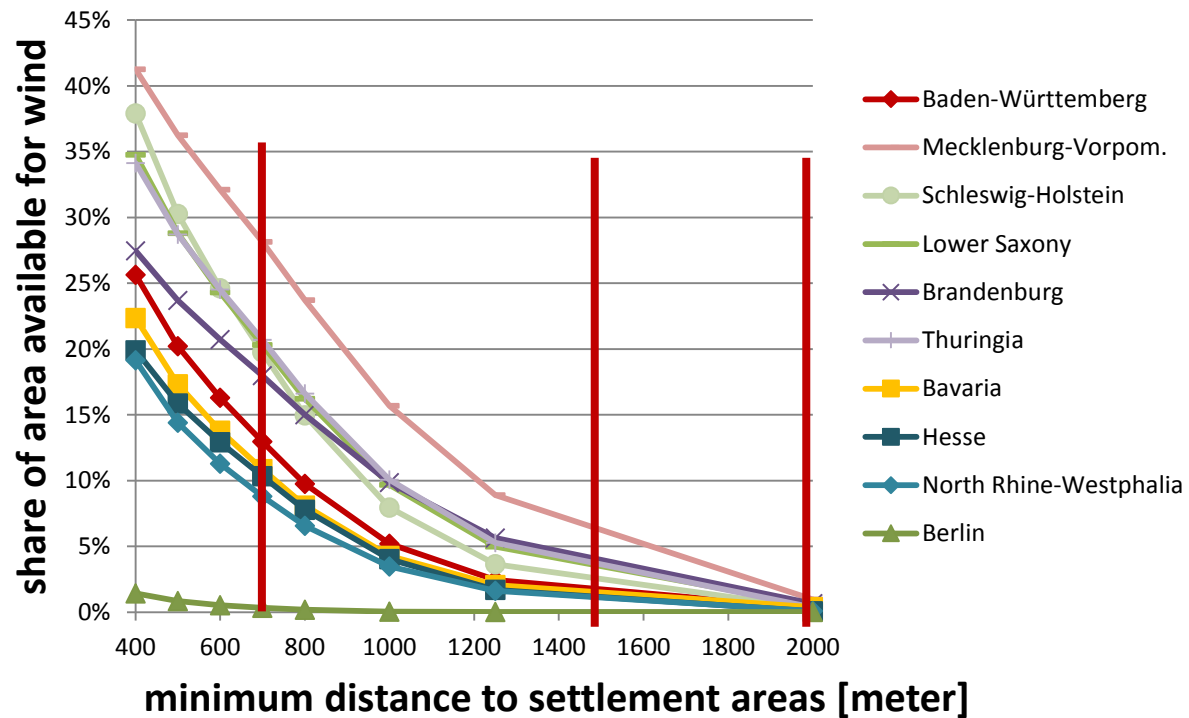
- implemented setback distances differ significantly between states
- Approach is very broad – no distinction between types of settlements

Number of locations for wind power becomes to small!!

