

OPERATION OF WIND TURBINES  
AFTER DESIGN LIFETIME

La Défense/Paris, 15.03.2018

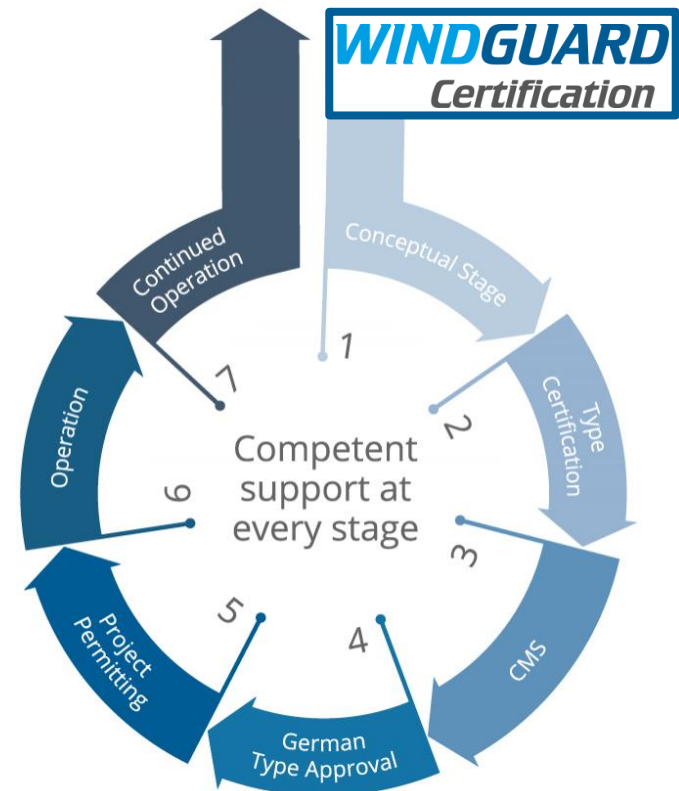
Konferenz zu  
Weiterbetrieb, Repowering und Recycling  
von Windparks nach Ende der Förderung

Conférence sur  
l'exploitation, le repowering et le recyclage  
des parcs éoliens après la fin du contrat d'achat

- Markets & Politics Department
  - Market analysis / Cost analysis
  - Consulting of authorities / NGOs with regard to political frameworks
  - Statistics
- Analysis „Extended operation of wind turbines after 2020“ (on behalf of Naturstrom AG)
- Deeper analysis will be published soon (on behalf of the German Wind Energy Association)
- Further services of Deutsche WindGuard:
  - Inspections of wind turbines >20 years
  - Certification of lifetime extension

