

Structure of Wind Supply Chain – Onshore to Offshore



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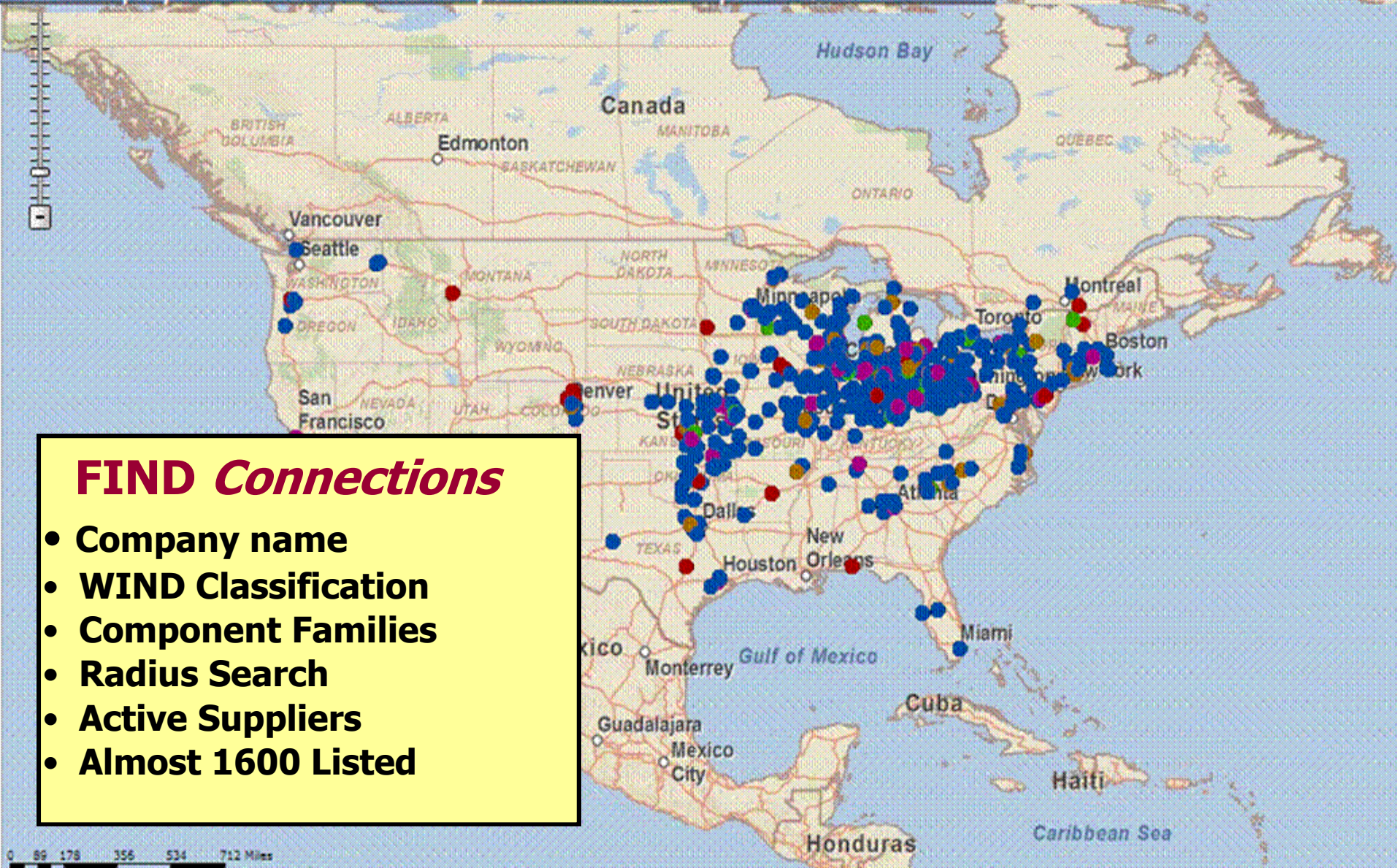


