

A low-angle photograph of a white wind turbine against a clear blue sky. The nacelle and parts of the three blades are visible. The Siemens logo is printed in teal on the side of the nacelle.

Introduction to Siemens Wind Power

Siemens Energy

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Agenda

- **Company profile**
- **Market overview**
- **Product portfolio**
- **Siemens scope of supply**
- **Key differentiators**

Siemens AG divided into 3 global sectors

Sectors	Divisions
 <p>Industry</p>	<ul style="list-style-type: none"> ▪ Industry Automation ▪ Drive Technologies ▪ Building Technologies ▪ Osram ▪ Industry Solutions ▪ Mobility
 <p>Energy</p>	<ul style="list-style-type: none"> ▪ Oil & Gas ▪ Fossil Power Generation ▪ <u>Renewable Energy</u> ▪ Service Rotating Equipment ▪ Power Transmission ▪ Power Distribution
 <p>Healthcare</p>	<ul style="list-style-type: none"> ▪ Imaging & IT ▪ Workflow & Solutions ▪ Diagnostics

405,000 employees
 190 countries
 65,000 in U.S.A.
 Annual Turnover (2009)
 €77B

Siemens
 Energy Sector
 \$25.7B or 34%

Siemens
 Wind Power
 \$3B or ~4%

Siemens Wind Power delivering strong, solid performance

Siemens Global Wind Power facts

Currently 6,200 employees (800 in 2004)

Deliveries: > 2260 MW in 2009 (600 MW in 2004)

Installed Base: > 8,700 turbines with > 11,000 MW capacity

Record wind turbine order backlog

Record order entry in FY 2009 and FY 2010

No. 1 in the global offshore market in 2009

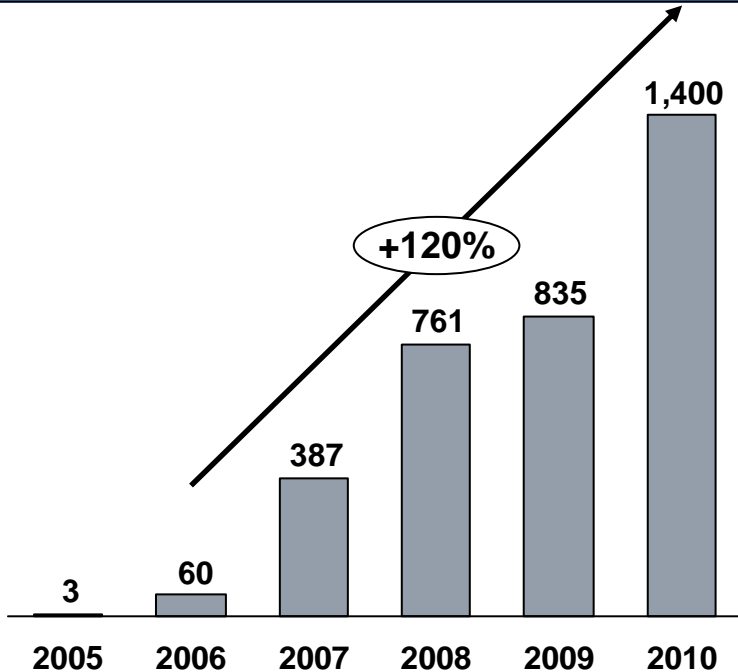
No. 3 in the U.S. onshore market in 2009

Double digit growth in revenues, profit, installations and employees since acquisition of Bonus

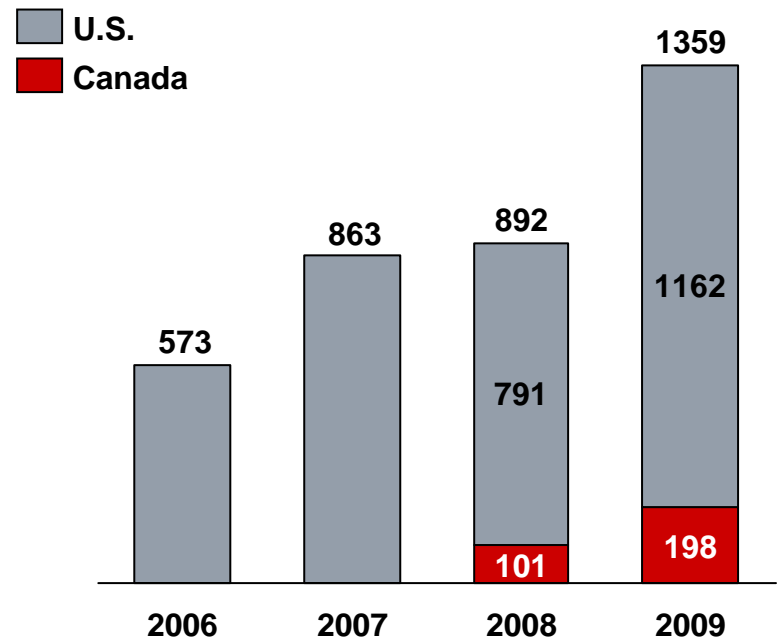
Siemens is committed to the U.S. market

- 64,000 U.S. Siemens employees
- 9 headquarters located in the U.S.

