The Next Generation - Repowering Wind Energy in Germany

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Agenda

- Early days and historical milestones of wind energy
- Restart of wind energy in Germany
- Growth of the value chain of German wind industry
- State of-the-art in the field – 27 years of experience
- Reasons to RE-power – reasons to UP-power
- Lifeline of German repowering
- The value chain of wind technology pillard by skilled workforce
- Wind Energy – Fully Fletched – Fully Obliged
  A Mature Element of High-End power Supply
- Important Role of Repowered Wind Farms – Full Integration Into the New Power Market Design
- Q&A
Early days and historical milestones of wind energy

Use of wind is not that new

- Vertical axis wind mill in old Afghanistan year 945 b.C.
- Russia
- Austria
- American classic
The End of the Traditional Use of Wind Power

The Challenge

- Vast and extensive grids bring power to the cities and to most remote areas

- Innumerable large scale power plants spread over the countries

- A rude wake-up-call for the industrialized countries: The Oil crisis of 1973
The German Response: Restart of Wind Energy Conversion

- Some trials and some failures
  - Direct subsidies for technology developments in the 80ies failed
  - Dinosaurs – GROWIAN 3 MW – never went competitive

- Next trial: The German FiT by „Einspeisegesetz“ of 1990
  - Premium tariff - 90% of the average wholesale price
  - 100% off-take obligation + grid access
  - 2002ff annual tariff reduction of 1.5%
  - Encourage technological development of WEC efficiency
  - Political support by ambitious growth targets for RE
The German Response: Restart of Wind Energy Conversion

- Since 1990 changes in rules and regulations caused some ups and downs
- Germany’s Industry developed fast and strongly along the whole value chain of wind industry
  - Financing and equity available
  - Clear and practical political frame conditions
  - Clear planning rules and procedures
  - Clear power off-take conditions - longterm
  - Open market and competition (no local content barriers)
  - Skilled workforce
  - High ratio of investment in R&D by “German Mittelstand” – Small & Middle-sized Enterprises
Development Wind Energy
Onshore 1990 to 2015

Sources: BWE 2016, nach Deutsche WindGuard, 2016, Datengrundlage 1990-2011: DEWI
German state-of-the-art in the field
2017 – 27 years of Experience

- 27,270 WECs in operation  (3. in global ranking after China + USA)
- 42,000 MW installed capacity  (3. in global ranking after China + USA)
- Generate over 100,000 GWh p.y.
- 61.2 % of electricity generated by wind turbines (WEC)

- Average installed capacity per WEC  2.848kW
- Average rotor diameter of 109 m
- Average tower height: 128 m
- Yield per strived area: 314 W/sqm
- Wind farm yield per ground surface 100 to 250%

- Offshore: 4.145 kW per WEC, Rotor 120 m, Hubheight 89 m

* ref year 2000
27 years of Experience – Plenty of Reasons to Repower > UP-Power

- Technical lifetime of a wind turbine: 20 years
- Economic operation time: Depreciation or amortization

- Why wait? What is the “Re-power” deal today?

- 1. category: Substitution after expiration of full life time (20-22 years)
- 2. category: Premature substitution by state-of-the-art wind turbine
  - Re-power/power-up with high performance wind turbine(s)
  - Higher lease income for landowner
  - Higher revenues
  - Improved OMS (grid integration, less down time etc.)
Lifeline of German Repowering > UP-Powering

- Marginal “early-birds” in 2002 / 2003 – regular end after 20 years
- 2009-2014 strong growth in repowered capacity
- Slight plunge in 2015 due to the expiration of a tariff bonus
- In 2015 repowered capacity reached 484 MW p.y.
- Repowering means start from the scratch – greenfield
- Only very few items of the earlier project can be used
- Average investment to repower 1,100 EUR/MW
- Future impact of unpredictable wind energy auction results possible (obligatory also for repowered projects)
- End of the repowering bonus
Excellence in Wind Technology Pillard by Skilled Workforce Along the Whole Value Chain

Investment in professional training (dual vocational education) produces skilled workforce, it pays off:

- Off-Taker, Utilities, Grid Owner
- Authorities
- Consultants
- Project developer
- Banks & Investors
- Turbine manufacturer
- Sub-supplier
- OMS-Provider

Improvements along the whole value chain increase competitiveness
Wind Energy – Fully Fletched – Fully Obliged
A Mature Element of High-End power Supply

Wind turbine technology:

