

Wind Energy Component Supply Chain

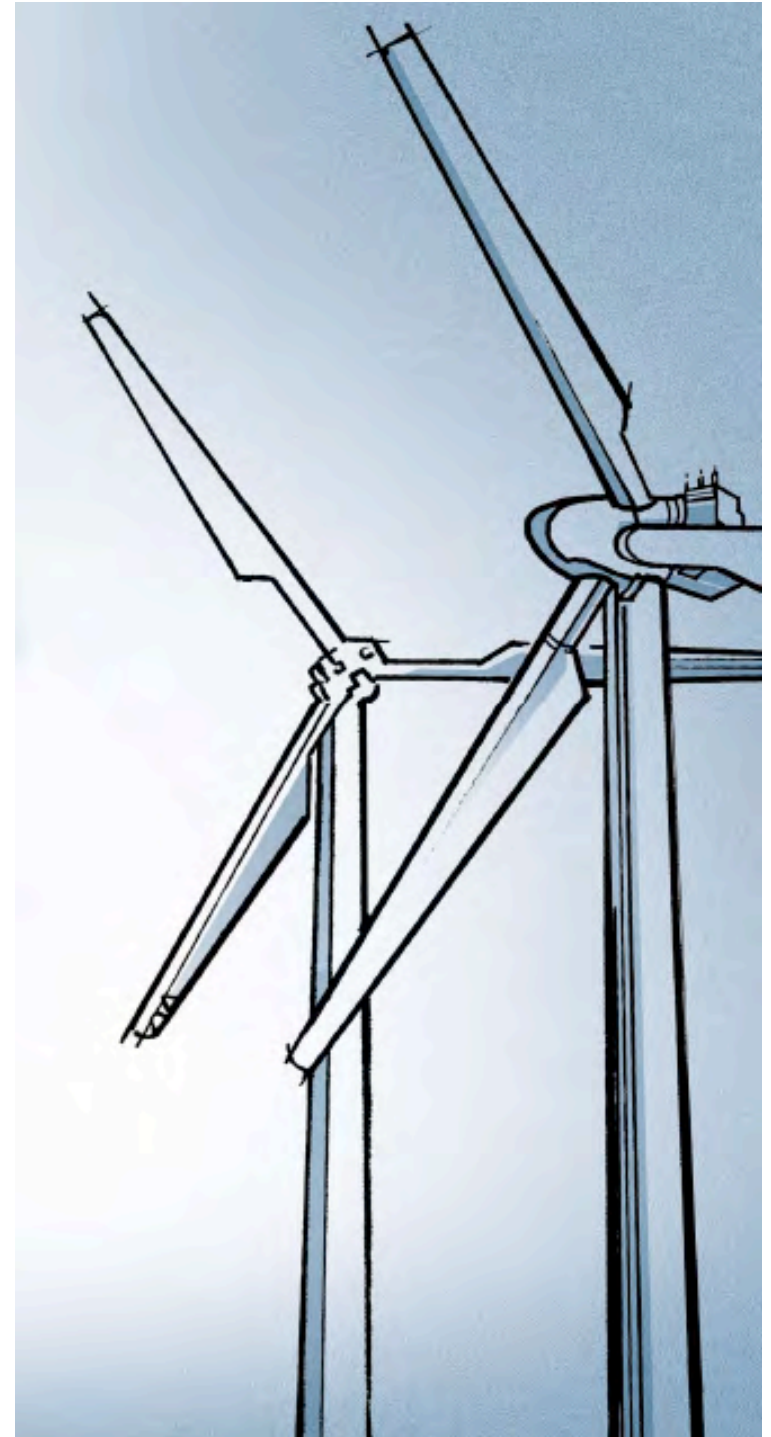
Pat Timon
GE Drivetrain Technologies

Buffalo Niagara Wind Component
Manufacturing Symposium

July 15, 2009



imagination at work

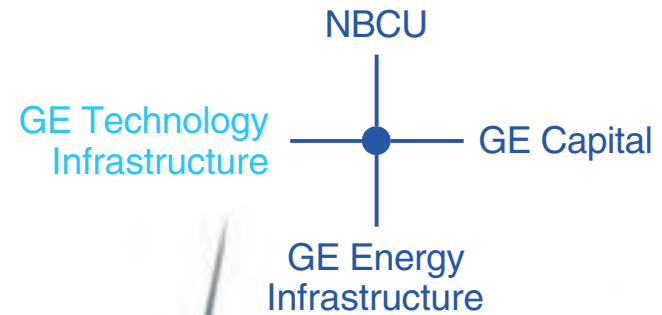


Agenda

- GE Drivetrain Technologies Background
- Anatomy of a Wind Turbine
- Major Component Sourcing
 - Supplier Approval Process
 - Variable of Logistics
 - Supply Chain Outlook
 - Opportunities and Challenges

GE Drivetrain Technologies Background

GE Technology Infrastructure



- Aviation
- Enterprise Solutions
- Healthcare
- **Transportation**



Transportation

2008 Revenue of \$5.2 B

Signaling & Comm



Locomotives



Financial Solutions



Traffic Mgmt Systems



Parts & Service



Propulsion & Specialty Services



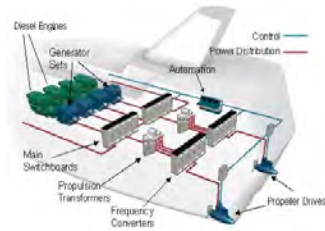
Propulsion adjacencies



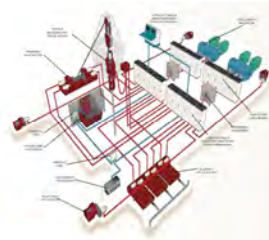
Mining Propulsion



Marine Propulsion



Drill Systems



Wind Turbine Drive Trains



Energy Storage



- Built on GET vital organs ... Engines, AC Propulsion, Generators, Motors, Controls, Gears ... Batteries next
- Leverages system design/control ... technology advantage
- Higher value add ... compete as propulsion system vs. component supplier