Siemens Wind Power Headcount in the Americas

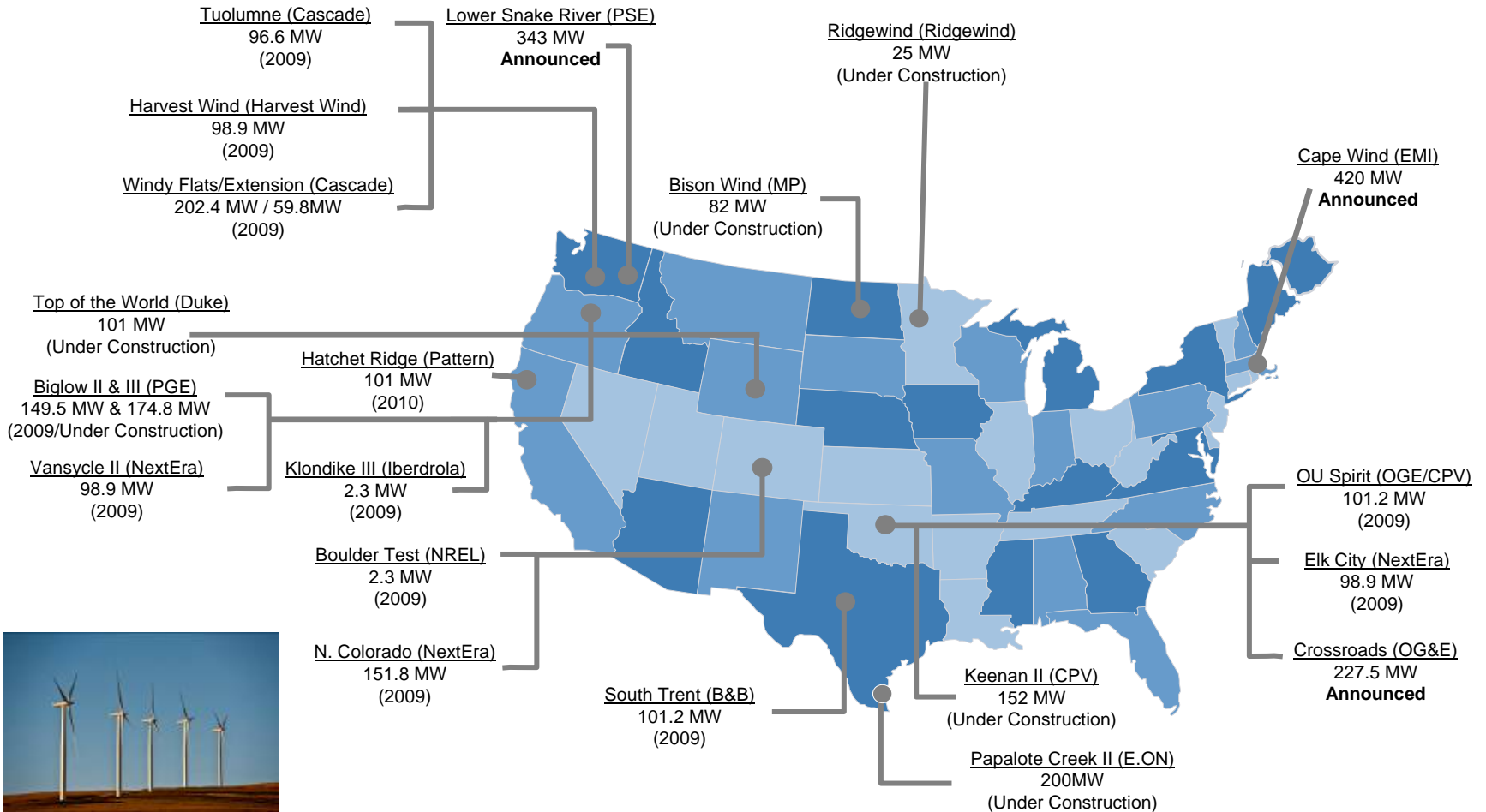


Siemens Wind Power Installations in the Americas (MW)



Recent Siemens Wind Power projects in the U.S.