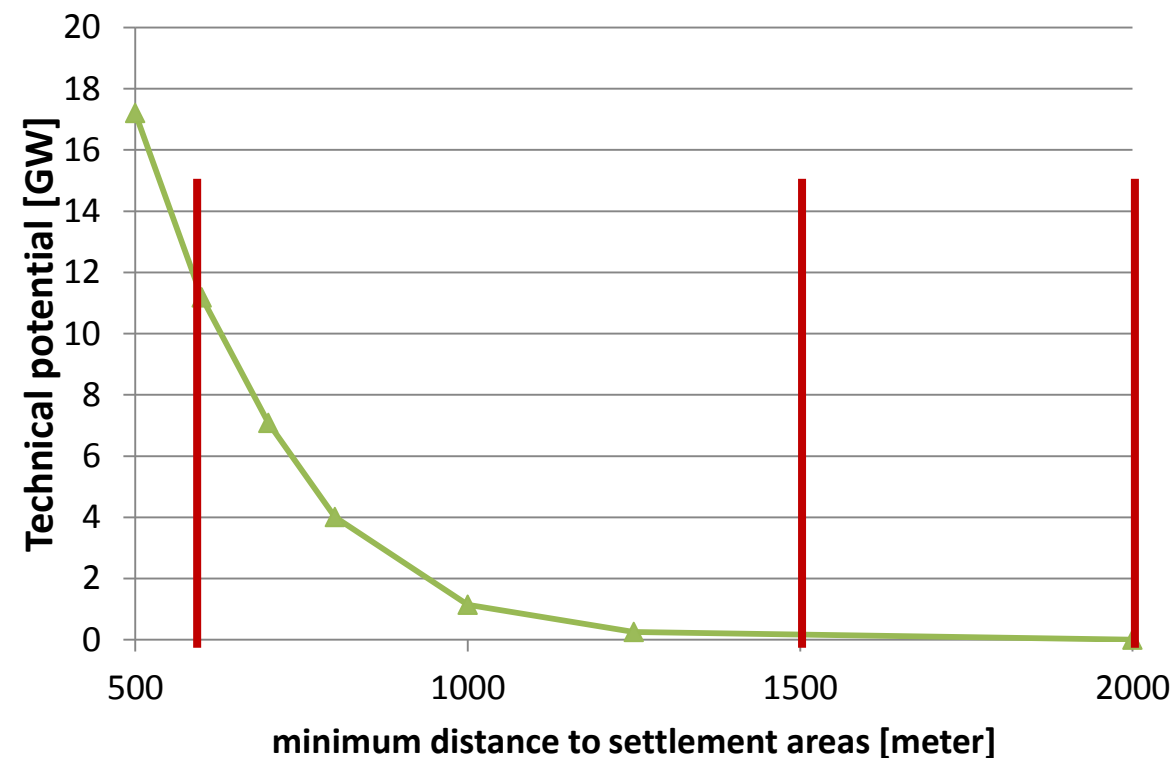
## 4A Regulation I: Acceptance

# Model shows significant influence of minimum distance on wind potential

### Available areas for wind power based minimum distance to settlements



### Potential for installable wind power in BW [GW] based on minimum distance to settlements [meter]



# In 2017 a auction for wind capacity was introduced in Germany

## 1. Windenergie auction in may 2017

Overall tender: 800 MW

- Bids: 2. May 2017
- Results: 19. May 2017

Bids:

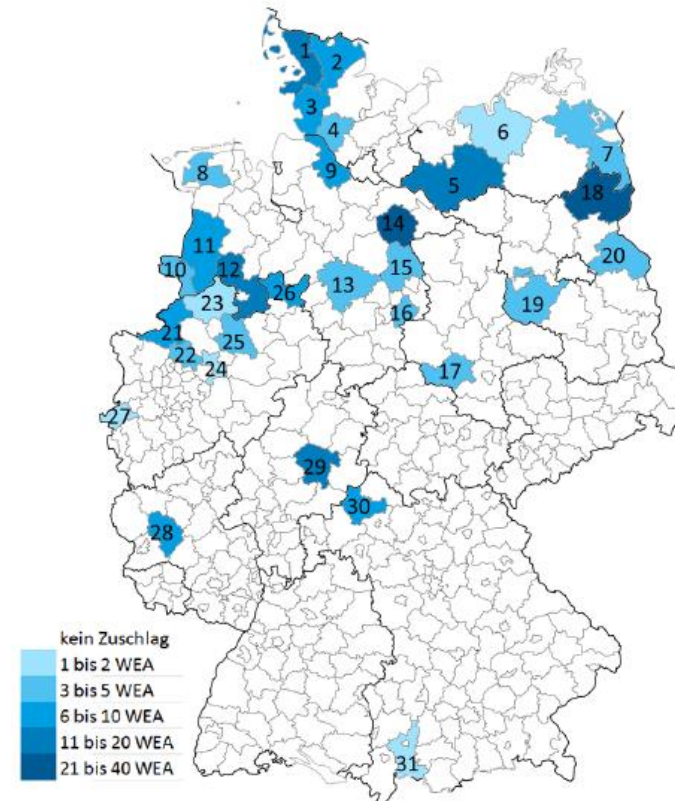
- 256 bids
- Capacity of wind: 2.137 MW

Auction results:

