criteria for the economical evaluation of Repowering Projects

*Wind farm portfolio approach*

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• Introduction to the wpd and the considered portfolio
• Repowering references, wpd
• Repowering – definitions from Germany applicable in France?
• Technical and planning considerations
• Evaluation of the “Repowering potential”
• Considered economical perspectives - profitability
• Examples and comparisons
• Outlook
wpd windmanager

- 319 members of staff
- 1,770 wind turbines
- 3,500 MW technical and/or commercial management

Manufacturers

- Enercon 43.6%
- Vestas 21%
- Nordex 9.4%
- NEG Micon 7.9%
- GE 6.7%
- AN Bonus 6.1%
- Others 5.3%

Locations

- Germany
- Croatia
- Finland
- France
- Italy
- Poland
- Canada

10 offices
Successfully realized Repowering Projects:

- Wind farm Wehren: 8 x E-40 (4MW) replaced with 6 x E-70 (13,8 MW)
- Wind farm Hasenkrug-Hardebek: 12 x NM60/1000 (12MW) replaced with 12 x E-82 (27,6 MW)
- Wind farm Borne: 7x Enercon E-82 (16.1 MW)
- Wind farm Bokel/Ellersdorf: 9 x NM64/1500 + 1 NM60/1000 (14,5 MW) replaced with 6 x V-112 (18 MW)
- Wind farm Ahndeich: 5x Enercon E-40/5.40 replaced with 2x Enercon E-70 and 2x E-82

Current projects in building phase:
Bremerhaven, Meyn, Drochtersen and Sillerup with about 45 MW

Current projects: 4 further projects in permission phase / 4 additional projects to be permitted in 2016

Pipeline: about 20 further Repowering-Projects with a capacity of 350 MW, different development status
Repowering

Planning & Acquisition

Financing & Realisation

Project (WTG/WF)

Operation (commercial & technical)

Repowering

Min. 20 years of Operation
Repowering - Markets and Definitions

Markets:
Depending on the Development and the WTG age (Denmark, Germany, Spain, France, USA)
Depending on the market conditions and political framework (Germany, France)

Repowering: Some special considerations and definitions according the German system

• Replacement of the old WTG with new WTG
  – At the site (all)
  – At a neighboring site (maybe possible)
  – Within a certain area definition (Germany, consideration of Repowering Bonus until 2014)

• Consideration of the Repowering within the statistics
  – MW removed + MW installed
  – MWh/a removed + MWh/a installed
  – Within the target definitions of the German Feed In System 2017 (tendering)?
  – Further operation of the used WTG in different locations
Input parameters – Defining the Repowering Potential

The site:
WF size and area geometry, wind potential, turbulences, site suitability

The technology:
Existing WTG: type, hub height, production data
Planned WTG: type, hub height, amount, production estimates

Administration / Planning
Overall height limitations
Regional planning aspects / restrictions
Possible obligation for the operation
Land owner / local aspects

Correct Assessment of the site conditions (current situation)

Data analysis and WTG scenario comparison

Detailed feasibility study
Evaluation of operating wind farm portfolio

- Repowering Potential
  - WF age
  - Economical evaluation
  - Ownership viewpoint
  - planning requirements
  - land securement
  - site parameters
  - wind potential
  - technical status

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- WF age
Profitability of Repowering projects - Statements

Statement 1:
The profitability of a Repowering project is calculated with the identical parameters like a new planned project if the ownership should remain identical.

Please note:
Profitability of the Inventory-project (WTG condition, Liquidity of company)
Additional revenue from WTG sales
Changing conditions (Land lease, Restrictions due to environmental regulation...)

Statement 2:
The main factor, the location quality and the expected energy yield, can be determined relatively accurately in a Repowering project. ->less uncertainty in the funding

Please note:
Partly low representativeness of inventory WTG (hub height, WTG technology)
Statement 3:
The effort of the project planning is nearly identical to new projects

Please note:
New building permission, including new site investigations
New land securement (partly advantage due to the option of further operation)
New local agreements (important, history of the old wind farm project)

Statement 4:
A Repowering must increase the economical value compared to further operation

Please note:
Comparison of economical value in further operation vs. Repowering
Agreement from the owner, operator
The currently very good financing situation is a push factor for Repowering, but might change
Economical considerations

Energy yield estimates (calculation based on production data)
• Procedures and uncertainties
• Acceptance form the banks (France)

CAPEX vs. OPEX
• Comparable costs relation to new projects
• Normally no or only less possible synergetic effects with the infrastructure of the old wind farm sites
• Costs for dismantling to be considered /Revenue for the selling of old WTG difficult to estimate

Equity and ROI
• Old equity will be considered for comparison purposes
• Financing defines the new frame, partly equity requirements could be fulfilled from the liquidity of the operating wind farm
Comparison, before and after Repowering

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<thead>
<tr>
<th></th>
<th>Wind Farm A</th>
<th>Wind Farm B</th>
<th>Wind Farm C</th>
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<tbody>
<tr>
<td></td>
<td>Old</td>
<td>REP</td>
<td>Old</td>
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<tr>
<td>Capacity (MW)</td>
<td>15</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>Production (est.) in MWh/a - p75</td>
<td>26'500</td>
<td>42'300</td>
<td>24'900</td>
</tr>
<tr>
<td>Production (real) in MWh/a</td>
<td>18'600</td>
<td>43'500</td>
<td>19'100</td>
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<tr>
<td>Disb. 20a</td>
<td>147%</td>
<td>379%</td>
<td>67%</td>
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<td>O&amp;M concept</td>
<td>Basic</td>
<td>Full</td>
<td>Basic</td>
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</tbody>
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Examples (new auction model, permission after 2016)

Sensitivitätsanalyse: Cash Flow in Abhängigkeit verschiedener Parameter

Example:
- Repowering together with old investors (closed fond, private investors)
- WF planned for 2018.
- 11 new WTG, 14 old WTG
- Feed In tariff adjusted to auction model (competitive price)
- WTG technology: Vestas V126, 137 m hub height
- Disbursement lower than further operation but long-term option is excellent
Experiences Repowering

Planning viewpoint

• Existing projects do not allow automatically repowering
• Wind farms grow in time (further WTG in the surrounding, strong limitations)
• Energy yield with higher hub heights in the majority better than calculated
• Acceptance problems regarding lighting, sound and height of the new WTG
• Potential area for new WEA no longer fully usable (reduction of the usable area within the development should be noted)
• Repowering is often linked with area-extensions (annex, foreign WTG)

Economical viewpoint

• Solid and conservative plans for shareholder structures are preconditions in a Repowering-Project
• A Repowering must show a clear advantage to the option of ongoing operation
• Wind farm owners must be convinced and not “sold out”
Thank you very much for your attention.

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