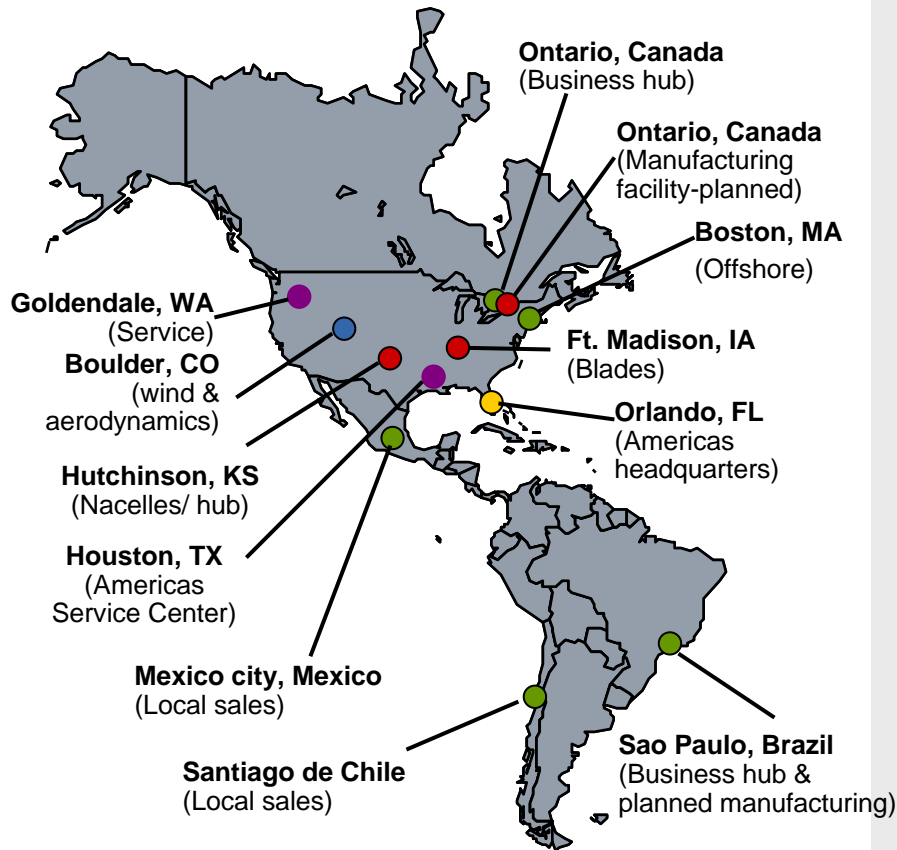
On time, on budget and meeting performance



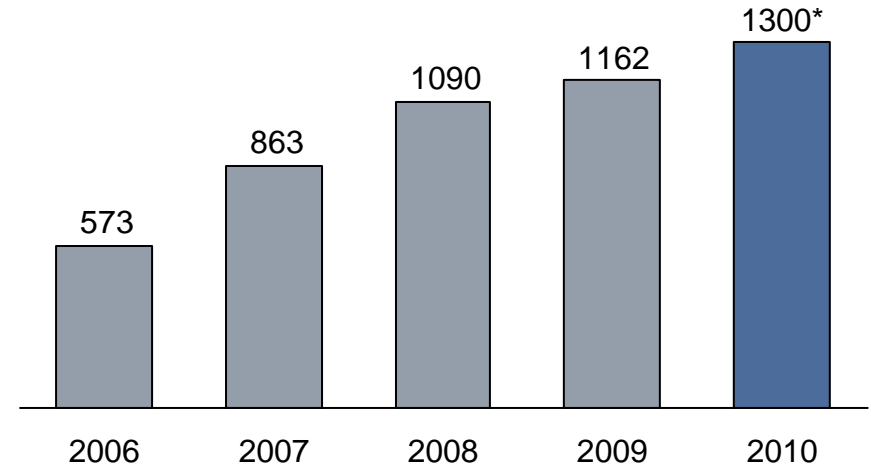
Continued growth in manufacturing, service and business hubs to meet growth demand



Supply chain, R&D and sales presence in the Americas



Siemens installations in the Americas (MW)



- More than 1,300 MW expected to be installed in 2010
- Rapidly increasing Americas-based employees and facilities for manufacturing and service
- More than 1,400* employees by end of 2010 in different locations – Orlando, FL, Houston, TX, Ft. Madison, IA, Ontario, Canada

*Estimated values

Increasing capacity

Ft. Madison Plant Expansion

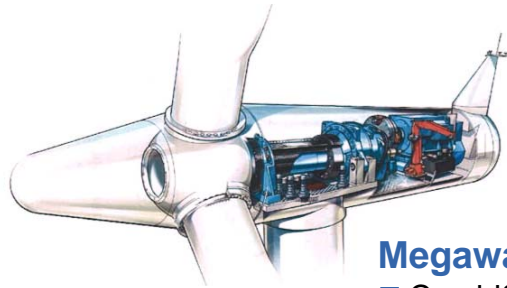
- Warehousing
- Manufacturing
- Machining, rough & fine finish, and painting
- Direct rail shipping
- **~500 employees/3 shifts**
- Manufactures B45 & B49 Wind IntegralBlade®