- 50,000 MW installed capacity will be hit in the near future
- RE-ratio of electricity fed into the grid has reached “relevant” levels
- wind farms are not a “coastal issue” anymore
- higher towers, larger rotors, advanced SCADA and OMS
  - increase yield and
  - open new locations for exploration
- wind energy has to meet 100% the power supply market requirement (technically, economically)
- Competitive prices, dispatchable, available, save, predictable
- Integrate with other new power supply elements
Important Role of Repowered Wind Farms – Full Integration Into the New Power Market Design

Not only wind technology has advanced significantly over the last 20 years. The power supply structures are going through a tremendous transition of huge magnitude. Challenging future ahead

- sole electricity generation is not enough anymore
- more players – more roles – more functions – multiple functions
- intelligent interaction required
- power – heat – storage – mobility
- storage, demand side management, active and passive elements, extreme dynamics, multifunctional elements (batteries of e-mobility), consumer turns into prosumer, power market design
- New challenges – new opportunities
- Competitive – available – secure – reliable
- Transition will go on . . . . . that is sure!
Thank you for your attention

Questions & Answers

Sources: BWE, Deutsche WindGuard, DEWI, IRENA; IEA, GWEA, VKU

All data are indicative and subject to conditions that may vary from time to time and depending on individual project circumstances. Data provided herein is derived from sources we believe to be reliable but we do explicitly not represent or guarantee that it is accurate or complete, and it should be not be relied upon as such. This document is not intended as an offer nor a solicitation of an offer. The author assumes no fiduciary responsibility or liability for any consequences, financial or otherwise, which arise should you chose to rely on this information. The content of this document is confidential and proprietary information of the author and should not be disclosed to any third party without prior written consent of the author. JB EMS 2017.
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| WIND | SOLAR PV | SOLAR CSP | RE GOVERNMENT PROGRAMS | INTERIMS MANAGEMENT |

22 YEARS +++
HANDS-ON RE-XPERIENCE
International Marketing & Sales of industry automation products

Marketing and Sales Manager at Siemens, responsible for several European Countries, Central and South America,

Wind
Marketing - Sales - Global Export

Supply of wind turbines to projects in - China (36.3 MW), (1.2 MW), Tender of (24 MW), (17 MW), Canada (1.2 MW), Brazil (1.2 MW, 1.0 MW) - Tenders in UK (36 MW, 47 MW) Greece, (4.8MW) India (2.4 - 24 MW) France (1.5 MW) Austria (3.6 MW) Japan (500 kW) USA (4.5 MW) Poland (1.2 MW) expansion of the export department and the worldwide sales and marketing structures

Wind
Business Development - Joint Ventures

Setting up of the new renewable energies business of TRT for development, Implementation, EPC contracting, financing of wind energy projects in Europe and Latin America - 48 MW in Renkenberge, Germany (at the time the largest wind farm in Germany); - 13 MW Flomborn, Germany; - 100 MW near Ferrara, Italy; - 100 MW in Zaragoza, Spain; - 15 MW Hatay-Senköey, Turkey; - 100 MW development in Paracuru, Brasil and others. Establishment of strategic co-operations (Project Development Fund) with turbine manufacturer (NEG Micon), banks (HVB), engineering companies, local developer and equity provider (BVT, München).
Wind | Solar CSP | Solar PV | Government Programs

Business Origination and Project Development at Abu Dhabi Future Energy Company (better known as Masdar).

Wind farm, Solar PV, Solar CSP project developments.

Developing the SRP (Solar Roof Program) for the Emirate of Abu Dhabi a feed-in-tariff and subsidy program for roof mounted PV systems.

Implementing 11 PV pilot projects in the UAE with different PV systems suppliers using different components and technologies.

Performance based PV system procurement guide “How to select suppliers and contract PV-systems to secure project revenues and best OMS over system lifetime”.

Technical advisory to National Bank of Abu Dhabi for their development of a “PV system credit package for the UAE”
Wind
International Expansion - Restructuring - Integration - Partner Evaluation

As Executive Director and head of global wind and hydro business of Umweltkontor Renewable Energy AG evaluation, restructuring and integration of all international business activities of wind and hydro.

Expert Network  set-up and operation of Government NRW - German Power Industry Network

Head of the Competence Network for Advanced Power Plant Technology of North Rhine Westfalia (Kompetenz-Netzwerk Kraftwerkstechnik NRW) for the state Government of NRW, Düsseldorf. Management of international strategic partnerships of the state Gov. In the power sector