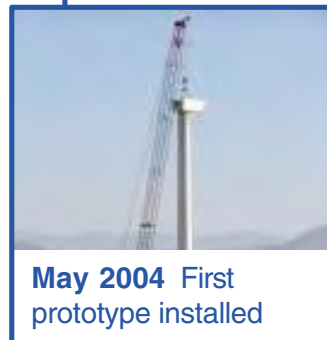
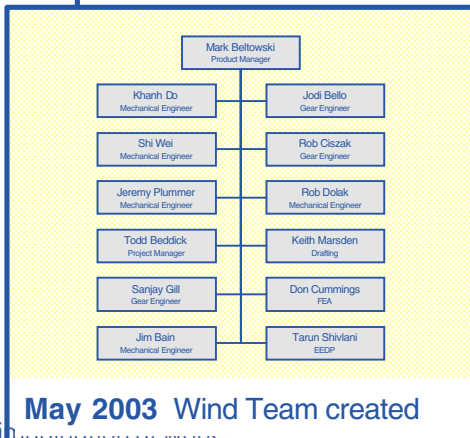
Origin of Drivetrain Technologies



December 2003 Startup of HALT stand with prototypes



January 2005 Three prototypes installed at Trent Mesa, CA



May 2004 First prototype installed

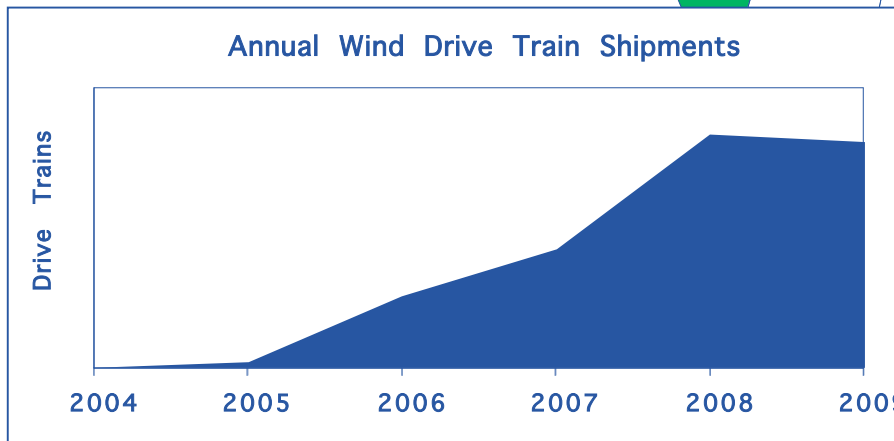
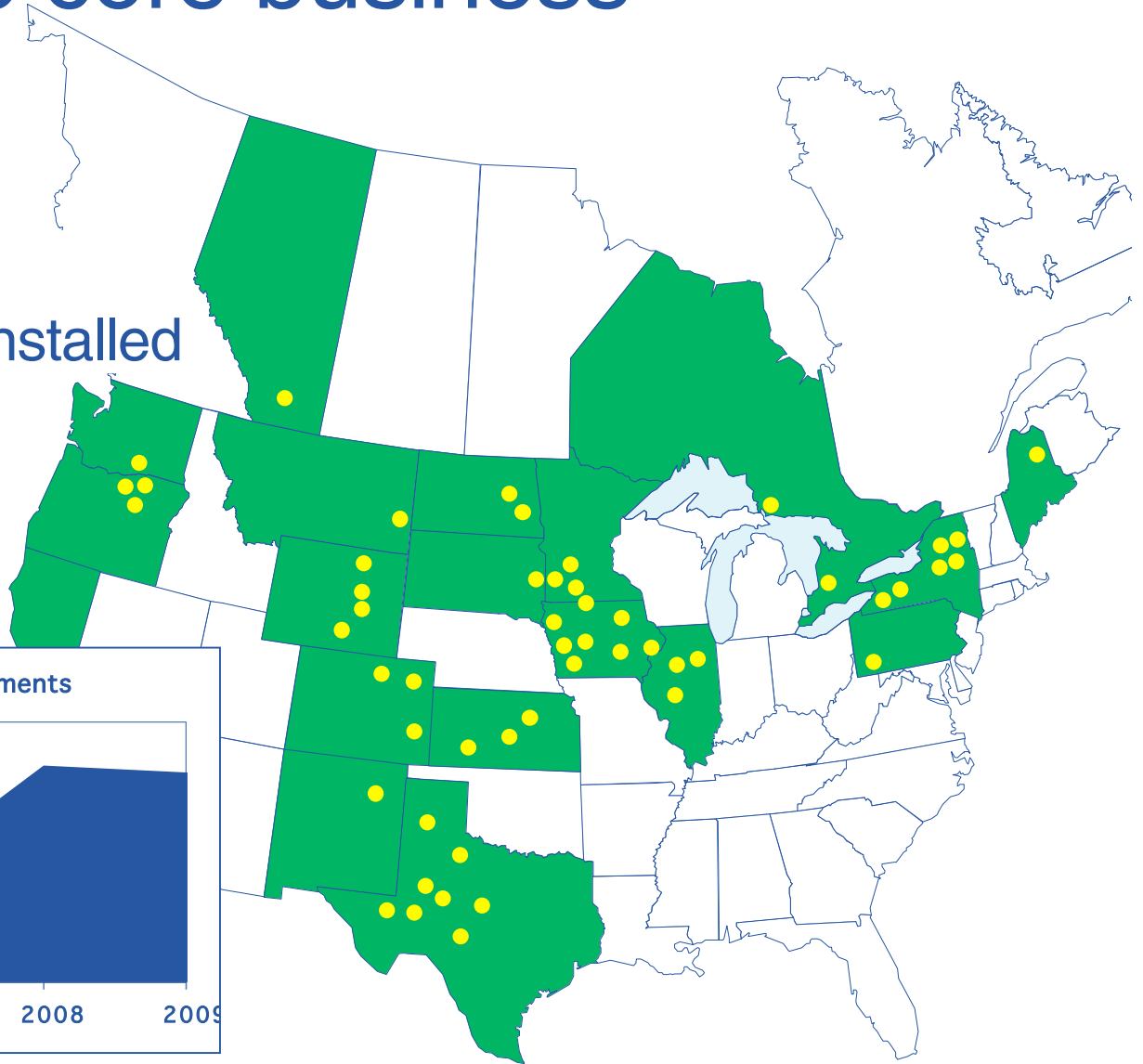