New Nacelle Plant in Hutchinson, KS

- Capacity of 1,500 MW per year
- **Creating more than 400 jobs in the community**
- Initially assemble the 2.3 MW nacelle
- First nacelle left the facility in December 2010

Evolution of the product portfolio with over 30 years of experience



Megawatt class

- CombiStall technology
 - SWT-1.0-54: 356 WTG
 - SWT-1.3-62: 1,545 WTG
 - SWT-2.0-76: 165 WTG
 - SWT-2.3-82: 514 WTG

Multi-Megawatt class

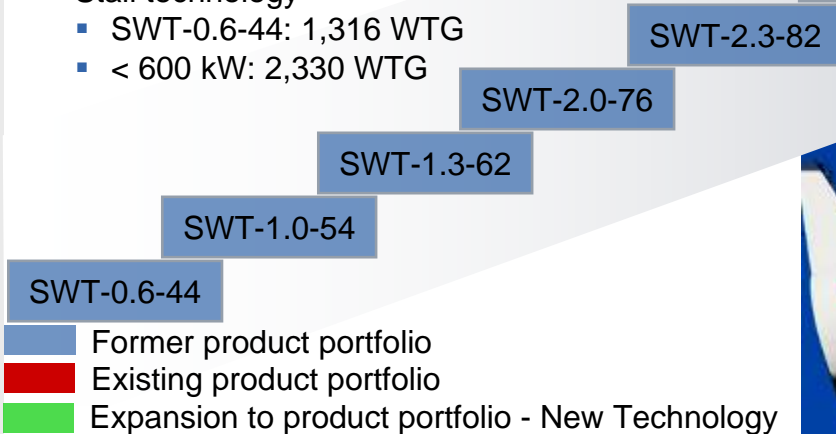
- Pitch technology with variable speed
 - SWT-2.3-82 VS and SWT-2.3-93: 2,335 WTG
 - SWT-2.3-101: 175 WTG
 - SWT-3.6-107: 220 WTG
 - SWT-3.6-120: 5 WTG