- 70 bids selected
- 224 WEA with 807 MW
- Between 4,20 ct/kWh and 5,78 ct/kWh



## Regional distribution of wind farms

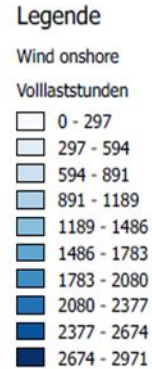
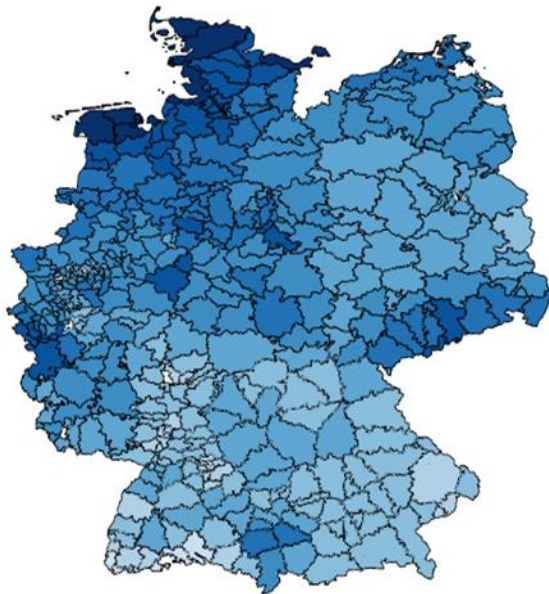


Market design matters !!  
Six auction since January 2017 ended similar

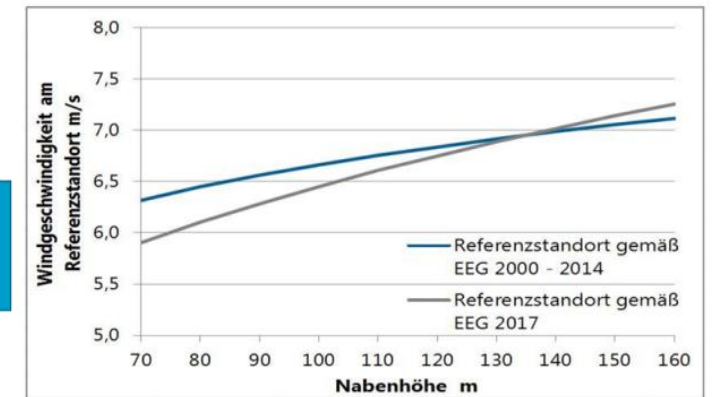
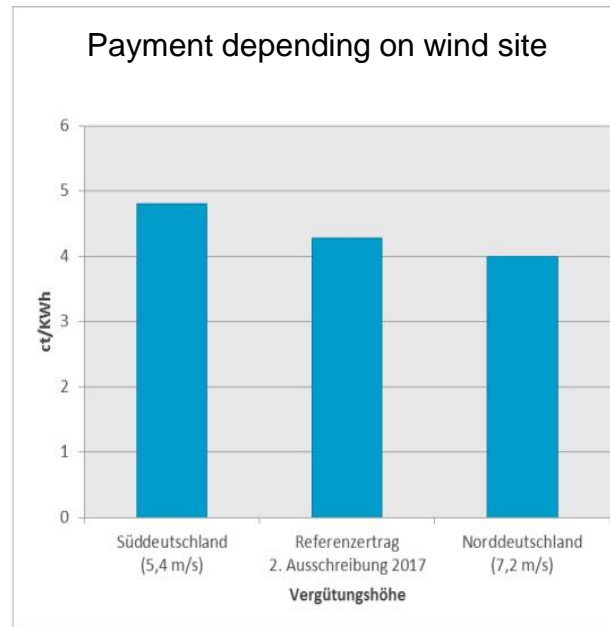