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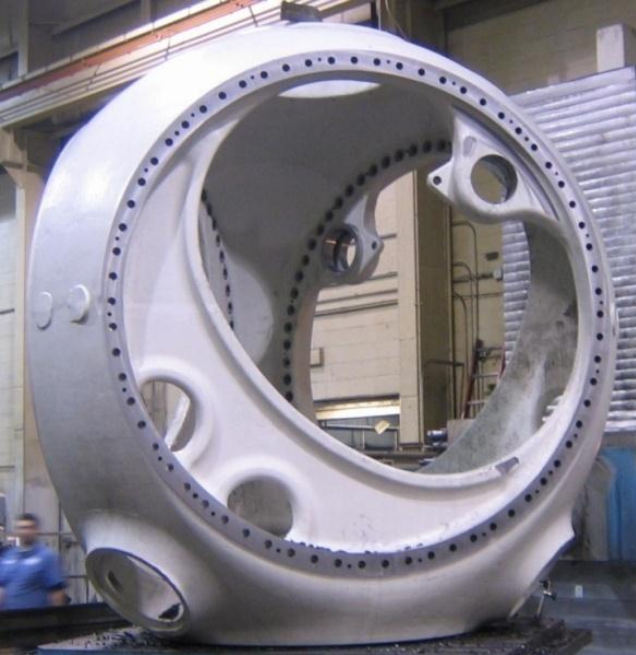


Search Company Name | Search Wind Industry | Search Turbine Components | Find Near



FIND Connections

- **Company name**
- **WIND Classification**
- **Component Families**
- **Radius Search**
- **Active Suppliers**
- **Almost 1600 Listed**



Today's Session

Structure of the Supply Chain

■ Who buys *What*?

- Original Equipment (turbines)
- Project Construction
- Operations and Maintenance

