Optimization of wind turbine performance and related revenues

“What to expect of specific applications”

Jörg Fuchs | Head of Sales | Deutsche Windtechnik X-Service GmbH
One company which provides all services for the operation and maintenance of wind energy turbines.
<table>
<thead>
<tr>
<th>Company figures</th>
<th>Deutsche Windtechnik AG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service vehicles</td>
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<td>Service stations</td>
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<tr>
<td>Employees</td>
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<td>Maintenance contracts WTG</td>
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<td>Substations</td>
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<td><strong>180</strong></td>
<td><strong>74</strong></td>
</tr>
<tr>
<td><strong>750</strong></td>
<td><strong>2.900</strong></td>
</tr>
<tr>
<td><strong>66</strong></td>
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</table>

Locations - Headquarters in Germany:
- Bremen
- Osnabrück
- Kiel
- Ostenfeld
- Viöl
“Long term successful operation of your windfarm can only be guaranteed through reliable service and continuous optimization of your assets.”
Performance and revenue optimization for wind turbines

**Background**

Assynchrone setting of all three rotor blades

**Consequences**

Relative deviation of the blade angle higher than 0,3° cause significant aerodynamic disballance of the rotor.

- Increased loads
- Decreased performance
- Lower production output
<table>
<thead>
<tr>
<th>Performance and revenue optimization for wind turbines</th>
</tr>
</thead>
<tbody>
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<td>Blade angle</td>
</tr>
</tbody>
</table>

![Wind turbine image](image-url)
Performance and revenue optimization for wind turbines

Solution

High quality photographs of the blades
Blade angle adjustment
Measurement of results
# Performance and revenue optimization for wind turbines

- **Deutsche Windtechnik AG**

## Upgrade assessment

<table>
<thead>
<tr>
<th>Upgrade assessment</th>
<th>★★★ Optimal value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expenditure of time</td>
<td>★★★</td>
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<tr>
<td>Amortisation</td>
<td>★★★</td>
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**Yes**
Performance and revenue optimization for wind turbines

Background

Blade design has a strong impact on turbine efficiency and environmental noise.

Consequences

Production output ≠ potential output

Environmental noise may effect the local acceptance of a wind farm
Performance and revenue optimization for wind turbines

Solution

- Enlargement of the aerodynamically effective surface
- Extension of sections with a blunt trailing edge in the range of the blade root
- Passive Extraction of the boundary layer in the range of the blade root
- Reduction of tip vortex
- Improved air duct
- Diverting of extracted boundary layer

Blade angle | blade optimization | yaw optimization | oil additives | parameters

Deutsche Windtechnik AG
# Performance and revenue optimization for wind turbines

**Blade angle**  | blade optimization  | yaw optimization  | oil additives  | parameters
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<td>★★☆</td>
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★★★ Optimal value
Performance and revenue optimization for wind turbines

Blade angle blade optimization yaw optimization oil additives parameters

Background

Shadow effects and turbulences are causing tranversal approach flows

Consequences

Increased loads
Decreased performance
Lower Production output
Increased noise emissions
Performance and revenue optimization for wind turbines

Blade angle  blade optimization  yaw optimization  oil additives  parameters
**Performance and revenue optimization for wind turbines**

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**Solution**

- Installation of an additional highly resolving wind vane
- Installation of a control box holding a computer unit
- Use of an optimized self-learning set point tracing by a patented operation
- Site specific adjustment of turbine individual set point tracing
Performance and revenue optimization for wind turbines

Proof of effectiveness

Guggenberg WF:
Annual production (MWh) | before optimization | after optimization | delta
--- | --- | --- | ---
WEC 01 (FL261) | 1.788,2 MWh | 1.971,3 MWh | +10,2%
WEC 03 (FL263) | 1.589,2 MWh | 1.695,3 MWh | + 6,7%

Production of the non optimized turbine in the reference period:
WEC 02 (FL262) | 1.566,0 MWh | 1.583,4 MWh | + 1,1%*

* Differences at the non optimized turbine related to fluctuating air density.
Performance and revenue optimization for wind turbines

Blade angle  blade optimization  yaw optimization  oil additives  parameters

Proof of effectiveness

<table>
<thead>
<tr>
<th></th>
<th>WKA 198 (ertüchtigt)</th>
<th>WKA 199 (ertüchtigt)</th>
<th>WKA 197 (nicht ertüchtigt)</th>
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<tbody>
<tr>
<td>0-1.0</td>
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<tr>
<td>1.0-2.0</td>
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<td>5.0-6.0</td>
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<td>6.0-7.0</td>
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<tr>
<td>7.0-8.0</td>
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Langenbach WF:

Annual production (MWh)  before optimization  after optimization  delta

WEC 01 (FL198)  1.868,1 MWh  1.950,2 MWh  + 4,4%
WEC 03 (FL199)  1.617,3 MWh  1.787,9 MWh  + 10,6%

Production of the non optimized turbine in the reference period:

WEC 02 (FL197)  1.540,8 MWh  1.578,8 MWh  + 2,5%*

* Differences at the non optimized turbine related to fluctuating air density.
Performance and revenue optimization for wind turbines

Blade angle, blade optimization, yaw optimization, oil additives, parameters

Equivalent to an increased production of 120,000 kWh/a

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**Without additives**

**With additives**

### Results

- **2-4% increase of efficiency degree by reduction of friction**
- **Reduction of operating temperatures**
- **Increased life expectancy**
Performance and revenue optimization for wind turbines

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**Application assessment**

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★★★ Optimal value
Performance and revenue optimization for wind turbines

In most cases the turbine manufacturers parameter set up of controller is a general one.

Optimal set up of turbine parameters according to site specific characteristics such as:
- Roughness of the terrain
- Annex of additional WEC
- Appearance of wind and its quality
- Turbine type
- Characteristics of the local grid
# Performance and revenue optimization for wind turbines

**Blade angle** | **Blade optimization** | **Yaw optimization** | **Oil additives** | **Parameters**
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## Application assessment

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Thank you for your kind attention.