

Strategies for Supply Chain Development

Preliminary Results of the Chicago
Renewable Energy Taskforce Survey
and Supply Chain Assessment

Market Opportunity Analysis

- The key to success for most companies is strategic planning and the key to strategic planning rests on the matching of market needs to corporate capabilities – “strategic fit.”*
- Does this apply to both the firm and the regional supplier network?

Market Size and Growth

- 5,249 MW of new installed capacity in 2007
- 8,545 MW of new installed capacity in 2008
- 26% CAGR from year-end 2001 to 2008
- About 5,000 MW of new installed capacity expected in 2009
- Credit crisis and minimization of inventories
- 16,000 MW of new installed capacity expected annually by 2018*

* American Wind Energy Association Annual Wind Industry Report - Year Ending 2008.

Market Size and Growth (contd.)

- 2008 US wind turbine market \$12.4 billion
- Drivetrain and Nacelle account for 46% of market for \$5.7 billion
- Rotor accounts for 28% of market for \$3.5 billion
- Tower accounts for 21% of market for \$2.6 billion
- Foundation accounts for 5% of market for \$620 million*

Market Size and Growth (contd.)

- Rotor
 - Blades – 16.6% of market for \$2.1 billion
 - Hub – 7.2% of market for \$893 million
 - Pitch mechanisms and bearings – 4% of market for \$496 million

Drivetrain and Nacelle

Gearbox	13.4%	\$1.7 billion
Variable-speed electronics	6.9%	\$856 million
Generator	6.7%	\$831 million
Support structure	3.8%	\$471 million
Transformer	2.5%	\$310 million
Mainshaft	2.3%	\$285 million
Cable	2.0%	\$248 million
Nacelle cover	1.9%	\$235 million
Yaw Drives and Bearings	1.8%	\$223 million
Switchgear	1.4%	\$174 million
Mainshaft bearing and block	1.3%	\$161 million
Control and Safety System	0.8%	\$99 million
Brake system, hydraulics	0.6%	\$74 million
Elastomeric mounting system	0.3%	\$37 million
Generator cooling system	0.3%	\$37 million
Coupling	0.3%	\$37 million
Generator isolation mounts	0.1%	\$12 million

Gearbox Components

Gears	25.0%	\$415 million
Housings	23.6%	\$392 million
Bearings	16.0%	\$266 million
Other	9.1%	\$151 million
Labor	7.7%	\$128 million
Shafts	7.3%	\$121 million
Hubs	5.3%	\$88 million
Cooling	3.9%	\$64 million
Hydraulic	2.1%	\$35 million

Market Size and Growth (contd.)

- As of year-end 2007 the US is the largest market followed by China, Spain, and Germany.
- The US is expected to remain the largest market through 2012 followed by China.*

Basic Growth Strategies

- Market penetration
- Product development
- Market development
- Diversification

Market Penetration

- Expansion of existing product markets
 - Product knowledge
 - Market knowledge
- Increasing market share
 - Attracting buyers of competitors products
- Increasing size of market unlikely
 - Altering purchasing patterns
 - Attracting nonusers

Product Development

- Development of new products aimed at existing markets
 - Market knowledge
 - Lack of product knowledge
- New features
- Improved quality
- Increased sizes

Market Development

- Development of new markets for existing products
 - Product knowledge
 - Lack of market knowledge
- New market segment
- New geographical market

Diversification

- Product or technology related diversification consists of adding products which are technologically related to existing products even though they are aimed at different markets.*
- Neither market nor product knowledge
- Most strain on management
- Gain knowledge through acquisition of managers or companies with market and product knowledge

Supplier Types

- Established suppliers
- New entrants or prospective suppliers
- Those not interested or not qualified
 - Relatively small market segment
 - High quality requirements
 - Product or technology risk
 - Capital requirements
 - Low margins

Top Ten Wind Turbine Manufacturers Worldwide in 2007*

Vestas (DK)	22.8%
GE Energy (US)	16.6%
Gamesa (ES)	15.4%
Enercon (GE)	14.0%
Suzlon (Ind)	10.5%
Siemens (DK)	7.1%
Acciona (ES)	4.4%
Goldwind (PRC)	4.2%
Nordex (GE)	3.4%
Sinoval (PRC)	3.4%

*BTM Consult ApS, Supply Chain Assessment 2008-2012, August 2008.