October 2005 First production gearboxes ship



Scaling up the core business

- 53 sites
- 1,611 units installed

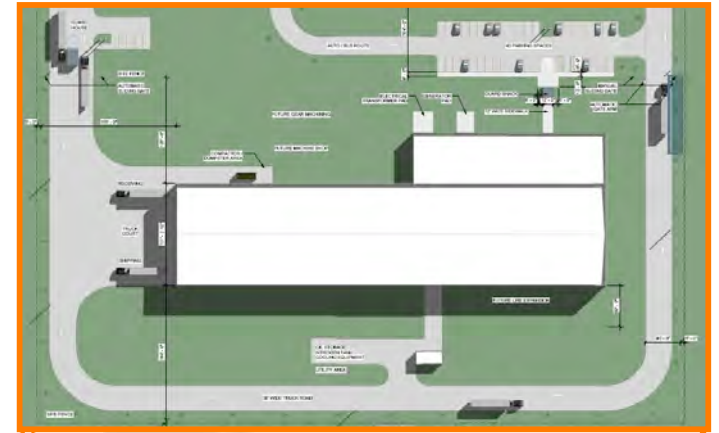


Moving beyond the core ... new customers, gearboxes, and geographies

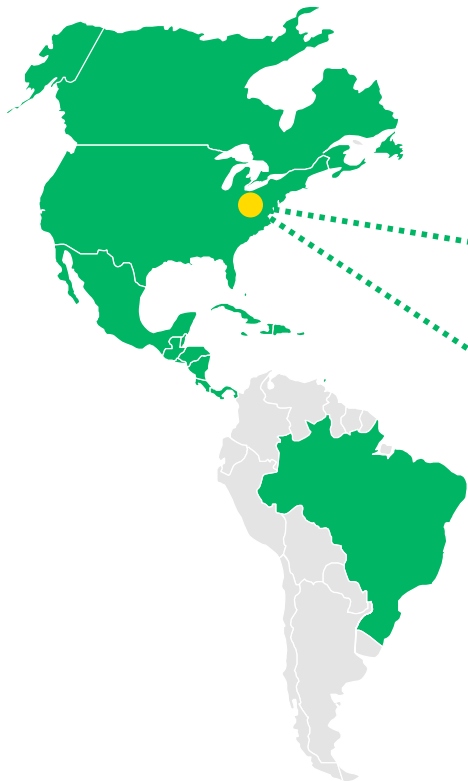


Expanding the manufacturing footprint

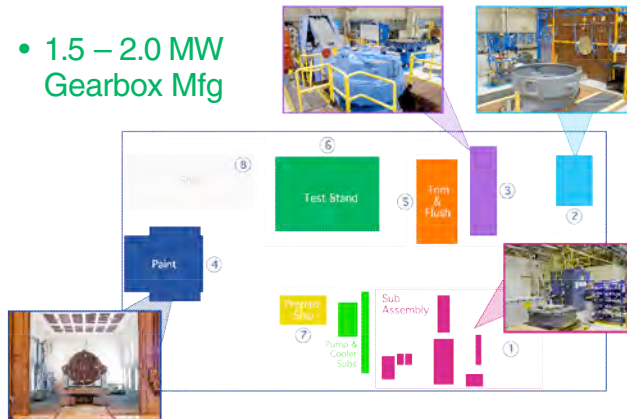
- 2.2 - 5.1 MW Gearbox Mfg
- 3Q 2010 Commissioning