■ Tips for Wind Suppliers

■ Interactive Supply Chain Q&A

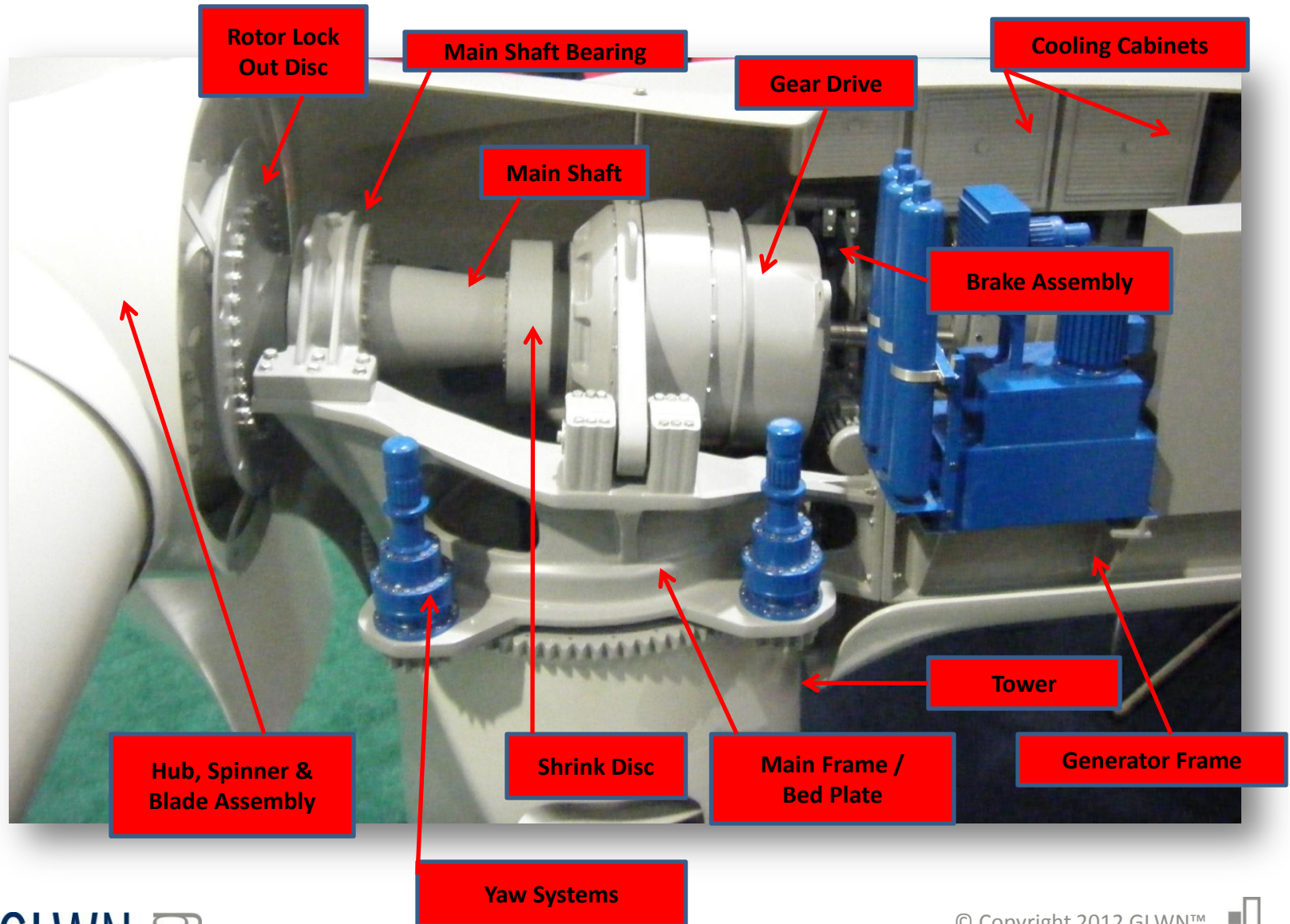


Original Equipment: Wind Turbines

- ◆ Wind Turbine Companies:
Manufacturers(?)



Machine Head / Nacelle



What do OEMs buy Direct?

Direct Purchase – Tier 1

Foundry	Forge	Machine Shop	Fabricator
Bases Housings Hubs	Main Shafts Shrink Discs Yaw Gears Large Fasteners	Bases Housings Hubs Main Shafts Retainers Seal Labyrinths	Brackets Plates Rear Frames Structural Supports

Tier 2 and Tier 3

Various component/service suppliers: Fabricators → Machine Shops → Coaters
 Machine Shop → Metalizing → Epoxy

What else do OEMs buy

Direct

Direct Purchase – Tier 1

Electrical & Electronics

Bus Bars
Cables, Wires, Etc.
Cabinets
Controls
Electronic Components
Harnesses
Heating Elements
Instrumentation
Lighting
Motors
Sensors
Software

Hydraulics

Accumulator
Ducting
Filters
Heat Exchangers
Hoses
Lube Systems
Motors
Pumps
Rotary Unions
Seals
Valves

Composites

Insulators
Spinner Covers
High Speed Shaft

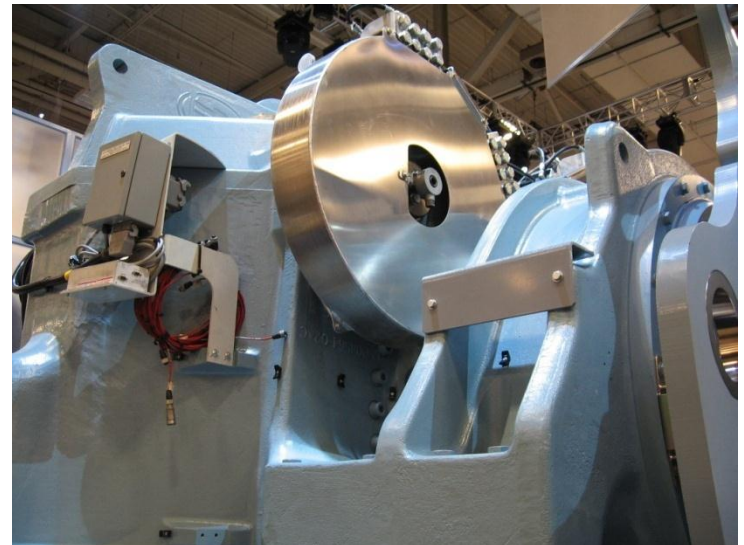
Miscellaneous

Packaging
Plastic Components
Rubber Components
Signage
Transportation &
Logistics Frames

What do OEMs Buy from Integrators

From Integrators

- ◆ Bearings
- ◆ Brake Systems
- ◆ Generator/Transformer
- ◆ Gearing & Drives
- ◆ Towers
- ◆ Blades
- ◆ Nacelle Structure