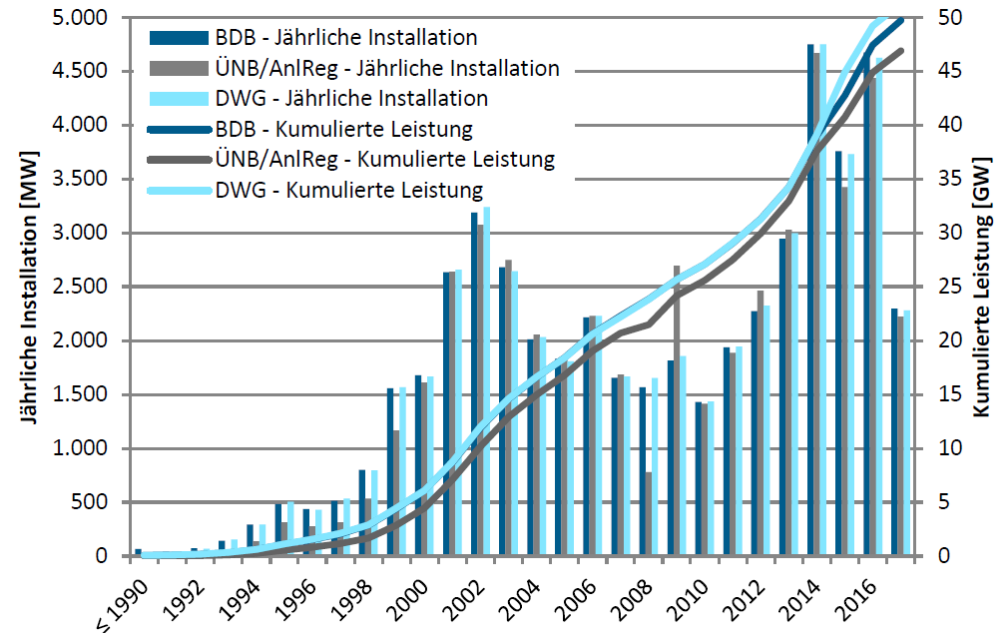


- Certification of Continued Operation of Wind Turbines
  - Extended operation of turbines beyond design lifetime (normally 20 years)
  - Combination of load estimation and inspection
  - Accredited by DAkkS
  - Experienced with continued operations projects for at least 800 turbines of several manufacturers (e.g. Enercon, Vestas, Tacke, AN Bonus...)
  - as stability verification for manufactures and authorities
  - as a forecast with regard to lifetime and performance