Manufacturing COE
Shenyang - China



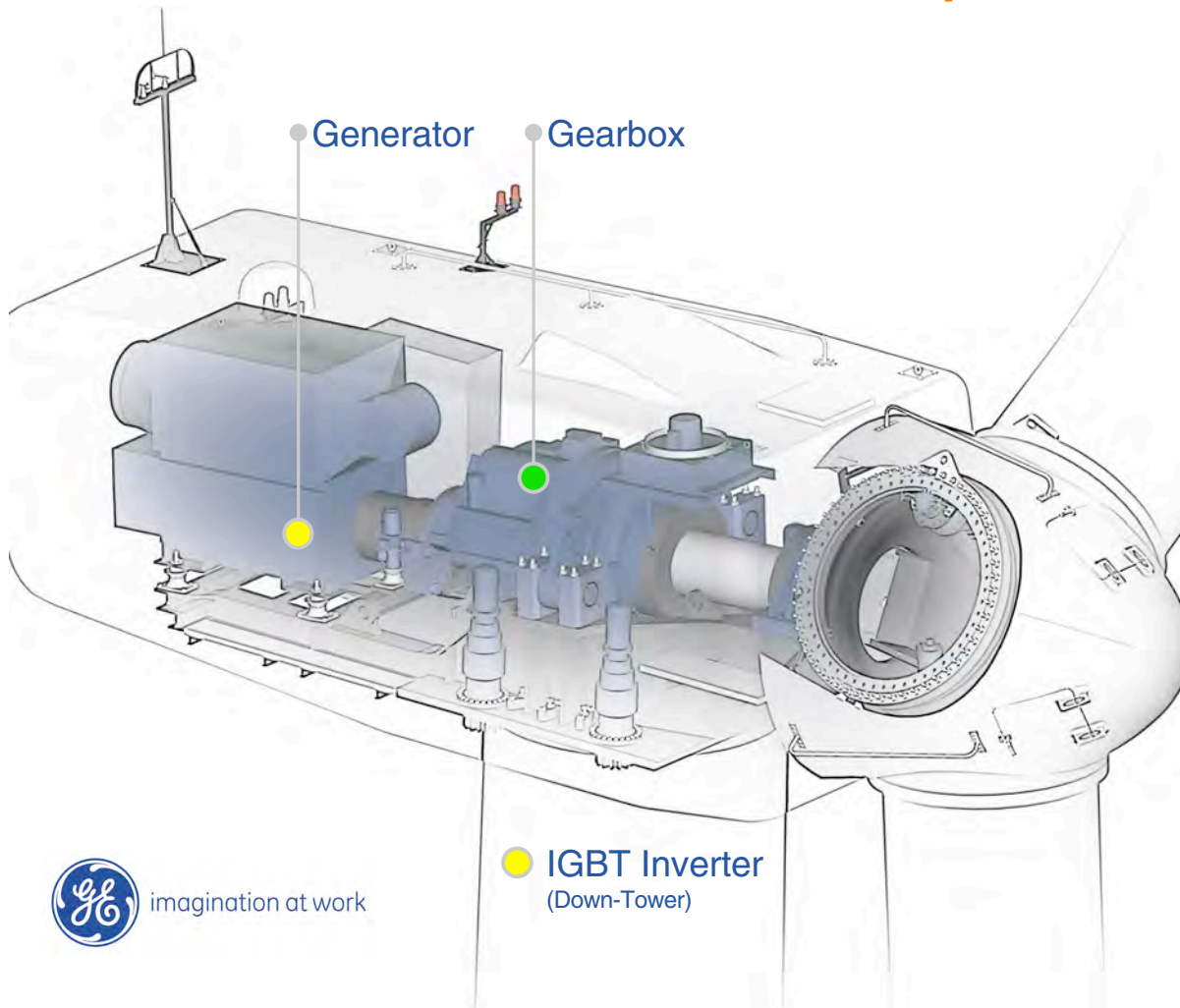
- 1.5 – 2.0 MW Gearbox Mfg



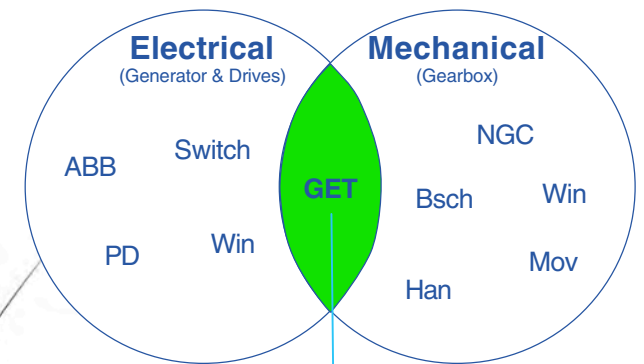
Erie - USA
Manufacturing COE

Moving from component to propulsion system

Gearbox + Generator + Inverter = Propulsion System



Wind Turbine Drive Train Competitive Landscape



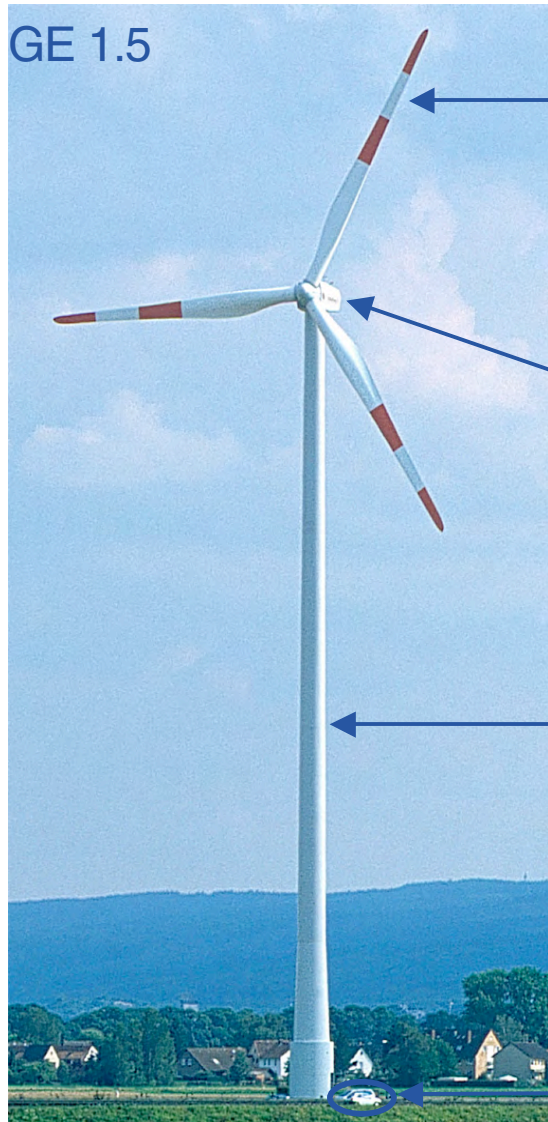
Uniquely positioned based on electromechanical systems integration expertise

