An example of Systems Engineering

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A Systems Engineering Approach - Providing Solutions in all phases of a wind power plant project

Planning
- Siting guidance
- Financing packages
- Insurance packages
- Network evaluation

Construction
- Product delivery
- Project management
- Installation
- Commissioning
- Turnkey experience
- Local presence around the globe

Service and Expansion
- Inspections
- Maintenance programs
- Modernizations
- Extensions
- Repairs
- Spare parts
- Training
- Global service network

Operation
- Operation & maintenance agreements
- Monitoring
- Diagnostics
Siemens SWT-3.0-101: high customer value minimizing the cost of energy

Summary: SWT-3.0-101

- New drive train design with permanent magnet generator is a technological leap forward
- Simple design with less moving parts reduces complexity and need for maintenance
- The compact and light weight design is major advantage for transportation and installation
- The proven 101 m rotor features high performance aerodynamics at reduced loads
Agenda

1. Description & Application
2. Performance
3. Siemens direct drive technology
4. Blade design
## SWT-3.0-101: Direct drive turbine with 101 m rotor

### Technical data

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
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<tbody>
<tr>
<td>IEC class:</td>
<td>IA</td>
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<tr>
<td>Nominal power:</td>
<td>3,000 kW</td>
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<tr>
<td>Rotor diameter:</td>
<td>101 m</td>
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<td>Blade length:</td>
<td>49 m</td>
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<td>Swept area:</td>
<td>8,000 m²</td>
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<tr>
<td>Hub height:</td>
<td>Site specific</td>
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<td>Annual output at 8 m/s:</td>
<td>11,600 MWh</td>
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<tr>
<td>Rotor weight:</td>
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<td>Nacelle weight:</td>
<td>73 t</td>
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<tr>
<td>Power regulation:</td>
<td>Pitch regulation, variable speed</td>
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<td>Prototype installed:</td>
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<td>Pilot series</td>
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<td>Serial production:</td>
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</table>
1. Description & Application

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Direct drive train enhances the efficiency of the wind turbine

Performance: Power curve

Power curve

Annual Energy Production

Btw. +2% and +11% at 4–10 m/s

+18%

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Streamlined and effective design with few and highly efficient components

- Direct drive with permanent magnet generator
- Simplified nacelle design with 50% less components
- Passive liquid cooling system
- Service-friendly design
- Previous proven solutions for the remaining components (blades, hub, power conversion, etc.)
A wind turbine designed to minimize the cost of energy

Technology advantages...

- Increased efficiency due to minimum losses in drive train, generator and cooling system
- Reduction in number of wearing parts due to the simplified drive train
- Compact (nacelle Ø = 4.2m) and light weight design (nacelle weight = 73 t)

... bring down the cost of energy

- Enhanced performance
- Reduced effort in maintenance
- Designed for lean transport and installation
Compact and light weight design, major advantage for transportation and installation

- Designed for standard transport limitations
- Only requires trucks and tools available in high numbers worldwide
- Nacelle transported in one piece to minimize expensive and risky on-site assembly of critical components
## Product and service offering designed to optimize maintenance and reduce customer risk

### Product features optimize maintenance

- Gear box removed to increase reliability and optimize maintainability
- Simplified spare parts handling with 50% less components
- Service conditions improved by easier accessibility

### Service offerings reduce customer risk

- Worldwide network of highly trained Siemens service technicians to safely manage the new technology
- Safe Investment: Long term service program offered already from day one (incl. parts warranty)
- Advanced preventive maintenance
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A twist of revolution: 15% larger swept area with the same loads

- New aerodynamic profile redistributes loads in the B49 blade, reducing the cumulative bending moment.
- The root section is more heavily loaded due to the use of special flatback airfoils, and a larger planform (more chord).
- The tip section is less heavily loaded due to reduced chord length.

Thrust coefficient (Ct) on the B45 and B49 blade

- **More loaded**
- **Less loaded**

**Schematic**

Flatback & planform

Reduced chord

<table>
<thead>
<tr>
<th></th>
<th>B45</th>
<th>B49</th>
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<tr>
<td>Flatback &amp; planform</td>
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</tr>
<tr>
<td>Reduced chord</td>
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The new SWT-3.0-101 blade employs new “flatback” profile in root section

- Flat back airfoil ‘opens up’ the trailing edge
- Separation point moved further towards the trailing edge giving increased lift
Increasing capacity and U.S. content

- **Ft. Madison Plant Expansion**
  - Warehousing
  - Manufacturing
  - Machining, rough & fine finish, and painting
  - Direct rail shipping
  - ~500 employees/3 shifts
  - Manufactures B45 & B49 Wind IntegralBlade®

- **New Nacelle Plant in Hutchinson, KS**
  - Capacity of 1500 MW per year
  - Creating more than 400 jobs
  - Initially assemble the 2.3MW nacelle, moving to 3.0DD
  - First nacelle this month!

Siemens Wind Power has a goal of 90% US dollar content by 2012
Thank you for your attention!