Energy from Wind – Perspectives and research needs

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Perspectives



Use of wind energy world wide					
	Status quo 31.12.07 [MW]	share of world wide installed power			
Germany	22.200	24			
USA	16.800	18			
Spain	15.100	16			
India	8.000	8			
China	6.000	6			
Danmark	3.100	3			
Italy	2.700	3			
France	2.500	3			
Other	17.600	19			
Total	94.000	100,0			



Status of wind energy worldwide





New technology needs testing :Problems with gear boxes

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Percentage of the installed capacity (28 MW) of an onshore windfield

Source: Measurement of the 250 MW-wind program of the Federal Ministry for Research and Technology, Germany

Windenergy needs back-up power stations and grid extension

(Rated power is only 6%, 600 km new high voltage lines are necessary)

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Needs



- 1. Environmental & Social Impacts: Integration in to the landscape, noise impacts, birds flight paths, Life Cycle Analysis, Sustainability
- 2. Wind Turbine & Component Design Issues: basic research in aerodynamics, structural dynamics, dynamic forces, new materials, Feasibility studies of new systems, generators using permanent magnets, gear boxes
- 3. Testing, Standardisation, & Certification: common accepted certification procedures
- 4. Grid Integration: forecast of wind resource, power quality, use of storages
- 5. Operation & Maintenance: condition monitoring, early failure detection, maintenance of offshore turbines, corrosion
- 6. Offshore Wind Technology : foundation structures, meteorology, grid connection, transport and erection



Research needs

Results of Life Cycle Analysis







Example of ProcessChainAnalysis

Life Cycle Assessment (LCA):

Instrument to quantify environmental impacts of the entire energy supply chain

Study throughout the lifetime of a product (cradletograve)

<u>Cumulated Energy Demand (CED):</u>

CED is one part of LCA as far as the depletion of energy resources is concerned





Source: Enercon Magazin Data : LEE

Structure of cumulative energy demand of an onshoreplant (1,5 MW)



Source: Picture: REPOWER; Data: LEE



Structure of cumulative energy demand of an offshoreplant (5 MW)



5 MW Offshore with gear box (REPOWER)



Structure of Cumulated Energy of two different windmills

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Comparison of CED and yearly primary energy output



Cumulated CO₂/ kWh





CO₂- emission of electricity generation in consideration of the whole chain – Comparison of different studies



Integration of Storages





Modelling of an electricity system including wind energy and storages



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Results for the supply structure with storages during one exemplarily winter week





Courses of the EEX-price and the charging levels of the storages used during one winter week



Sustainability of Renewables



Energy security related risks

Cumulated Energy Demand

Energy Costs

Gross Employment Effects

> Usage of Air Resources

Usage of Water Resources

Land Use

- Covering supply, technical and economical related risks
- Aggregation via measure for concentration tendencies (Hirschman-Herfindahl index)
- > According to VDI guideline 4600: totality of energetic expenditures
- Distinction of sustainable / non-sustainable energy expenditures
- Calculation with annuity method according to VDI guideline 2067
 A 5% discount rate was used.
- Induced by installation of 1.000 MW capacity of a specific technology
 Comparison of two scenarios: "business as usual" vs. "installation"
 Software: MARES*forte*
- Critical air volume that is necessary to attenuate emissions accurate to limits that are defined and regulated by law
- Critical water volume that is necessary to attenuate water based pollutants accurate to limits that are defined and regulated by law
- Direct land use by energy system and infrastructure
- Indirect land use due to visual disturbance of the environment (= buffer area trading off the visual impact)



Reference System Specification	PV System	Wind energy converters onshore offshore		GCC plant NG fired
Installed capacity [MW]	0.5	1.5	5.0	353.0
Expected lifetime: System (IS*) [a]	20 / (40)	20 / (40)	20 / (40)	30 / (40)
System efficiency [%]	13.2	53.6	47.7	58.0
Solar irradiation [W/m ²]	1,000	-	-	-
Wind speed [m/s]	-	6.5	9.0	-
Capacity factor [%]	8.8	25.1	47.9	79.9
Investment costs (IVC) [€/kW]	5,110	1,250	1,700	1,330
Operational costs p. a. [% of IVC]	0.50	6.0	8.0	3.3









Results for energy systems with backup

Thank you for your attention





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