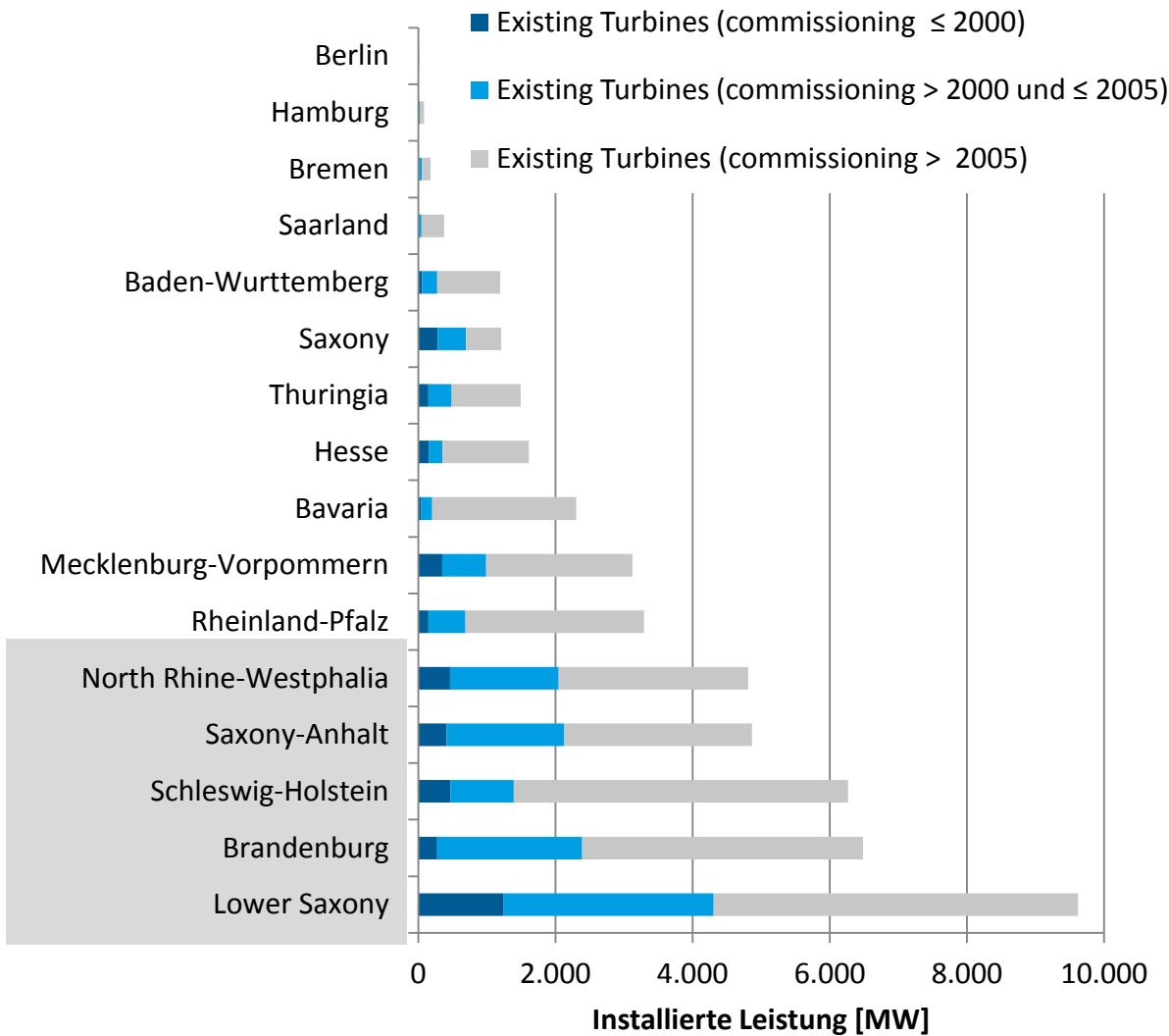


## Affected portfolio

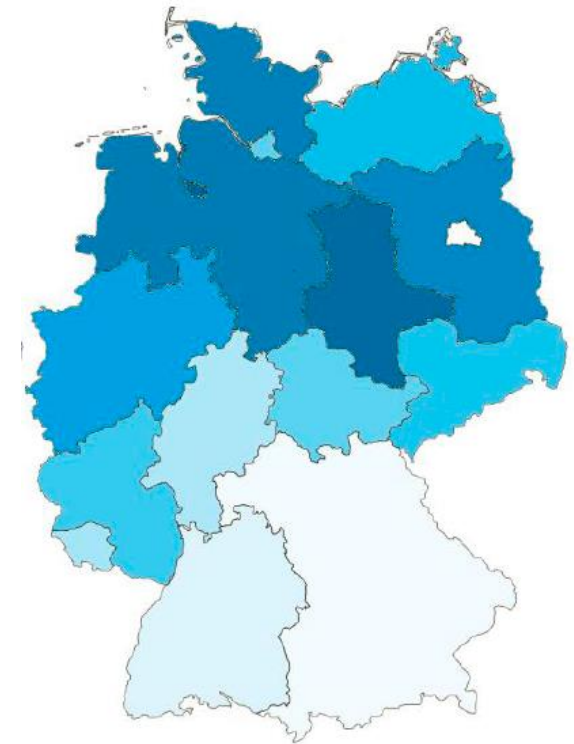
- WTG installed before 2000 receive the EEG feed-in tariff until 31-12-2020
  - By the end of 2020 the first share of existing turbines (4 GW) will drop out of EEG remuneration
  - In the years 2021–2025 on average 2,4 GW is affected each year
  - Operation of WTG after design lifetime is already happening
  - After 2020 a new assessment of profitability is needed
- How does the affected portfolio look in detail and what is the situation of projects after 2020??



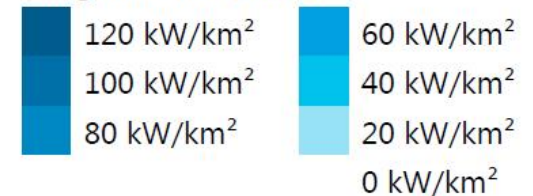
# Regional distribution of old turbines



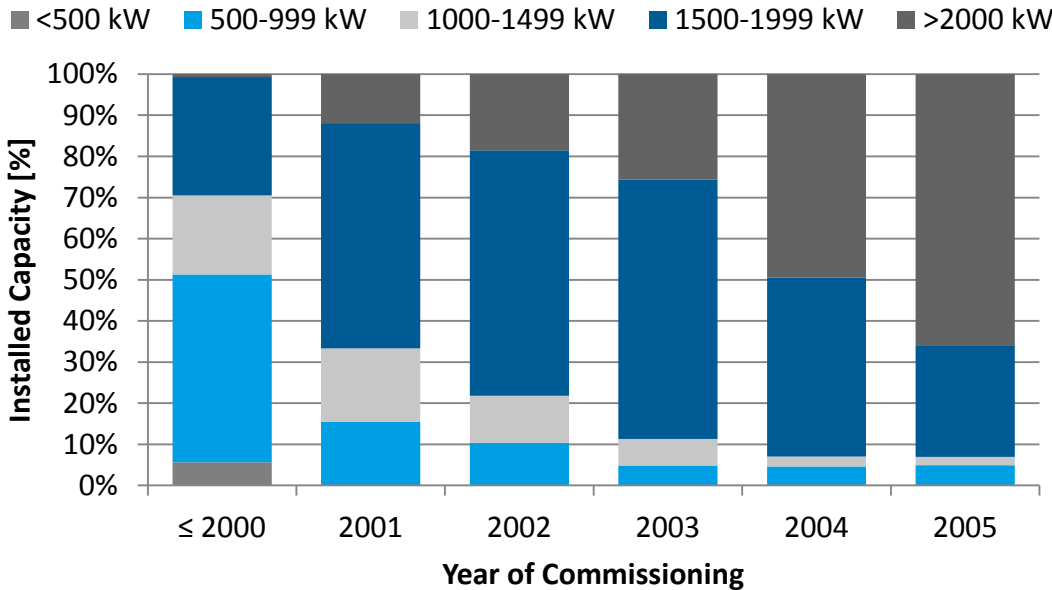
Installed Capacity  
(commissioning ≤ 2005) per km<sup>2</sup>