Only Eight Wind Turbine Suppliers to US Market in 2007*

GE Energy (US)	43.9%
Vestas (DK)	17.9%
Siemens (DK)	16.2%
Gamesa (ES)	10.8%
Mitsubishi (JP)	6.7%
Suzlon (Ind)	3.7%
Clipper (US)	0.9%
Nordex (GE)	0.0%

*American Wind Energy Association, AWEA 2007 Market Report, January 2008.

Top Ten Wind Turbine Suppliers to US Market in 2008*

GE Energy (US)	42.7%
Vestas (DK)	13.1%
Siemens (DK)	9.2%
Suzlon (Ind)	8.6%
Gamesa (ES)	7.2%
Clipper (US)	7.0%
Mitsubishi (JP)	6.0%
Acciona (ES)	4.8%
REpower (GE)	1.2%
Fuhrländer (GE)	0.1%

*American Wind Energy Association Annual Wind Industry Report - Year Ending 2008.

Wind Turbine Industry

- Increasing competition
- Globalization strategies
 - New production facilities in growth markets
 - China
 - US
- New capacity has been established in China, India, and South Korea by experienced European manufacturers through local subsidiaries and the regional industrial sector.
 - 70% local content requirement in China
 - Wind power technology transfer

Wind Turbine Industry (contd.)

- Increased vertical integration
- Long term framework agreements for key components
 - Restrictions on supplying competitors
 - Quality guarantees
 - Penalties
- Securing capacity and reducing lead times
- Pricing pressure on suppliers from countries experiencing higher exchange rates

Specialized Components

- Blades, control systems, gearboxes, generators, and power converters
- Preference for established suppliers with experience in the wind turbine industry and a proven track record of on time delivery and high quality
- Use of suppliers to gain from their collective experience
- Most likely to be in-sourced or for a buyout to achieve backward integration

Components Manufactured to Specification

- Towers, cast irons, forging services, and nacelle cover and spinner
- Preference for suppliers located near the point of assembly
 - Adhere to minimum quality standards
 - Use standard techniques
 - Total delivered cost is competitive
- Easily replaced

Challenges for Suppliers

- Increasing size of wind turbines
 - For some it may be worthwhile focusing on suppliers of smaller turbines <1.5 MW.
- Rapid changes in technology
- High quality requirements
- Foreign competition
- Pricing pressure

Cast Irons

- Large castings include the mainframe, rotor hub, and the gearbox housing.
- Smaller castings include the pedestal bearing housing, blade adaptor, torque bracket, and planet carrier.
- Ductile cast iron
 - High elasticity
 - Tensile strength
 - Performs well at low temperatures
- High quality requirements

Cast Irons (contd.)

- Some in-house capacity
- Independent suppliers may be required to abide by a quality guarantee system.
- New suppliers may be required to qualify through sample production.
- Many new entrants to the market from China
- Five of the top ten suppliers to the wind turbine industry are Chinese.

Cast Irons (contd.)

- Established US suppliers*
 - ATI Casting Service, LaPorte, Indiana
 - Cast-Fab Technologies, Inc., Ohio
 - Ellwood Engineered Casting, Ohio
 - Hodge Foundry, Pennsylvania
- None of these are among the top ten suppliers to the wind turbine industry.

Cast Irons (contd.)

- Worldwide balance of supply and demand for castings
- Surplus capacity in China
 - Allocated capacity is three times domestic demand.
- Capacity shortage in US
 - Domestic demand is four times allocated capacity.

Cast Irons (contd.)

- Cost of importing castings
 - Transportation and logistics
 - CO₂ emissions
 - Net Energy Gain
- Potential quality issues
- Balancing regional distribution
- Increasing US capacity
 - Upgrading quality
 - Increasing size capacity

Forging Services

- Large forgings include main shaft, wheel parts, and inner and outer rings for large bearings.
- Smaller forgings include flanges and gear blanks.
- No in-house forging capacity
- High quality alloy steel

Forging Services (contd.)