Kilowatt class

- Stall technology
 - SWT-0.6-44: 1,316 WTG
 - < 600 kW: 2,330 WTG

Direct Drive Technology

- Compact Direct Drive
 - SWT-3.0-101 DD



Installed base worldwide: > 8,700 turbines with > 11,000 MW capacity

Offering a product portfolio to meet the customer requirements

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Product portfolio



SWT-2.3-82VS



SWT-2.3-93



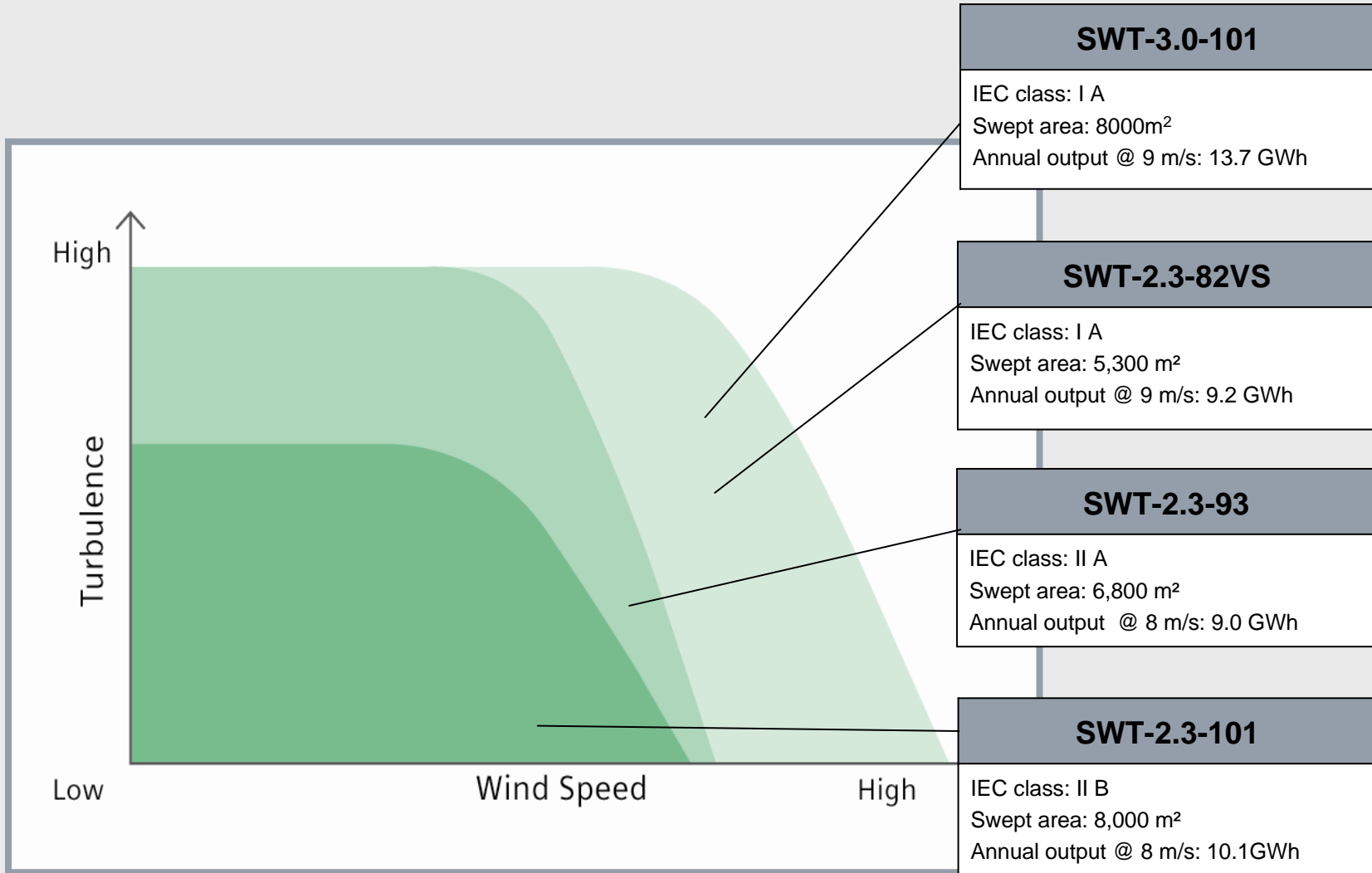
SWT-2.3-101



SWT-3.0-101 DD

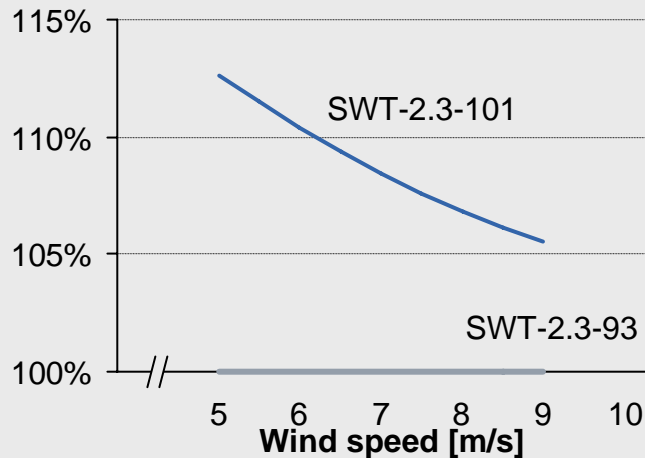
Continuously monitoring market trends and needs for new product development

Siemens offers turbine equipment for all wind conditions



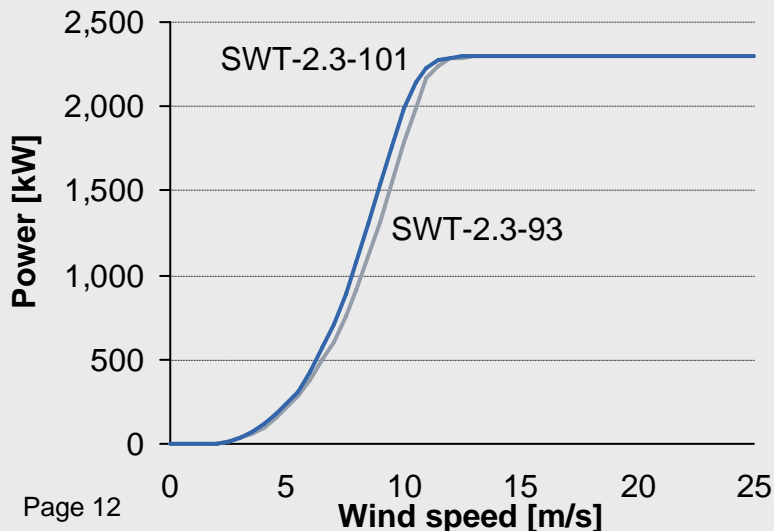
The SWT-2.3-101 wind turbine optimizes your energy yield in moderate wind conditions

Change in annual electricity production



- ➔ Completes the SWT-2.3 family with more performance in moderate wind conditions
- ➔ More output @ less noise
- ➔ Same reliability as the SWT-2.3 family
- ➔ Pre-bent blades

Power Curves



Differences from the SWT2.3-93

- Main difference is the **Quantum blade** with advanced aerodynamics and load reducing structural dynamics
- New hub due to increase diameter
- Same nacelle, power unit and towers (for most of the sites)