Legende [kW/km<sup>2</sup>]

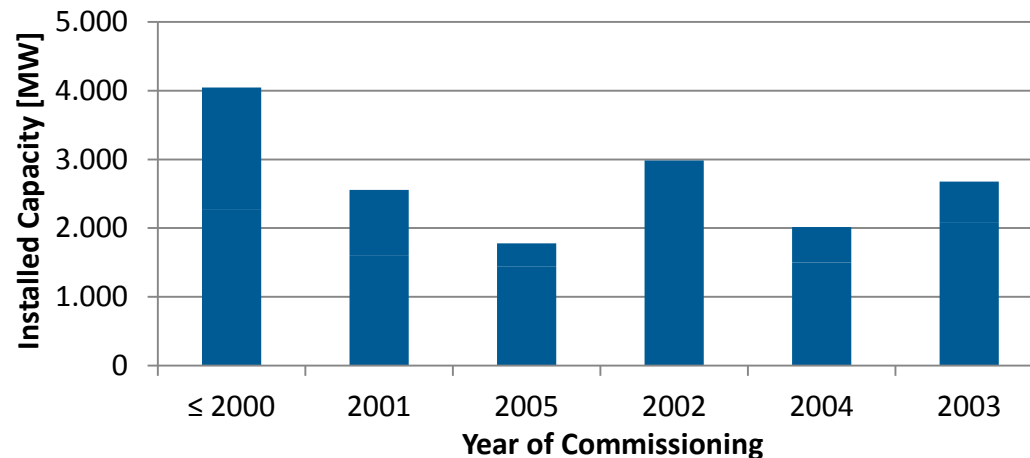


# Nameplate capacity classes of old turbines



WTG dropping out of EEG remuneration by End of 2020:

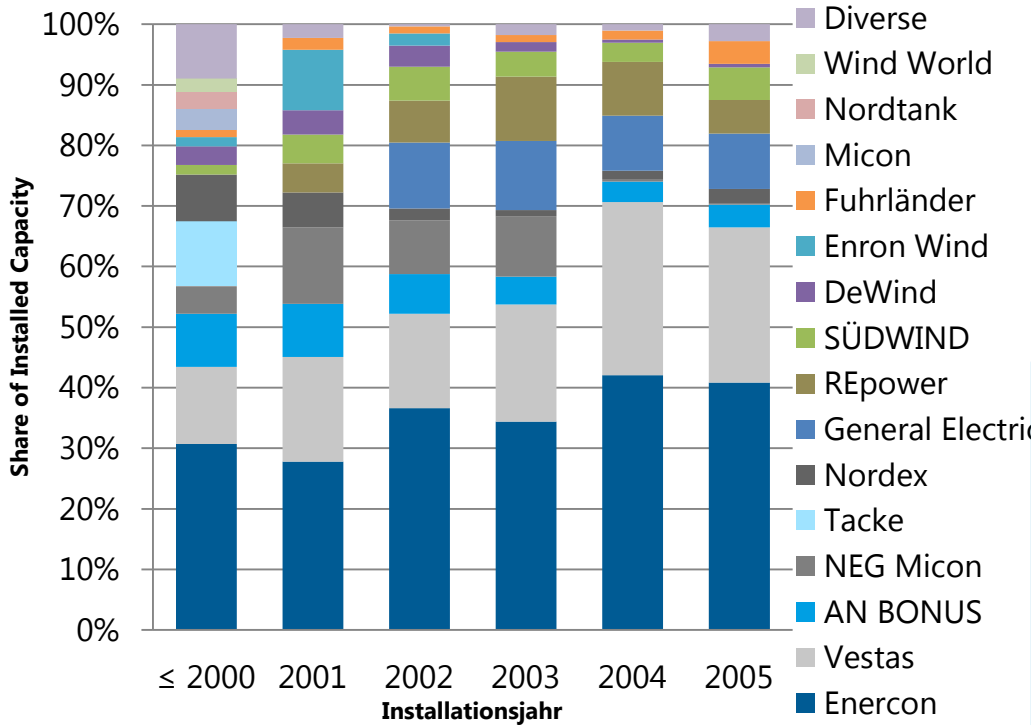
- About 50% < 1 MW
- About 100% < 2 MW



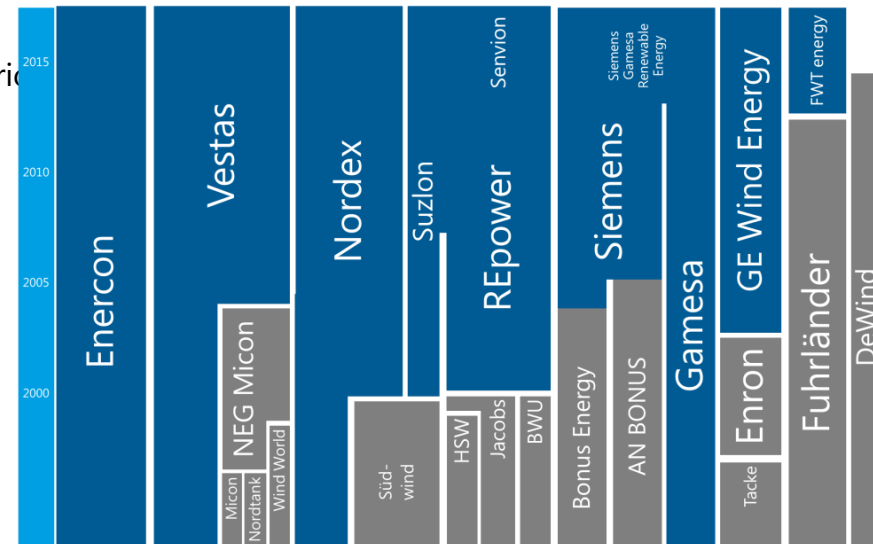
WTG dropping out of EEG remuneration by End of 2025:

- About 8% < 1 MW
- About 35% < 2 MW
- About 65% > 2 MW

# Turbine manufacturers



## Significant market consolidation



## Extended operation versus Repowering?

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So far, both strategies play a role

### Extended operation

- Repowering not always possible (e.g. due to spatial planning)
- Difficulties with agreement between different involved parties with a variety of interests
- Full exploitation of the claim to EEG-remuneration until the end of 2020
- Effects of tendering system in Germany