- Established US suppliers*
 - A. Finkl & Sons, Inc., Chicago, Illinois
 - CAB Incorporated, Texas
 - Ellwood Group, Inc., Texas and Pennsylvania
 - McKees Rocks Forgings, Pennsylvania
 - Ajax Rolled Ring and Machine, South Carolina
- CAB Incorporated is one of the top ten suppliers to the wind turbine industry.
- The others are in South Korea and China except for one in Spain.

Forging Services (contd.)

- Worldwide balance of supply and demand for forgings
- Surplus capacity in South Korea and China
 - Allocated capacity is eight times domestic demand.
- Capacity shortage in US and Europe
 - Domestic demand in US is twice the allocated capacity and increasing.

Forging Services (contd.)

- Cost of importing forgings
 - Transportation and logistics
 - CO₂ emissions
 - Net Energy Gain
- Potential quality issues
- Balancing regional distribution
- Increasing US capacity
 - Upgrading quality
 - Increasing size capacity
- Rolled ring forgings of high quality alloy steel may be a constraint for bearing manufacturers.

Bearings

- Main shaft, gearbox, generator, and slewing bearings for pitch and yaw are weak points in the supply chain.
- Market leaders*
 - FAG (Schaeffler)(Germany)
 - SKF (Sweden)
 - Expanding US production facilities
- Established US suppliers*
 - Timken, Ohio
 - Kaydon, Ohio, Michigan

Bearings (contd.)

- Japanese Suppliers with US production facilities
 - NTN Corporation
 - NTN Bower, Macomb, Illinois
- Established suppliers are increasing capacity in China and India.
- New entrants from China are manufacturing slewing bearings.
 - Positioning for future demand

Bearings (contd.)

- Shortage of supply is unlikely to be resolved in the near term.
- Gearbox and generator failures are usually due to bearings.
- Replacement bearings can take months to procure.
- Comprehensive qualification programs for new suppliers
 - Wind turbine industry experience
 - Proven track record of on time delivery and high quality
- Changes in specifications can be demanding.

Gearboxes

- Constraints in the supply of large bearings compounded by failures will probably limit the supply of gearboxes.
- Backwards integration of gearbox production*
 - Siemens (Winergy)
 - Suzlon (Hansen Transmissions)
 - GE Energy (GE Transportation)
 - Gamesa (Eschesa)
- Wind turbine manufacturers are unlikely to use new suppliers of gearboxes without a proven track record.

Gearboxes (contd.)

- US production of gearboxes*
 - Winergy, Elgin, Illinois
 - Brad Foote Gear Works, Cicero, Illinois
 - GE Transportation, Pennsylvania
 - Moventas, Minnesota
- Housings are usually outsourced.
- Gears and shafts may be produced in-house.
- If not, the focus is on assembly, quality control, testing, and design.
- Continuous improvement of gearbox design

Gearboxes (contd.)

- Bosch Rexroth is the largest independent supplier of gearboxes to the wind turbine industry.
 - Investigating possible expansion of gearbox production in the Midwest
 - Reassessing their sourcing strategy
- Marketing and attraction
 - Introduction to possible suppliers
 - Introduction to municipalities in the area

Competitive Analysis

- You are trying to uncover segments that are not currently being served or segments that are not being served well by competition.*
- Established suppliers to the wind turbine industry should pursue a market penetration strategy.
- For commodity items or components manufactured to specification, new entrants should pursue a market development strategy.
 - Product positioning
- For specialized components, the only option for new entrants is diversification.

Competitive Analysis (contd.)

- Diversification strategy
 - Acquire managers or companies with product and market knowledge
 - Form a joint venture with an established supplier
 - Focus on second tier and supply subcomponents to established first tier suppliers
 - Focus on suppliers of smaller wind turbines <1.5 MW

Conclusion/Disclaimer

- Key success factors will vary from industry to industry and an understanding of the economics of the industry is necessary to take advantage of these factors.*

Thank you

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