Integrator

TOWER Supply Chain

Tower Manufacturer – Focused Fabricator

- **Steel mills** - plate
- **Fabricators** – Tower Top
- **Forges** – Flanges
- **Small Components**

Door frames

Fasteners

Platforms

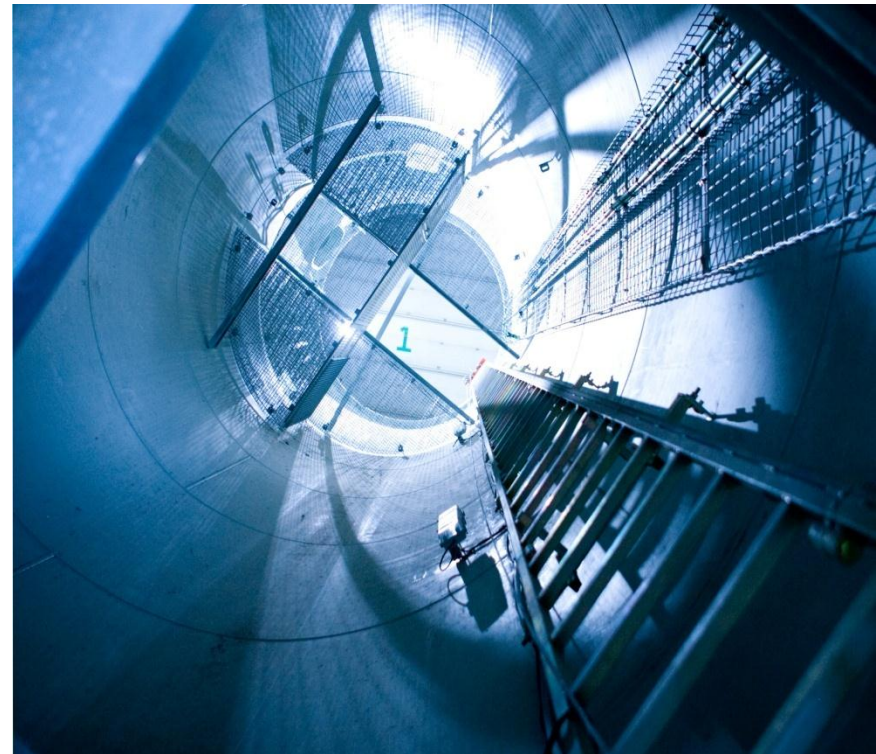
Electricals

Ladders

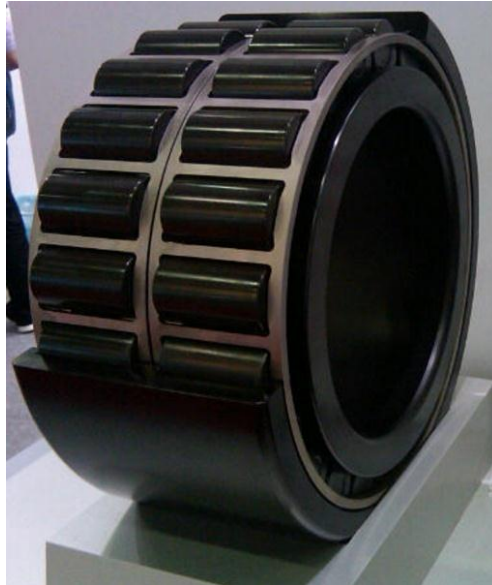
Coatings

Lighting

Cable



Main, Pitch & Slew Bearings



2nd, 3rd Tier Opportunities

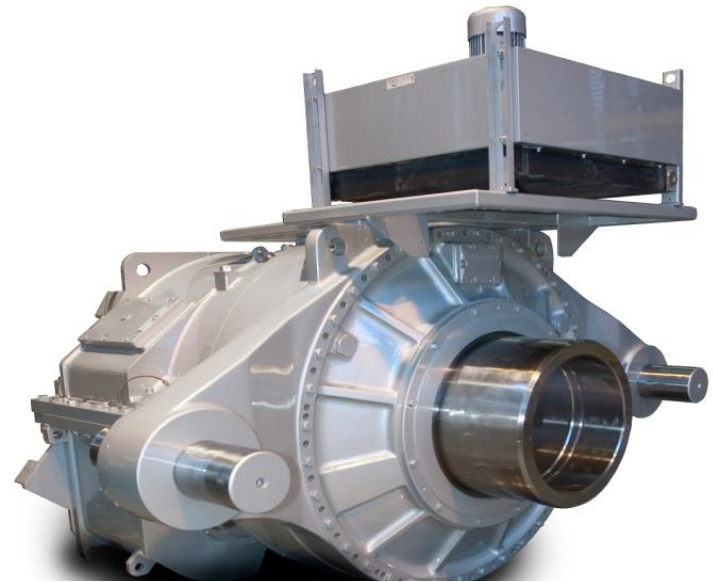
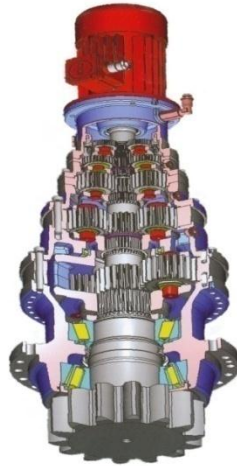
Roller Elements Forged Rings