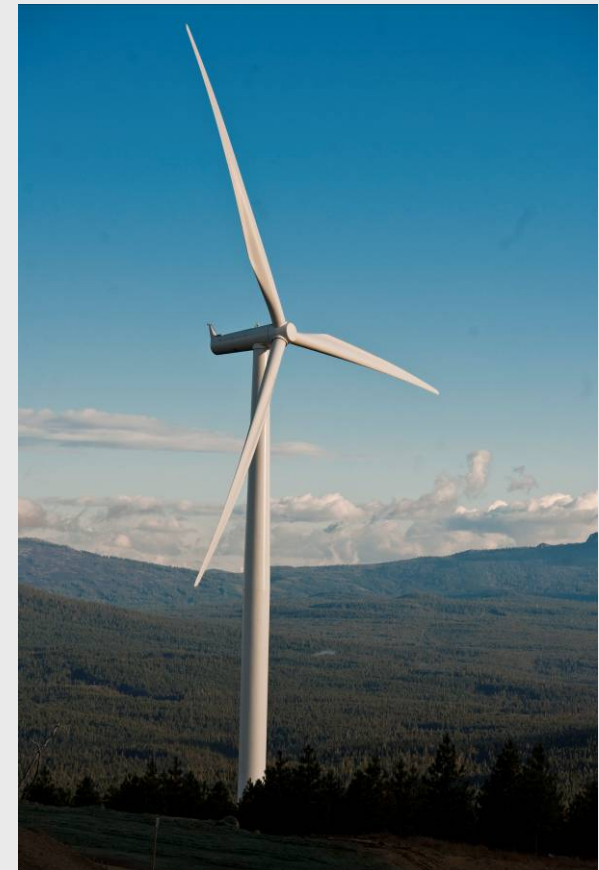


The SWT-2.3-101 wind turbine optimizes your energy yield in moderate wind conditions

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SWT-2.3-101 wind turbine generator

IEC Class:	IIB
Rotor diameter:	101 m
Blade length:	49 m
Swept area:	8,000 m ²
Hub height:	80-100 m
Power regulation:	pitch regulated, VS
Annual output at 8 m/s:	10.1 GWh
Blade weight:	10 t
Rotor weight:	62 t
Nacelle weight:	82 t
80 m tower weight (IEC IIB):	170 t
 <u>Experience Data</u>	
Prototype installed:	2008
Serial production:	2010
Total number installed:	200 operating
	> 650 MW will be installed before end of the year



SWT-3.0-101: Direct drive turbine with 101 m rotor

SWT-3.0-101 wind turbine generator

IEC class:	IA
Rotor diameter:	101 m
Blade length:	49 m
Swept area:	8,000 m ²
Hub height:	Site specific
Power regulation:	Pitch regulation, VS
Annual output at 9 m/s:	13,700 MWh
Rotor weight:	60 t
Nacelle weight:	73 t
Nominal power:	3,000 kW
Proof of concept turbines:	2008 + 2009
Prototype installed:	2009
Pilot series:	2010
Serial production:	2011



Newly introduced SWT-3.0-101 direct drive turbine

- **Reduces complexity and increases reliability and maintainability**
- **50% fewer parts, half the parts of the conventional geared turbine**
- **Simplified design for easier transportation, erection and maintenance**
- **Compact and light weight**
- **Generator located at the front of the nacelle, between the nacelle itself and rotor hub; reduction of the equipment inside the nacelle results in a shortened 4m length**



Our unique blade manufacturing technology avoids glue joint potential blade weaknesses

IntegralBlade® technology is a closed process invented by Siemens.

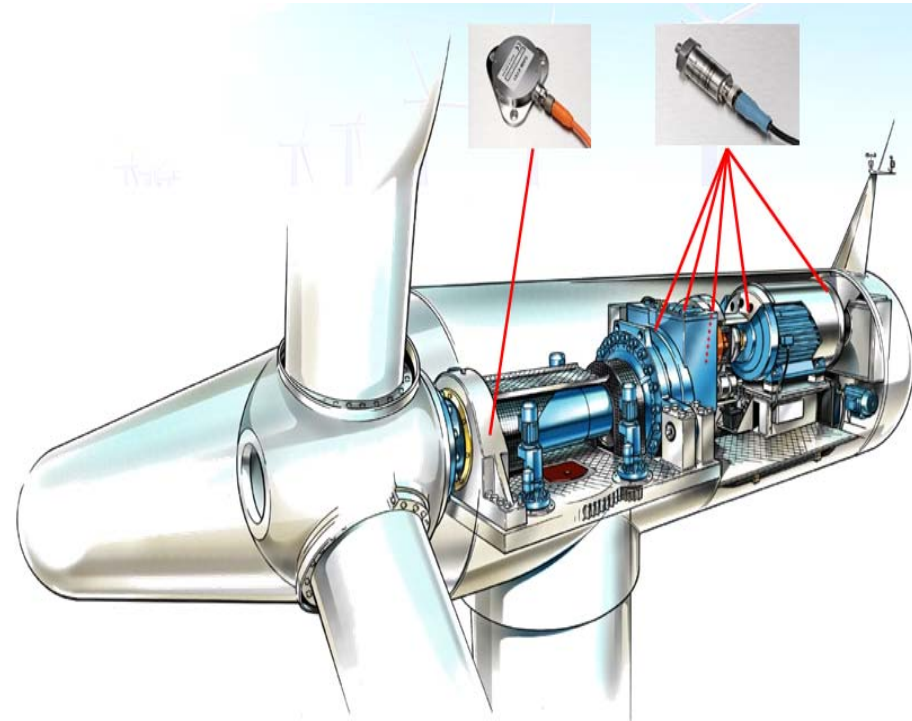
- Manufactured in **one piece**
- Superior **strength and resilience** due to an integrated structure
- **No glue joints** which reduce the risk for adverse effects of cracking and water ingress
- Designed for excellent **power and noise performance** due to superior aerodynamics, profile accuracy and damping