Approximately 890 MW of WTG  
>20 years in extended operation

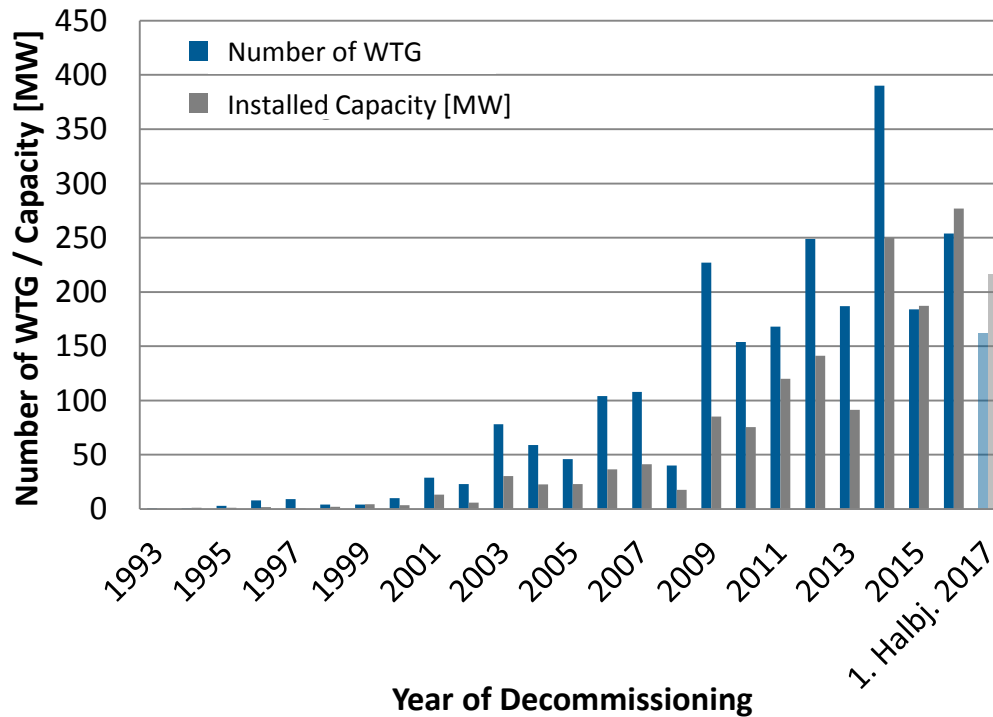
### Repowering

- Bonus incentives in EEG 2009 and EEG 2012
- Lack in green field land availability
- Attractive options for profitability under previous conditions
- Technology assessment does not allow prolonged operation

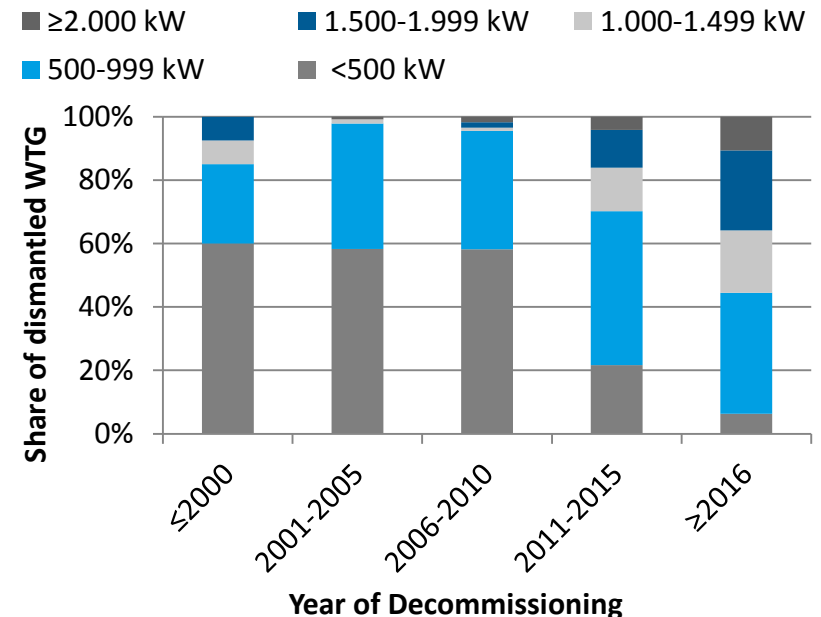
Approximately 560 MW of WTG  
>20 years decommissioned