## Annual full load hours for wind

Standortgüte: Jahresvolllast-Stunden

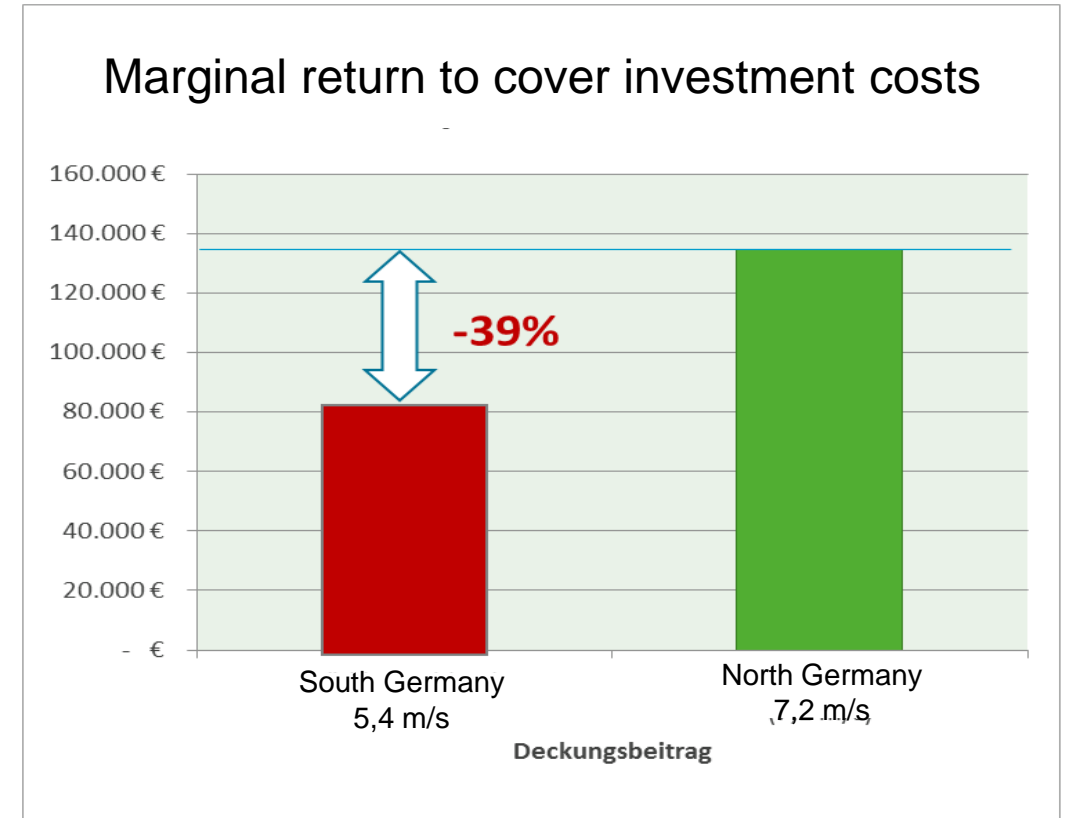
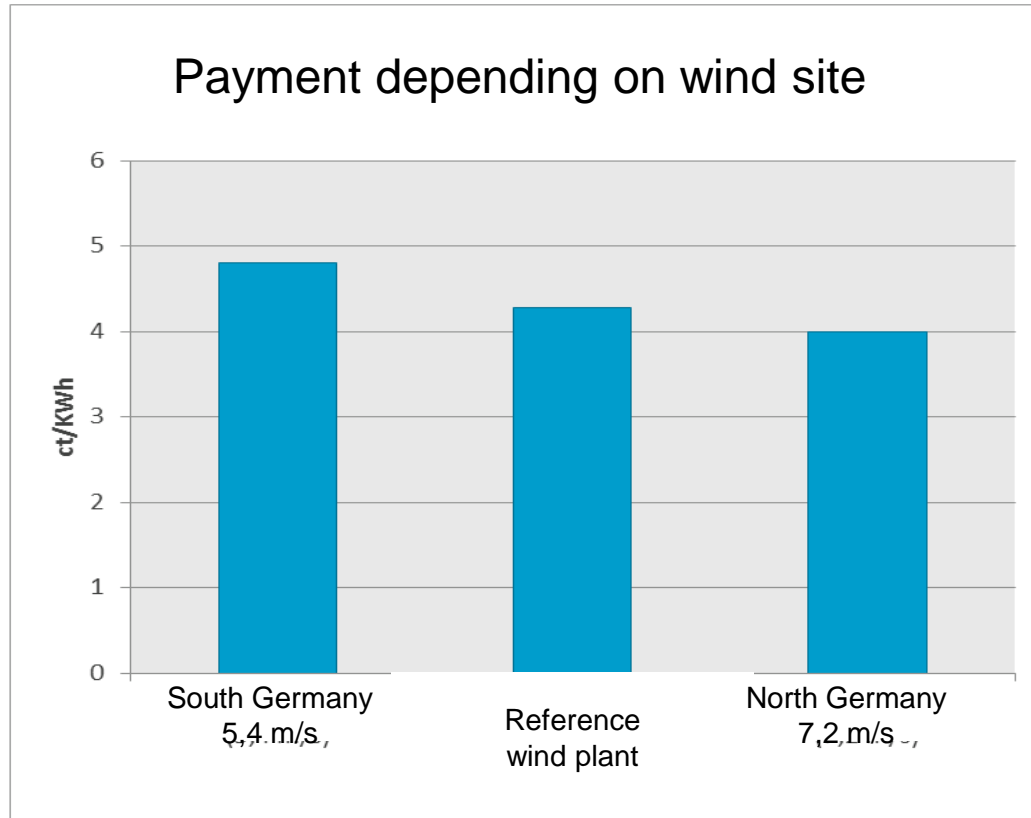