Siemens' long experience with condition monitoring can optimize fleet performance and save large costs

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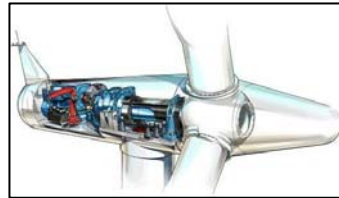
- **The TCM® system allows for the continuous online vibration monitoring of the wind turbine with sensors and allows for the assessment of:**
 - **Main bearing**
 - **Gearbox**
 - **Generator**
- **10 years of experience with thousands of turbines allows for precise diagnostics and preventive service planning.**
- **The system is certified by Germanischer Lloyd**



Robust design features contribute to longer lifetime and higher reliability

Selected high quality features

Lubrication System



- Continuously fed automatic lubrication system with oil temperature control
- In-line and off-line oil filters
- New oil from the supplier is pre-filtered

Yaw System



- Reduced loads with more motors and gradual ramp-up through a frequency converter
- Hardened yaw ring and gears for maintenance-free operations

Steel Canopy

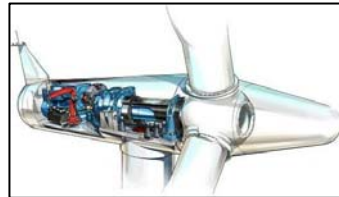


- Very robust design and low material flammability
- Extra lightning protection, functioning as Faraday cage
- Designed to withstand turbulence class A winds

Robust design features contribute to longer lifetime and higher reliability (cont'd)

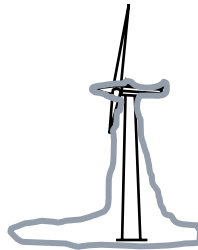
Selected high quality features

Cooling System



- Fully closed cabinet solely cooled by means of heat exchangers provides perfect isolation
- Dehumidifiers in offshore wind turbines
- Water cooling of frequency converter

Lightning Protection



- Blades equipped with lightning receptors and a flexible insulated metal wire
- Full metal design
- Transformer outside nacelle reduces fire risk

Siemens NetConverter® responds to grid codes with maximum flexibility and top performance



Siemens NetConverter® Capabilities

Operation range

Accommodate a wide range of frequency and voltage disturbances

Power quality

Minimum harmonic content and flicker emission

Low Voltage Ride Through

Advanced LVRT capabilities to meet the most demanding grid codes



Active power control

Multiple options to respond to under-frequency and over-frequency events

Voltage regulation

Best-in-class voltage regulation capabilities, even with no wind

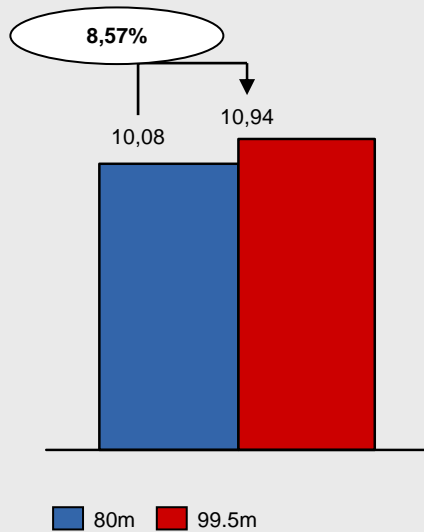
Capacity Factor Comparisons of 80 to ~100M towers

Wind speed=8.85m/s

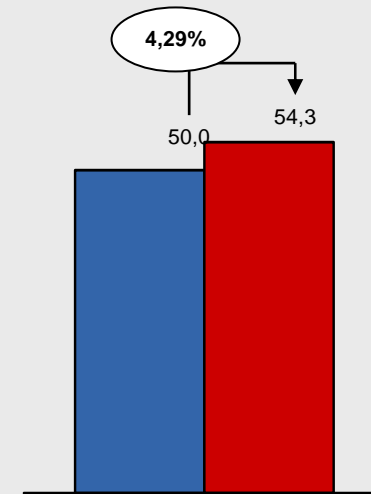
SWT 2.3-101



Net AEP (GWh)



Capacity Factor (%)



- Assumption: 95% Availability, 91.18% Park Efficiency
- P50

Comprehensive service solutions

What makes Siemens' service solutions unique?