Seals Lubricating Systems

Lubricants



Gearing and Drives



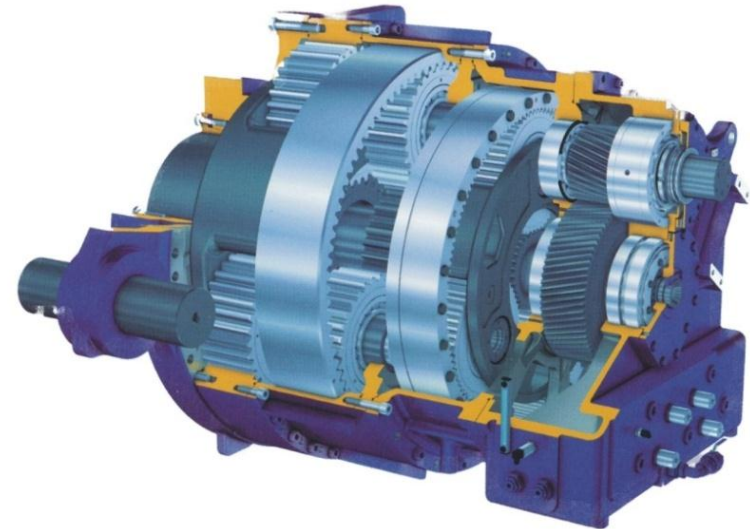
2nd, 3rd Tier Opportunities

Actuators Bearings Brakes

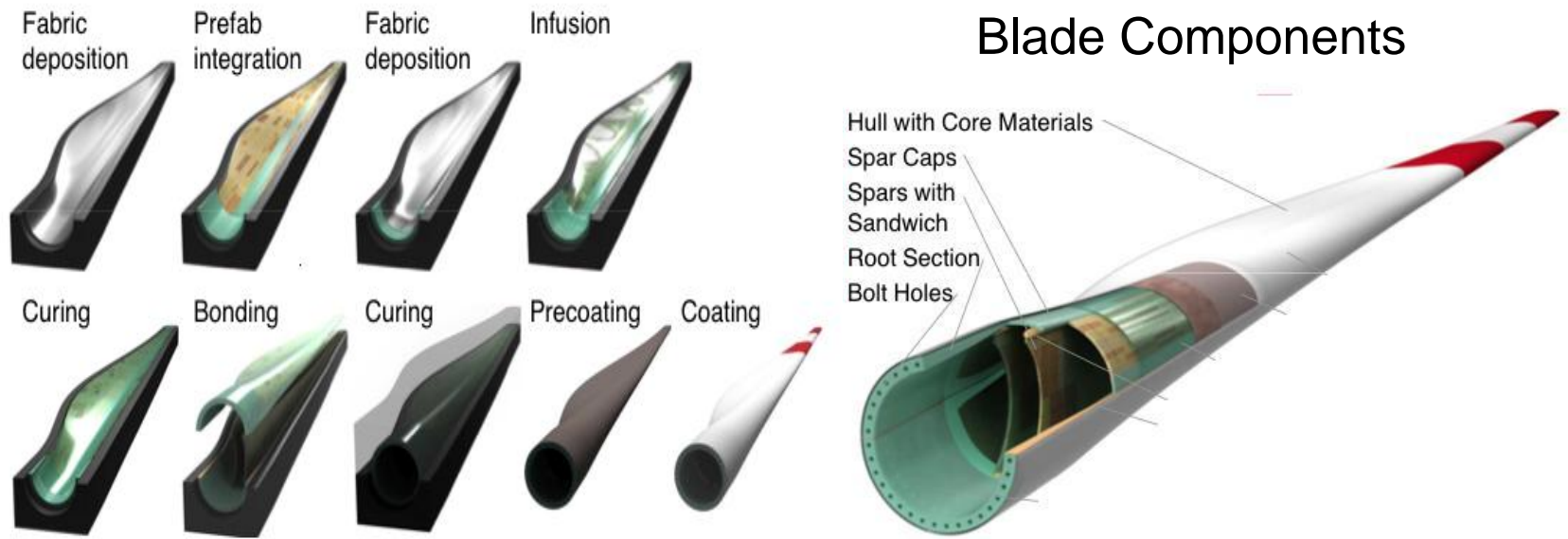
Cooling Systems Drive Motors

Gears Housings Lube Systems

Pitch Drive UPS Shafts



Wind Turbine Blades



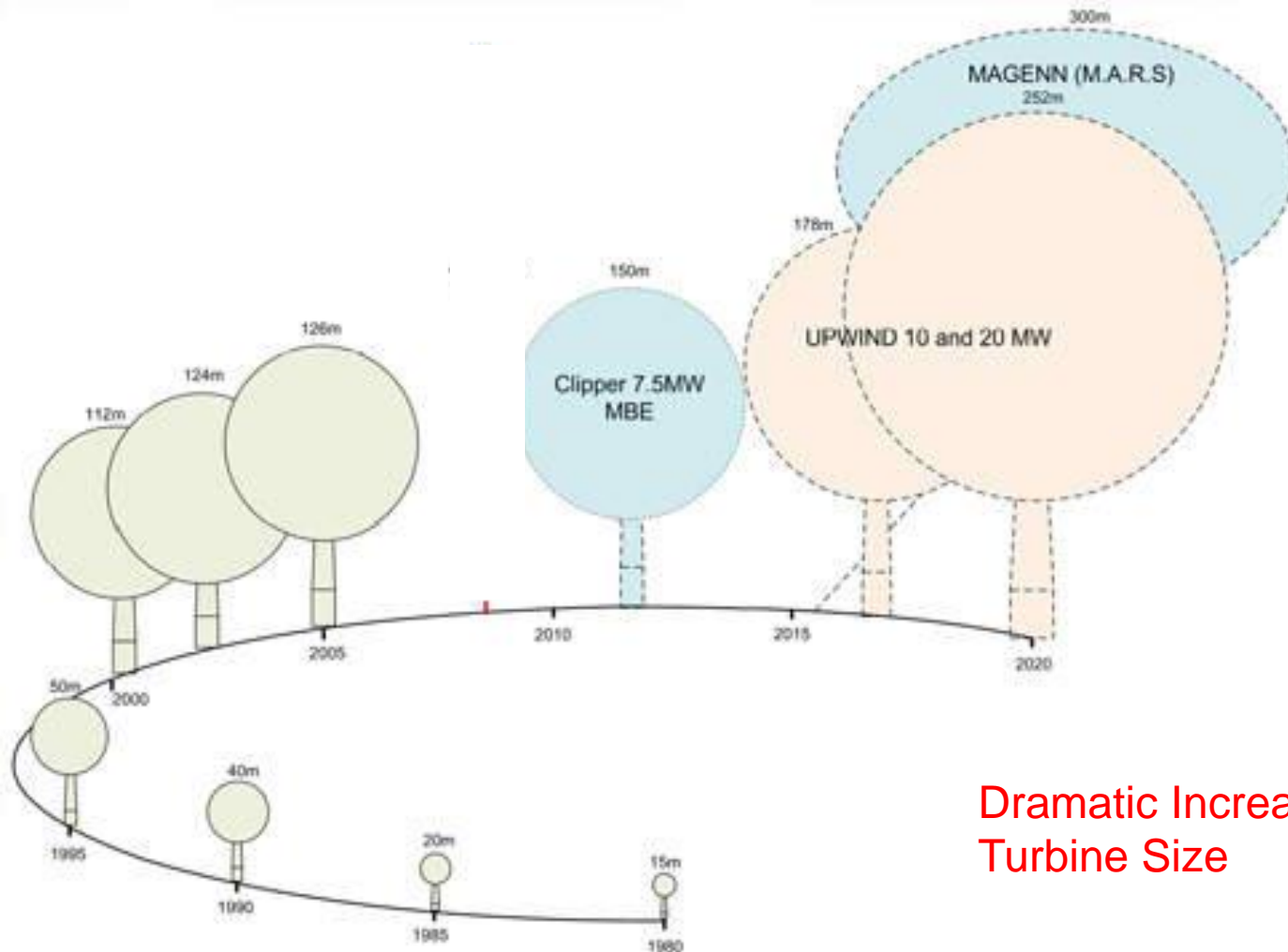
Credit: BASF Corporation

2nd, 3rd Tier Opportunities

Core Materials Fiber glass Carbon fiber Mesh Resins
Protective Films Dispensing/Dispensing/Vacuum Equipment
Coatings Lightning/Grounding Barrel Nuts Studs



Onshore vs. Offshore



**Dramatic Increases in
Turbine Size**



Project Construction: Onshore



Who is Developing?

- Single Landowners
- Landowner Collaborations (formal & informal)
- Developers who sell partially developed assets
- Developers who develop, build, and sell
- Developers who develop, build, sell, and operate
- Utilities who develop, build and operate



Foundation Construction

Customer: BOP or General Contractor

- ◆ Rebar: 20 - 50 tons of steel per foundation
- ◆ Concrete: 250-500 cy each
- ◆ Fabrication: Embed Rings