Anatomy of a Wind Turbine



imagination at work

Wind Turbine Components



Rotor

35 metric tons
77 meters diameter

Nacelle

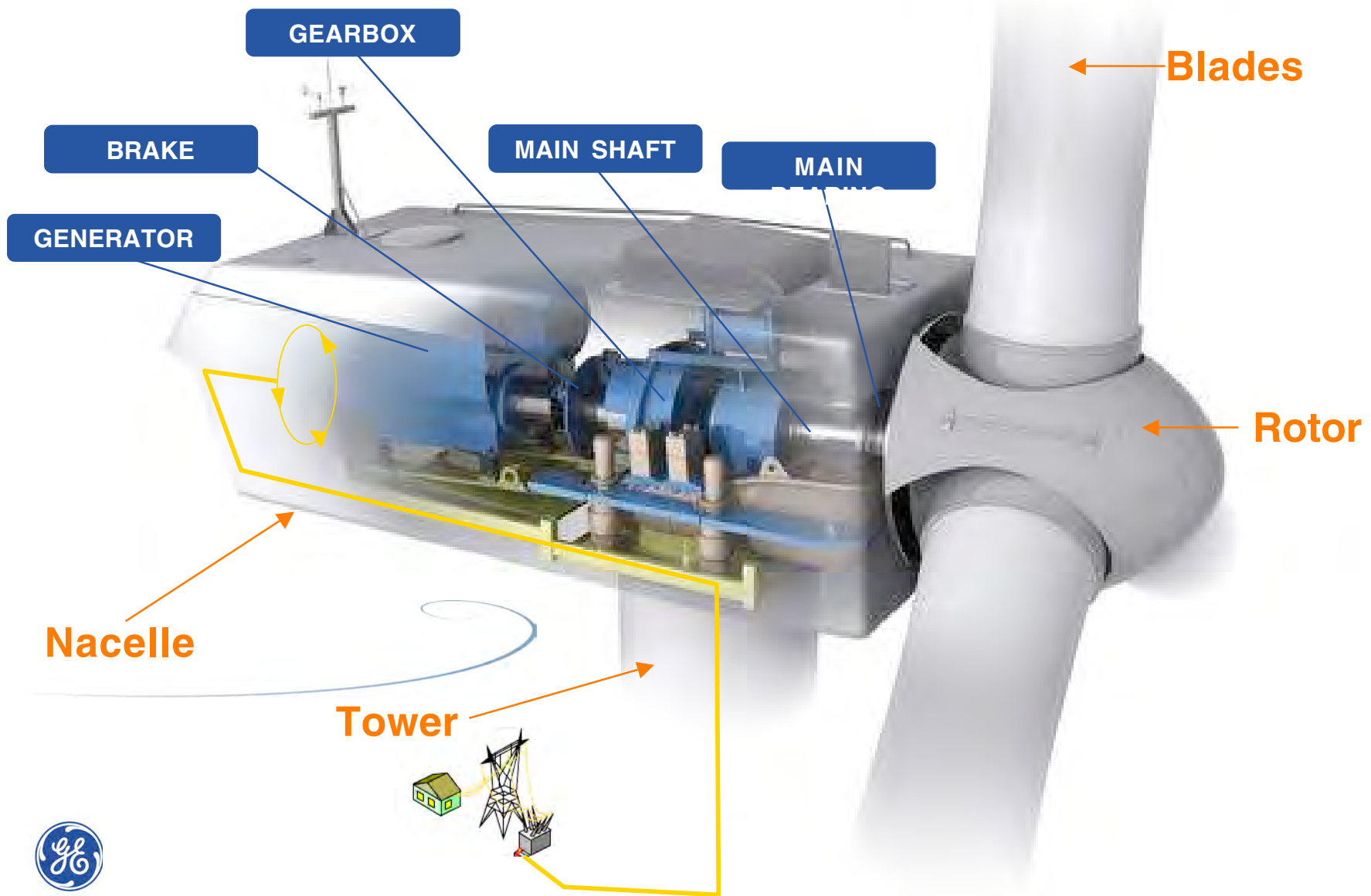
52 metric tons

Tower

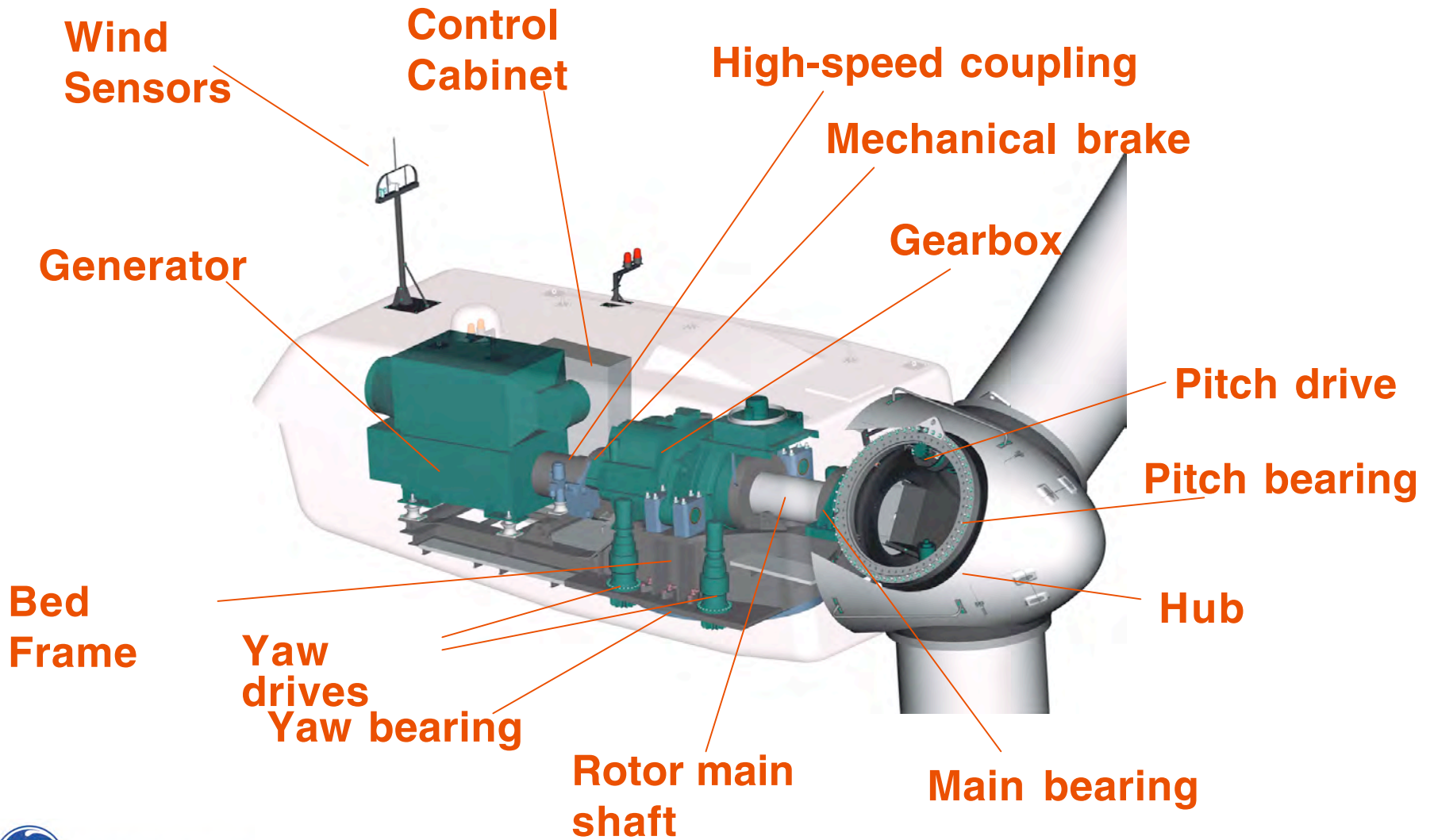
120+ metric tons
60 to 100 meters hub height

Car (for scale)

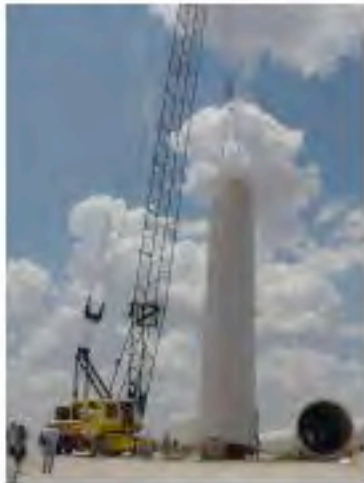
How does it work?