## Remuneration depends on wind speed



Gütefaktor	70%	80%	90%	100%	110%	120%	130%	140%	150%
Korrekturfaktor	1,29	1,16	1,07	1	0,94	0,89	0,85	0,81	0,79

# Auction design – and specific incentives

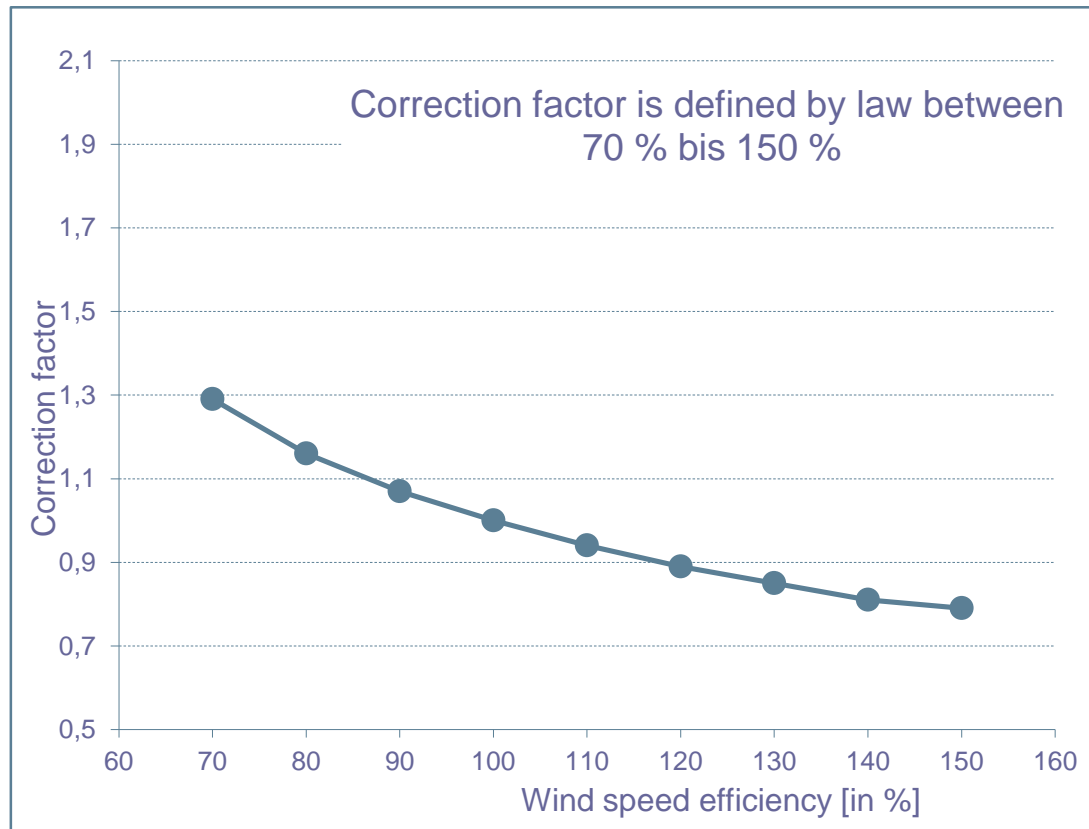


Investment model shows: No incentives for investment in South of Germany

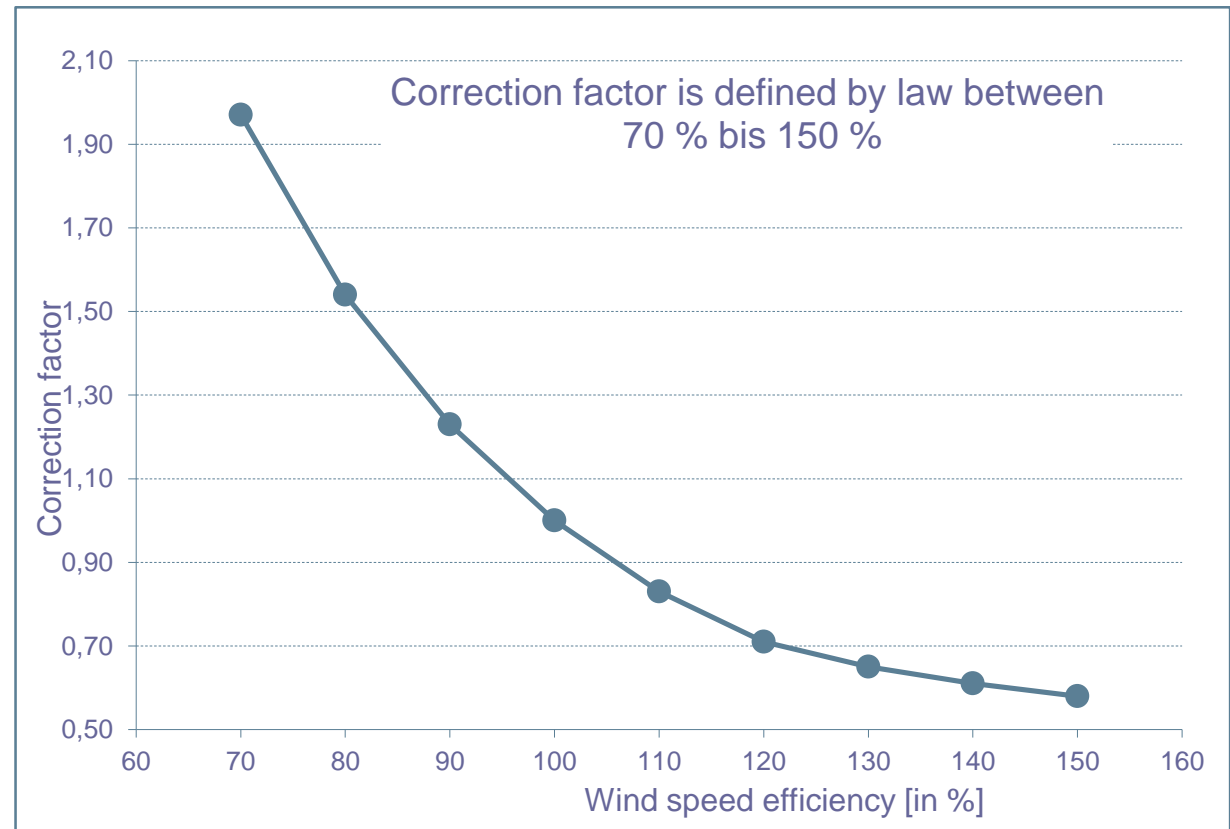
## 4B Regulation II: Market design

### Auction design – proposed changes

#### Current implemented correction factor



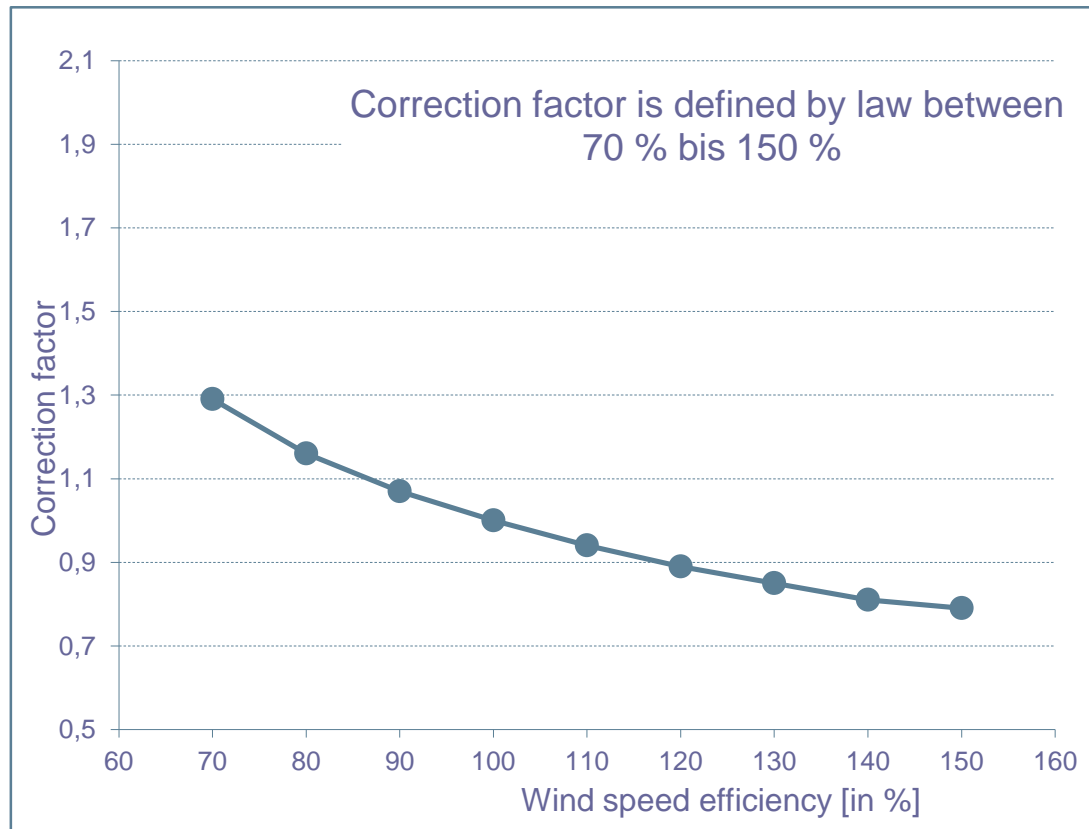