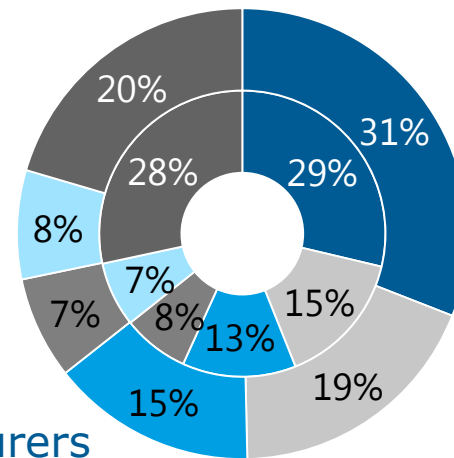
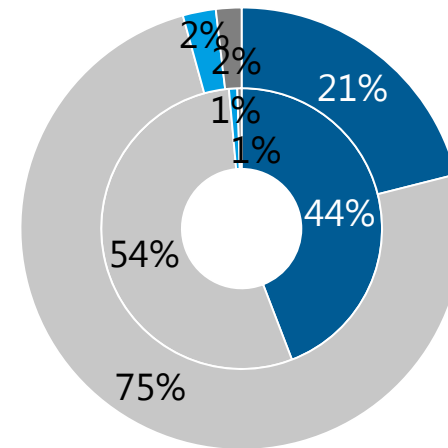
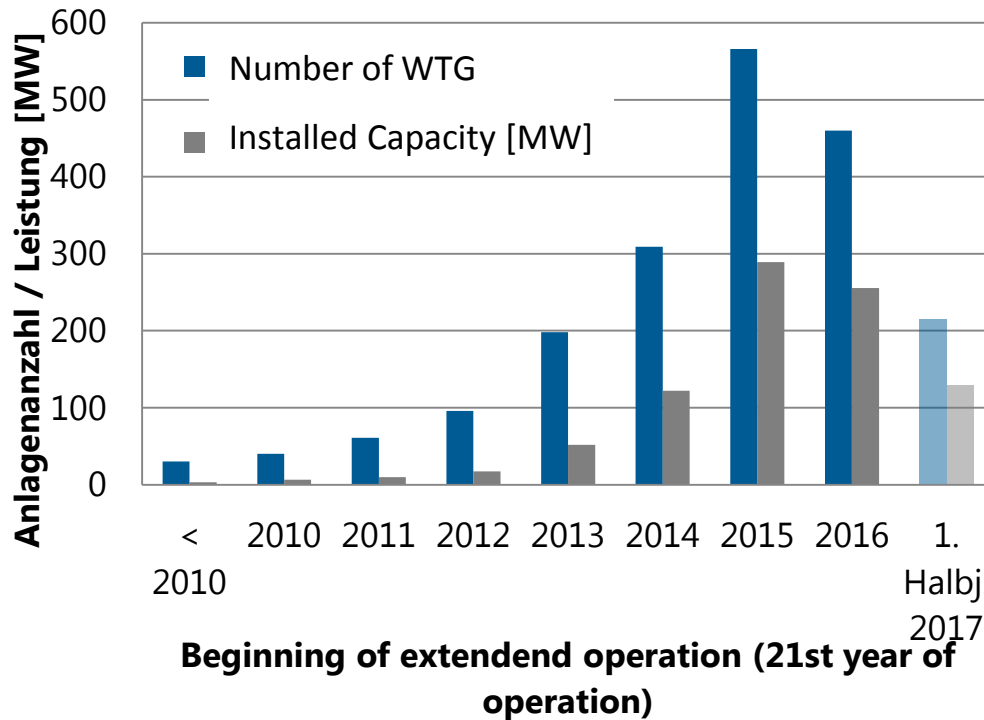
# Dismantled turbines



- So far ~2.300 WEA with ~1.580 MW dismantled
- Effect of Repowering-Bonus until mid 2014
- 50% of dismantled WTG are 13-17 years old



# Turbines in extended operation



Share of turbines in extended operation per capacity class  
Inside: Number of Turbines  
Outside: Installed Capacity

- < 500 kW
- 500-999 kW
- 1.000-1.499 kW
- 1.500-1.999 kW

Share of turbines in extended operation per manufacturer  
Inside: Number of Turbines  
Outside: Installed Capacity

- Enercon
- Tacke
- Vestas
- AN BONUS
- Micon
- Weitere

- So far ~1.980 WEA with ~890 MW
- Average WTG in extended operation < 1 MW
- Wide distribution through different manufacturers

- Interviews on the maintenance costs were conducted
- Results:
  - Basic maintenance as a central concept
  - Individual contract design
  - Costs depend on technology and location
  - Major component damage usually leads to decommissioning (amount of damage but very individual, information mostly between 50-200 €/kW)
  - Economic and strategic aspects in the decision on further operations
- Assumptions based on the interview information were needed to arrive at  $\emptyset$  values.

	Sustained Concept	Optimized Concept	Low Budget-Concept
Maintenance concepts in extended operation periode	Longer-term continued operation with continuation of the operational strategy of the 2nd operating decade; building up of reserves for larger repairs	Continuous operation designed for several years, with condition-oriented measures for the longest possible preservation of the plant; Carrying out small to medium repairs	Operation up to the first relevant case of damage with the expenditure of the minimum costs without accumulation of reserves, focus on stability
Decommissioning	After the end of the remaining technical life time	In case of large component damage	In case of relevant damage
<b>Expected average cost of maintenance</b>	<b>1,4 - 1,8 ct/kWh</b>	<b>1 - 1,4 ct/kWh</b>	<b>0,6 - 1 ct/kWh</b>