Components in the Nacelle & Hub



Wind turbine installation



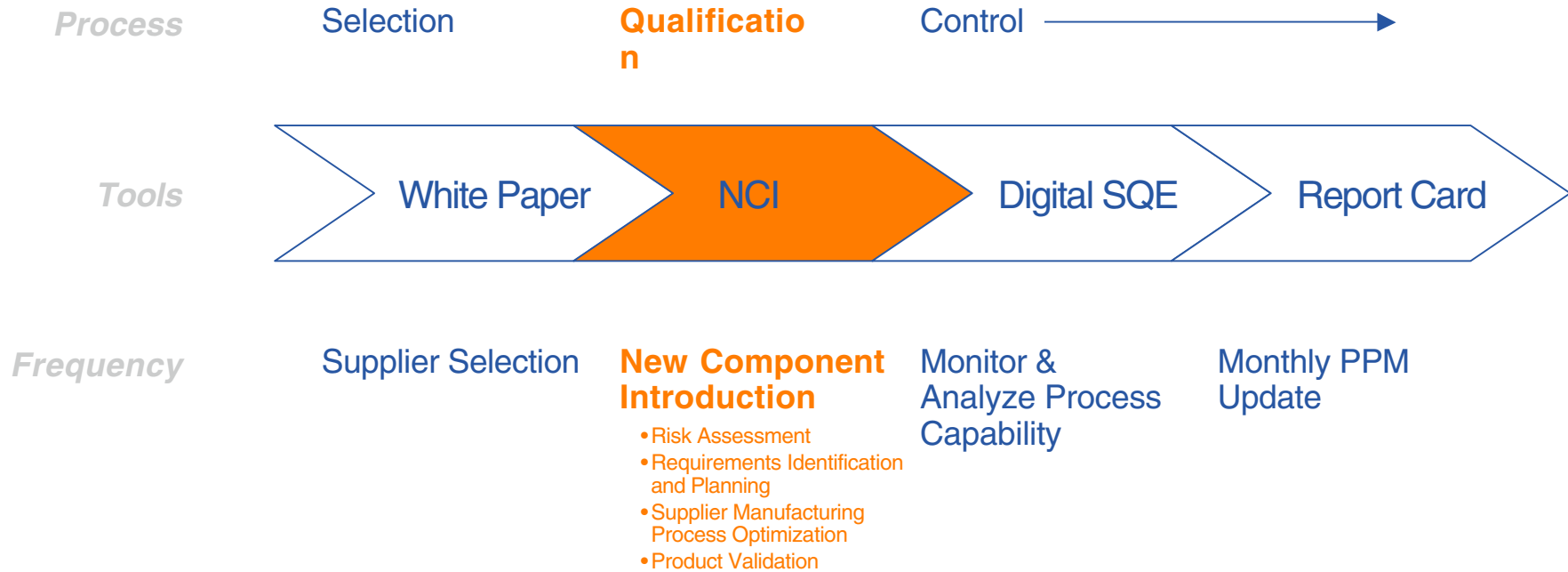
Supplier Approval Process



imagination at work

NCI process drives development of quality parts

GET Supplier Quality Process

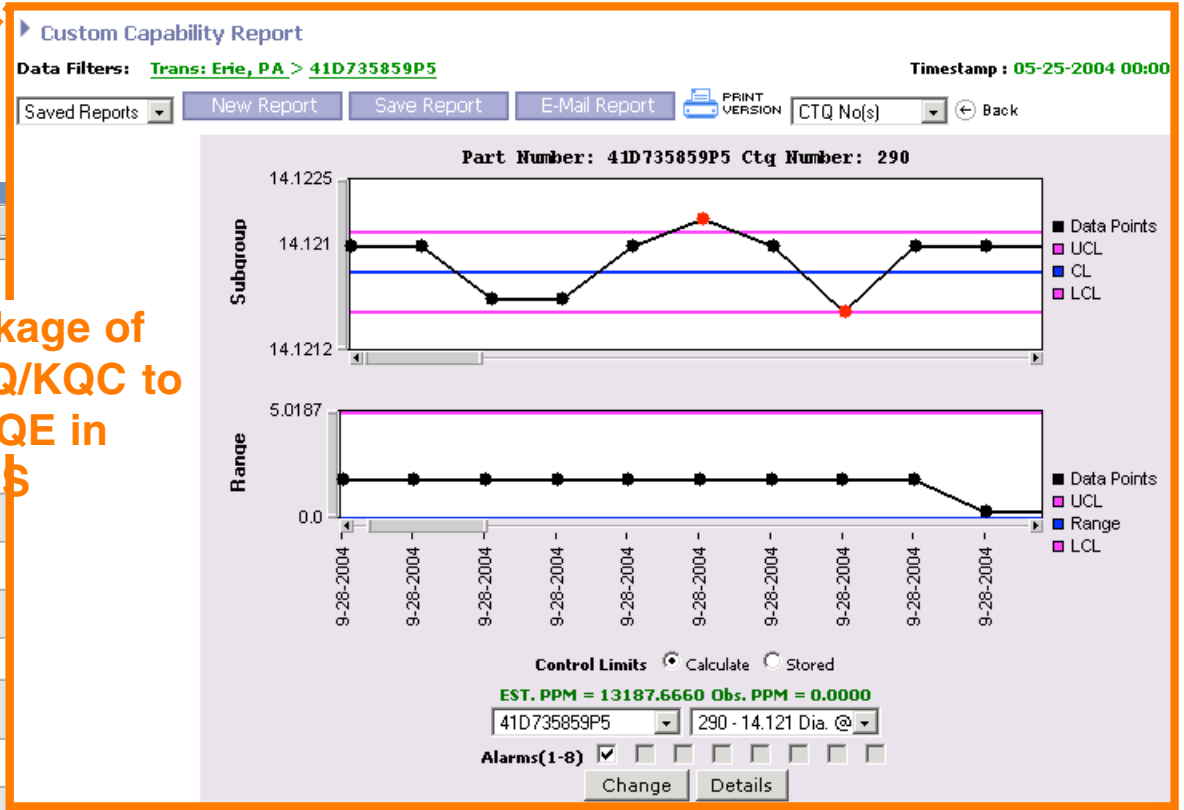


Example ... NCI process step 20A

View High Risk NCI - Microsoft Internet Explorer provided by GE Transportation Systems