#### Proposed correction factor



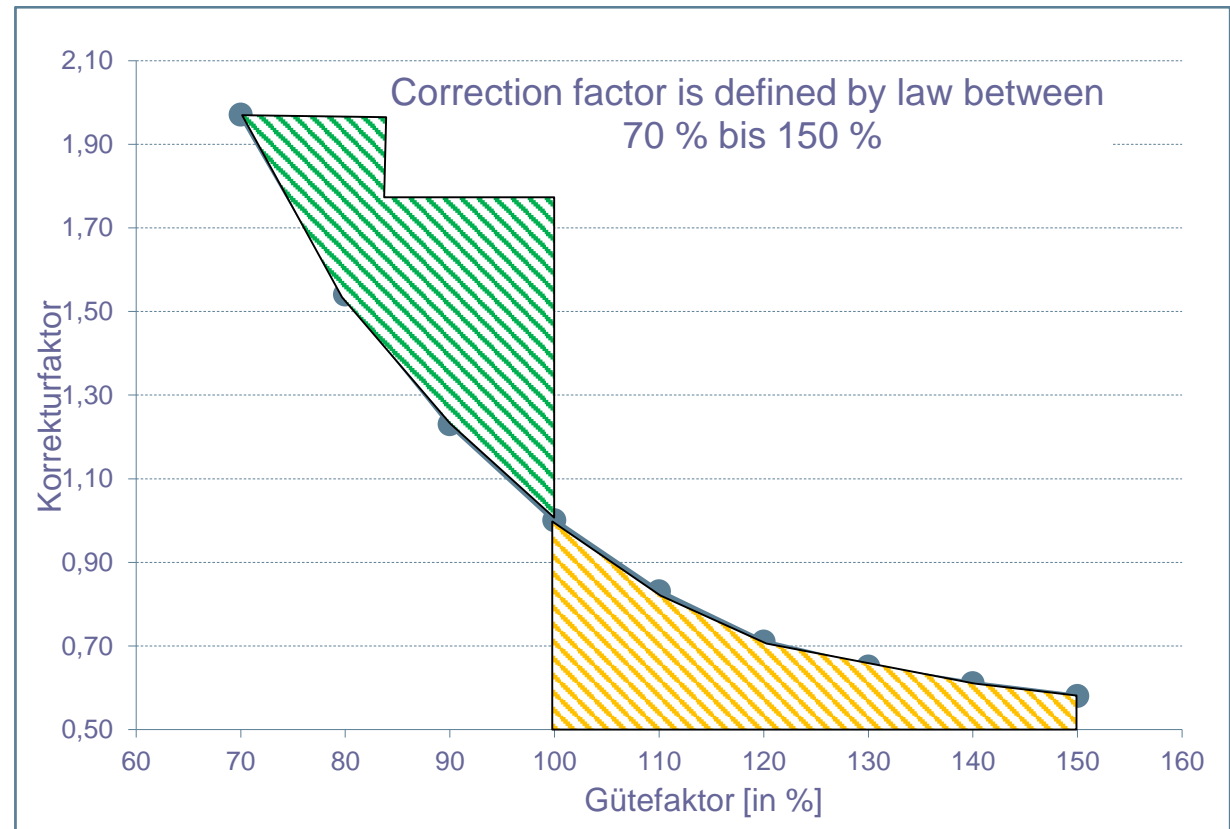
## 4B Regulation II: Market design

### Auction design – proposed changes

#### Current implemented correction factor



#### Proposed correction factor



## Next steps

### Market design:

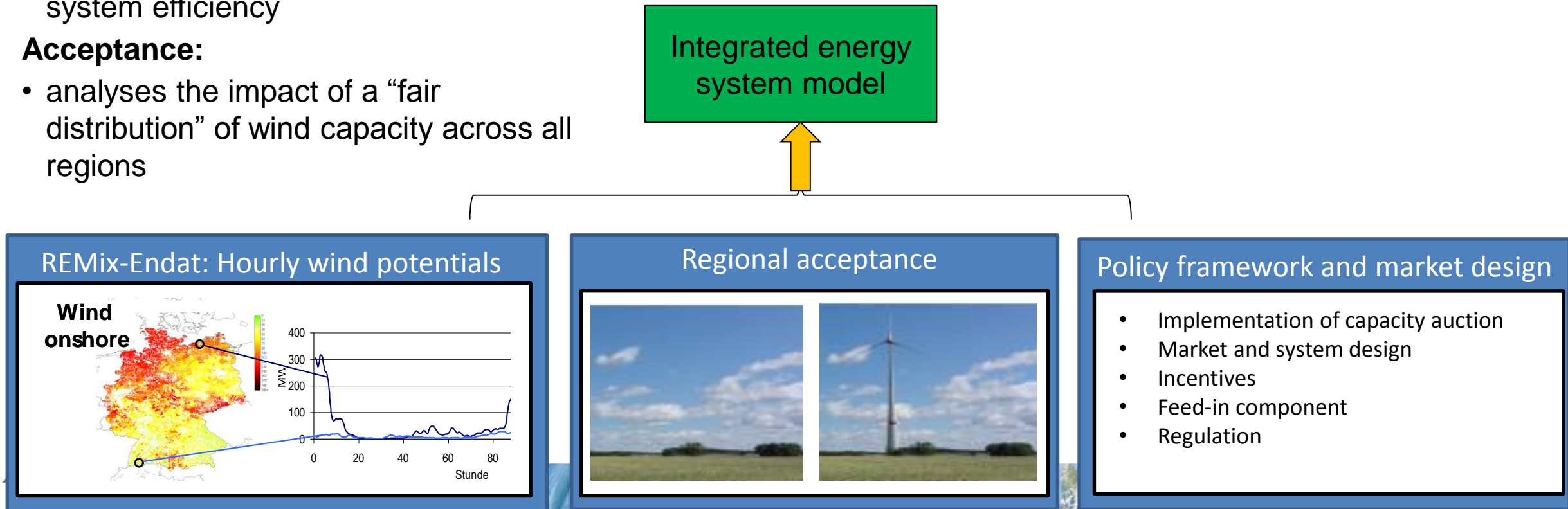
- Comparing different auction designs
- Investigate benefits of investments in the south: Trade-off between additional costs for wind power and higher overall system efficiency

### Acceptance:

- analyses the impact of a “fair distribution” of wind capacity across all regions

## ... and challenges

- Implementing acceptance and auction design back in electricity model
- Let the electricity system model choose the optimal investment path and market design



# Conclusions

## Acceptance:

- „**Avoiding acceptance problems**“ will not provide sufficient areas for wind power onshore
- **Distinctive**: „Distance to settlements“ must differentiate between types of settlements
- Measures to **raise acceptance** of wind turbines necessary:
  - Increase acceptance by implementing strict **burden sharing**
  - Implement **participation processes**
  - **Transparency**

## Market design

- Current market design does **not** provide **sufficient incentives** for investments in South Germany
- In 2018 and especially starting 2019 South Germany will see significant **underinvestments**
- Proposed market design: In the long run investments in wind based on regional market/system value



**Thank you!**

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