- OEM knowledge and engineering support
- Skilled and experienced personnel available 24/7
- Comprehensive portfolio of service contracts
- 24/7 remote monitoring capability
- Technical field assistance to support scheduled and unscheduled outages
- Access to Siemens' global logistics network with day-to-day management and control of inventory results in reduced lead-time for spare parts
- In-house training facility for customers



Exceptional innovation

Hywind



- Cooperation on technology with Statoil Hydro to develop World's first floating off-shore installation
- In 2009 Siemens installed the first turbine in Norway at a water depth of about 220 meters
- Floating offshore turbines could be installed at sites with greater water depths
- Reduced visual impact and increased power production due to strong and stable wind conditions

Siemens Boulder Wind R&D Team

Goal - Supporting Siemens Wind Power to lower cost of electricity by increasing energy production, lowering turbine cost and improving reliability

Siemens Wind R&D Boulder is focused on the following technology areas:

- **Loads** – Reduce mechanical loading per unit of energy = lighter blades and structures = cost savings = Lower COE
- **Aerodynamics** – Improve efficiency = higher capacity factors = Lower COE
- **Controls**- Improve energy output and lower loading = Lower COE
- **Wind Power Meteorology** –optimize Turbine design and operation of wind farms = Lower COE
- **Product Integrity** - Support prototype and turbine testing in the Americas



Boulder CRADA, Introduction

- **C**ooperative **R**esearch **A**nd **D**evelopment **A**greement between Dept. of Energy, DOE/ National Renewable Energy Lab, NREL and Siemens Wind Power
- A SWT-2.3-101 wind turbine is erected at NWTC, Boulder
- Budget: DOE/NREL \$5M
Siemens \$9M
- Time plan: Jan 2009- Jan 2012
- In a close cooperation between NREL and Siemens numerous test campaigns and data analysis will be performed



Commissioning Ceremony, October 19th, 2009

Boulder CRADA

Technology Development Project

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Objectives

- The primary objective is to gain detailed knowledge of **performance, aerodynamics, noise emission** and **structural characteristics** of the SWT-2.3-101 wind turbine being operated at a **severe wind condition** site with **strong wind shear** and **high turbulence intensity**.
- New measurement technologies
- The measured data will serve as a unique and valuable verification and validation data set for improvement and further development of wind turbine design codes used in Siemens Wind Power
- The test campaign is part of a Cooperative Research and Development Agreement (CRADA) between Siemens Wind Power A/S and National Renewable Energy Lab, NREL in Boulder, Colorado
- The wind turbine being tested is the Siemens SWT-2.3-101, which is rated at 2.3 MW and has hub height of 80 m and a rotor diameter of 101 m
- The turbine was erected October 2009 and tests are planned to run until January 2012.

Tests

- Power performance
- Power quality
- Noise emission
- Loads
- Blade torsion and modal test
- Reliability under severe conditions
- Full scale rotor aerodynamics
- Enhanced performance and load reduction

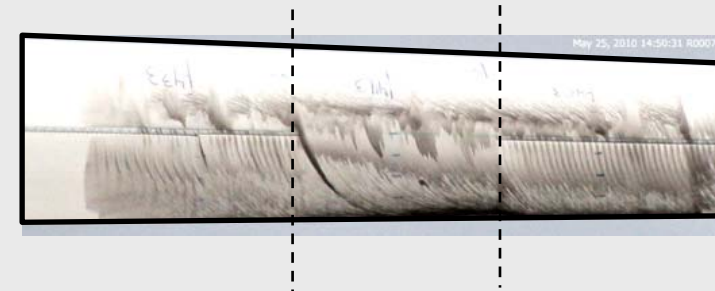
Inflow

- A 135 m met tower is located 200m upstream of the turbine. The tower is instrumented with six sonics anemometers and four cup anemometers and vanes
- A Windcube LIDAR is located 280 m upstream of the turbine. The LIDAR can measure inflow wind at several heights between 10 and 250 m

Flow Visualization



Tufts on the suction side of the root section for visualizing the surface flow. Here with two rows of VGs. The separated region is clearly seen.



Investigation of Vortex Generators on the outer part of the blades using oil flow visualization. The flow is on the suction side at rotor radius and centered at about ~ 44 m. The VGs are removed between the two dashed lines.



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Questions?