Item	Description	Yes	No	Start Date	End Date
18	Implement Corrective Actions	Yes	No	09/23/2004	09/23/2004
19	Implement Validation Plan	Yes	No	09/20/2004	0
A	First Article Inspection	Yes	No	08/18/2004	0
B	Functional Test	Yes	No	08/18/2004	0
C	Subsystem Level Functional Test	Yes	No	09/20/2004	09/20/2004
D	System Level Functional Test	Yes	No	09/20/2004	09/20/2004
E	EQT Test	Yes	No	09/20/2004	09/20/2004
F	Life Test	Yes	No	09/20/2004	09/20/2004
G	Certifications (specify)	Yes	No	08/17/2004	08/17/2004
H	Other Requirements (Defined by SQE and DE)	Yes	No	09/20/2004	09/20/2004
I	Sample Shipped	Yes	No	08/18/2004	08/18/2004
J	Validation/Fit-Up Feedback	Yes	No	08/18/2004	08/18/2004
20	Characteristic Control Plan	Yes	No	08/16/2004	08/16/2004
20A	Set up eSQE in QDW	Yes	No	09/23/2004	09/23/2004
20B	Unusable Material Disposition	Yes	No	08/18/2004	08/18/2004
21	eNCI Complete	Yes	No	Murthy, Keshava P 10/01/2004	10/01/2004

Linkage of CTQ/KQC to e-SQE in QM\$



Variables of Logistics



imagination at work

Logistics facts

- Logistics equal 10-15% of total turbine cost
- Logistics market \$1.1B (2008 est)
- Truck accounts for 85% of shipments
- 36,353 truck hauls for wind projects (2008 est)
- Logistics deficiencies limits wind growth

Source: MAKE Consulting, Professional Logistics Group



Logistics for one turbine

8 unique hauls

- One nacelle
- One hub
- Three tower sections
- Three blades



Logistics for one 150MW project

- 689 truckloads
- 140 railcars
- 8 ships



Green Mountain Wind Farm, Fluvanna, Tx
Source: AWEA

Logistics challenges

	Nacelles	Towers	Blades
<u>Dimensions</u>			
Size	28.5 x 11.6 x 11.5 ft	240 ft	110 feet
Weight (lbs)	50 – 70 tons	170 tons	6 – 7 tons
<u>Constraints</u>			
Weight	Yes	Yes (large base sections)	No
Dimensional	Yes	Yes	Yes

- Height, weight, width, and length limitations
- Growing turbine size exceeding equipment capacity
- Limited number of trailers and rail cars
- Increasing logistics costs + 10-25% to turbine cost

Inefficiencies add to project cost

- \$ Carrier demurrage at origin or site
- \$ Lost crane productivity
- \$ Construction delays
- \$ Opportunity cost of commissioning delays
- \$ Storage while awaiting installation

Opportunity for logistics and equipment companies that can satisfy over-sized load requirements