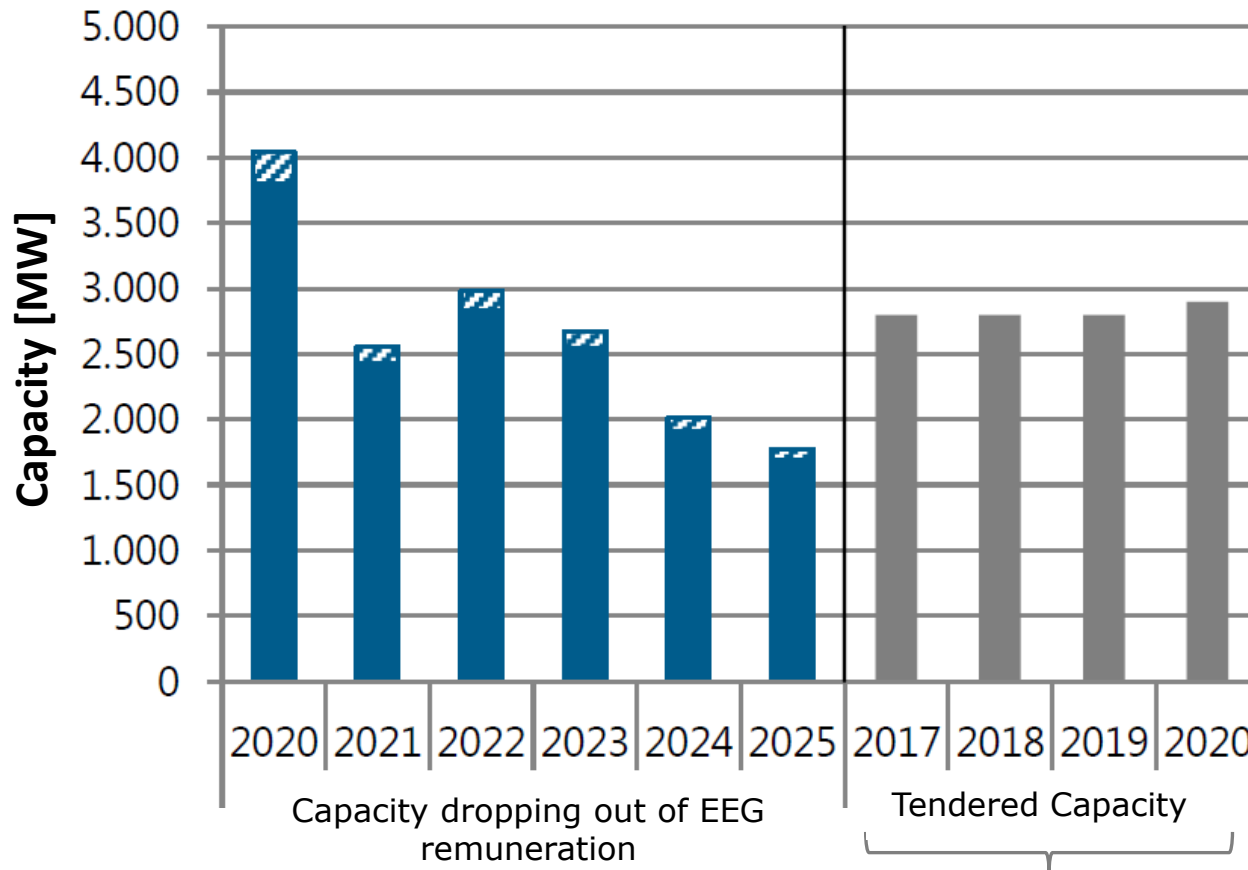
Cost component	Need for remuneration in extended operation period (ct/kWh)		
	Sustained Concept	Optimized Concept	Low Budget-Concept
Maintenance and repair (Average)	1,6	1,2	0,8
Further operating costs	0,96		
Cost related to approval of extended operation	0,33		
Minimum return expectations (Average)	0,75		
<b>Sum per Concept</b>	<b>3,6</b>	<b>3,2</b>	<b>2,8</b>

## Marketing Situation

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- Marketing options:
  - Direct marketing contract
  - Electricity supply contract with (eco) electricity provider
  - Further possibilities in the course of further development of the framework conditions
- Ø EPEX price wind energy 2017: 2.9 ct / kWh
  - Since 2014 mostly market values <3 ct / kWh
  - Monthly fluctuations
  - Operator receives value less direct marketing costs

# Possible effects on net additions



Estimation of expected annual installations difficult, political adjustment expected

- Low installations – high drop out of remuneration
- Depending on ongoing operation without EEG-remuneration very low net additions possible

Thank you!

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