Current markets, players and flows of wind turbine dismantling and recycling in Europe

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Context (1): Onshore wind market

Proportion of wind farms over 15 years old

- More than 16 GW in Germany
- More than 50% of Danish wind farms
- About 20-30% of Spain and Netherlands find farms

*Europe onshore wind installed capacity per age (Source: WindEurope)*
Context (2): Onshore wind market

- Most ageing wind farms are getting lifetime extension
- 22GW will be approaching their end of life by 2023
- By 2023, 14,000 blades would require recycling

Source: WindEurope
Context (3): Offshore wind market

- 22 GW of offshore wind in Europe in 2019, more than 60 % in NSR (North Sea Region)
- Leading countries: UK, Germany, Denmark
- Decommissioning will be significant by 2030
- Estimation, 120-350k€/MW decommissioning ≈ 2.5% of operating costs
Composite waste (1): Upcoming volumes (thousands of tonnes in 2025)

Source: EUCIA
Composite waste (2): Upcoming volumes of blade waste (ktons/year)

Source: EUCIA
Stakeholders in blade recycling
Wind farm End of life management

- 4 possibilities for wind farm end of life management

- Depends on new regulations adopted during farm first life

- Usually, when possible, repowering is the most cost effective solution

Source: ADEME
Regulation (1): Life time extension

- Lack of regulatory framework for lifetime extension
- Only 8 countries recognize lifetime extension

Countries that recognise life time extension in their legislation/guidelines

Existing incentives

Regulatory framework for life time extension

Source: WindEurope
Regulation (2): Repowering

- Spain: licence & permits for repowering hard to obtain
- France: new permitting laws since 2009 that makes repowering challenging for some old farms

Definition of repowering exists in legislation

Regulatory framework for repowering

*Source: WindEurope*
• National regulatory requirements to dismantle wind turbines and remove foundations up to 1m to 3m below ground (AT, BE, FR, DE, IT, PT)

• Requirements set project by project in the EIA or municipal/local authority planning conditions (DK, GR, ES, UK)
## Types of repowering (example of France)

<table>
<thead>
<tr>
<th>No repowering possible</th>
<th>Identical repowering (110%)</th>
<th>Repowering with height limitation (150m)</th>
<th>Repowering with no limitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prohibitive constraints making it impossible to renew wind turbines. Dismantling.</td>
<td>Renewal possible but exclude any substantial modification. Limitation of the rise in the total height to 110%</td>
<td>Aeronautical ceiling limiting the overall height to 150 meters but allowing substantial modifications below that. Example: increase in total height from 125 to 150 m.</td>
<td>No constraint limiting the total height of the wind turbines. Possibility of using the latest technology depending on the renewal deadline. Example: In 2020, 160 m rotor with 166 m tower for a total height of 246 m.</td>
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</tbody>
</table>

### Variation in conflict intensity: spatial and environmental constraints
End-of-life balance - trade-off extension vs. repowering

Repowering

Life extension

- Dismantling operations – Blade recycling
- Context of repowering, depends on local situation – Regulatory framework
- Secured Feed in Tarif (FIT) for 20 years

• Blade recycling postponed
• Wholesale market price and fluctuation
• Not subsidized electricity for the State
• O&M costs vs. production outcomes
• Risk for the project owner
THANK YOU FOR YOUR ATTENTION!

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