Supply Chain Outlook



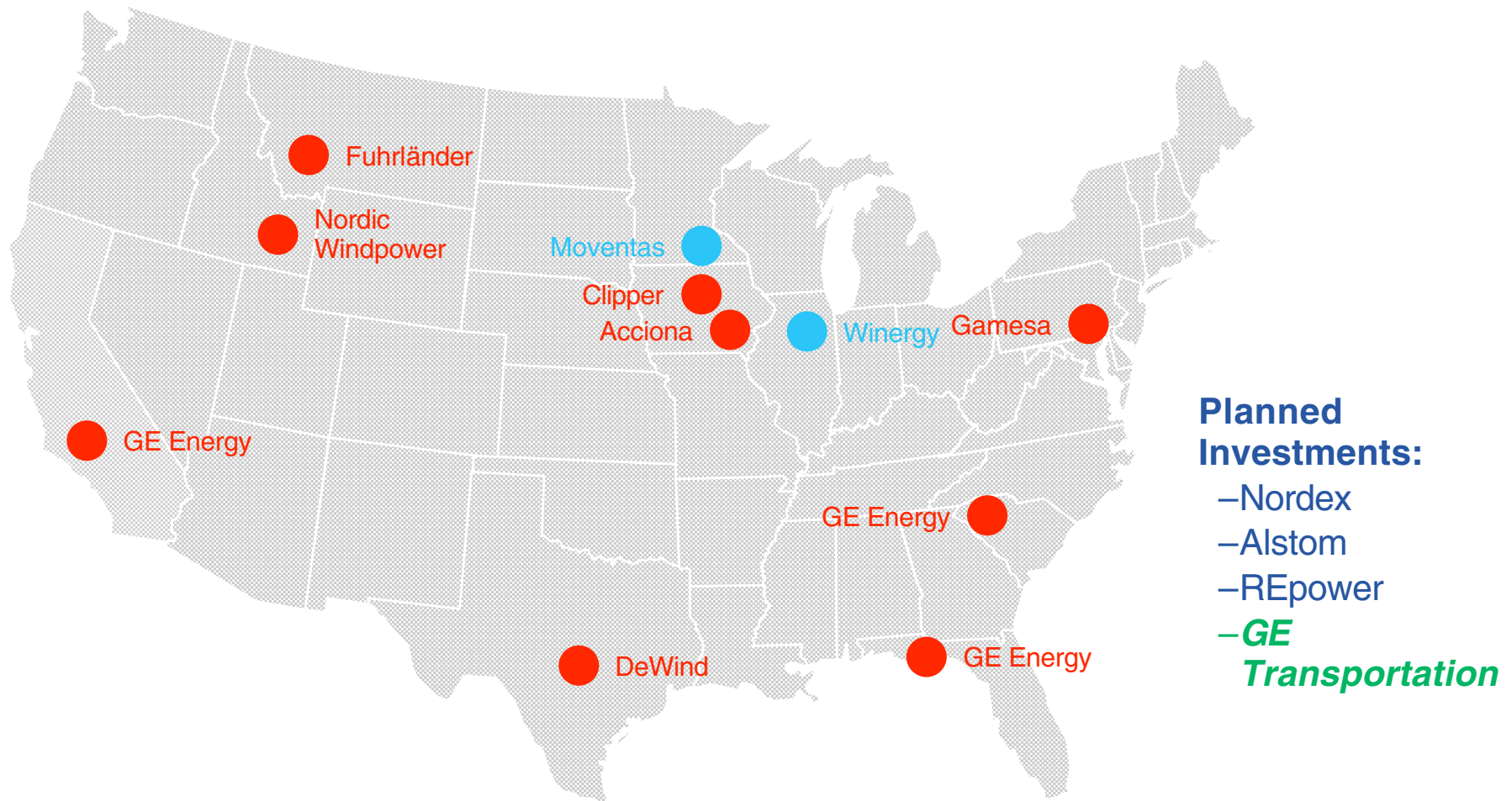
imagination at work

Global overview

- Key component shortages in previous three years
 - Gearboxes
 - Bearings
 - Castings
- Balance has shifted to overcapacity
- Highest growth markets in N.America and China
 - China: many new co's
 - NA: supply chain stretched



Supply chain investments reflect industry belief in future of N.A. market



NA overview

- Component gap exists between supply & demand (growth mode)
- Imports support NA market
- NA mfg base needs to expand to support expected growth
 - Gearboxes
 - Bearings
 - Generators
 - Castings

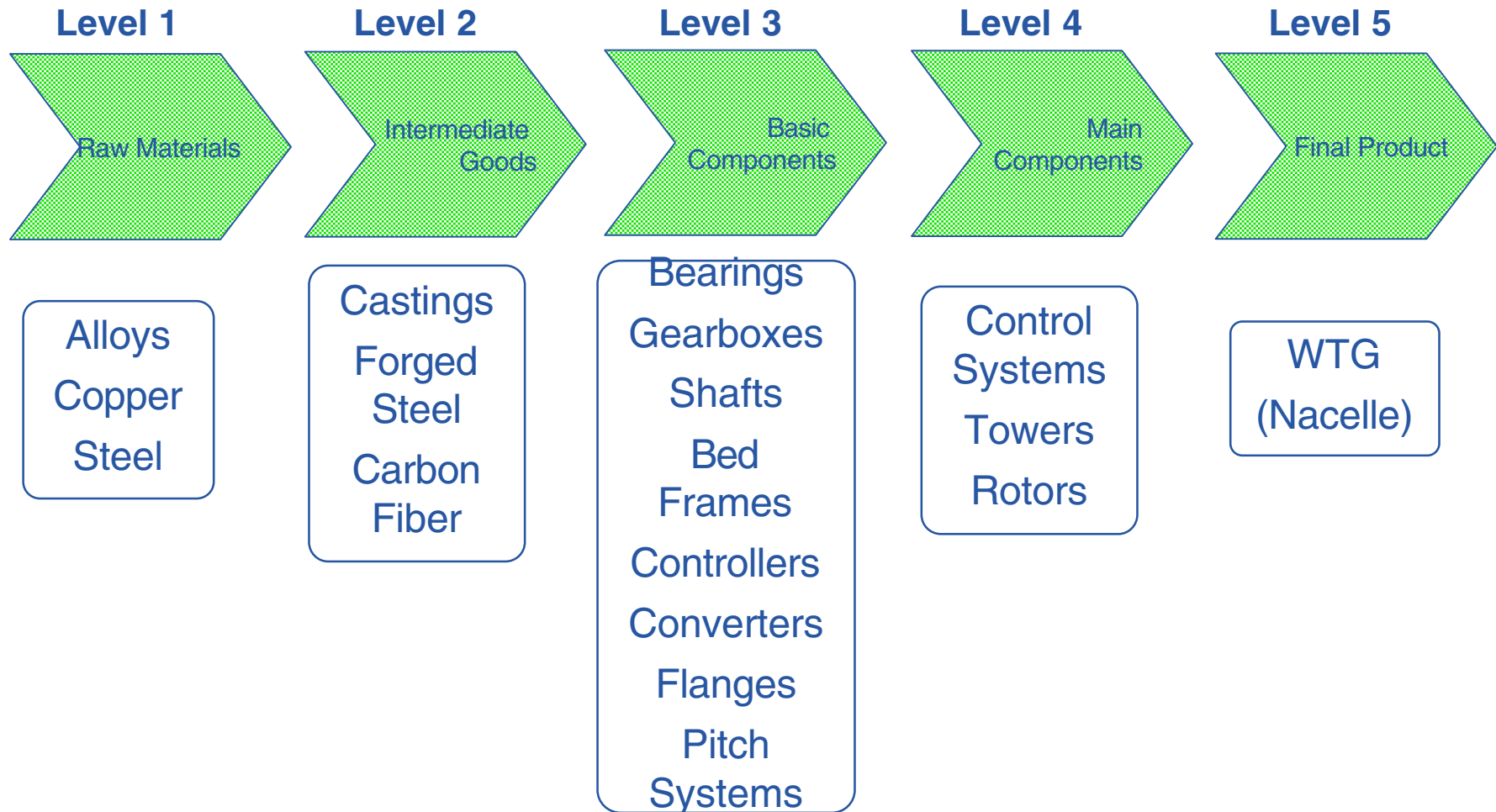


Opportunities and Challenges



imagination at work

Supply chain summary



Sourcing strategies vary

	Towers	Blades	Generators	Gearboxes	Control Systems
Alstom	0%	0%	0%	0%	90%
Enercon	50%	100%	100%	N/a	100%
Gamesa	40%	90%	30%	20%	100%
Siemens	20%	90%	10%	80%	20%
Vestas	30%	80%	20%	0%	100%

Source: MAKE Consulting

Percentage of goods in-sourced

Opportunities for NA suppliers

- Logistics advantage
- NA market poised for growth
- Strong market fundamentals
- Market developing
 - Off-shore
 - Bigger turbines



Challenges for NA suppliers

- Price
 - Global overcapacity
 - Labor costs
- Quality
 - 20 year design life
 - Market still “young”



Questions

Pat Timon
Senior Service Manager
814.875.3553
patrick.timon@ge.com



imagination at work