- ◆ Forging: Anchor Rods



Construction Supply Chain

Customer: BOP or General Contractor

- ◆ Electrical Systems
 - Cabling/Connectors
 - Transformers
 - Substations



More Manufacturing Opportunities



Customer: OEM, BOP or GC

Fabricators:

Shipping Fixtures

Structural Steel



Project Construction: Offshore



Wind Farm Construction Offshore



Customer: Developer or BOP

Foundations

- Monopile
- Gravity
- Tri-Piles & Tripods
- Floating

Dock
Worker



Offshore Monopile

Customer: Developer



Fabricator

300 – 700 Tons
of Steel Plate

Processing
Cut
Rolled
Welding
Grist Blast
Coating



Gravity Foundation

Customer: Developer



Fabrications: Welded Rings
Skeletal Structure

Concrete

Steel Molded Form (reusable)



Tri-Piles and Tripods

Fabricator

- Rolled, Welded Cylinders
- Fabricated Steel Plate
- Submerged arc welded

Specialty Coater

- Anti-corrosion coatings



Electrical Infrastructure

Customer: Developer

Transformers/Substations



Submarine Cable



Installation Vessels

Transport and Installation Requirements

- ◆ 30 Vessels per GW

Most require US manufacture



Equipment Transport Vessels



SBM GustoMSC
OFFSHORE

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Installation Vessels



Foundation Installation Vessels



Ocean Jack-up Vessel – BARD – Wind Lift 1 in Europe



Length hull	93.0 m
Breadth hull	36.0 m
Depth hull	7.4 m
Displacement	>20,000 t
Max water Depth	45.0 m

Shipyard Heavy Fabrication
4 Diesel Generators 1,600kW
1 emergency diesel 536 kW
31 m Main crane
70 m Aux. crane
71 m long pinned legs
Accommodations 50 POB
Helideck



Installation Vessels



Operations and Maintenance: Onshore



Operation & Maintenance Scope

- Uptower
 - Oil, Filter, Coolant & Brake Changes, Brushes
 - Preventative Maintenance
 - Inspections – Vibration, Borescope, Infrared, Oil
 - Regular cleaning
- Downtower
 - Major repairs – Gearbox, Generator, Blades
 - Substation



Operations and Maintenance Offshore



Support Vessels



Support Vessels: Mother Ship



<http://www.towingline.com>



Support Vessels

- Offshore Operations & Maintenance Costs:
- Up to 5X Onshore Farms
 - Comparable to cost of Turbine



Market Entry Tips

Find your Fit

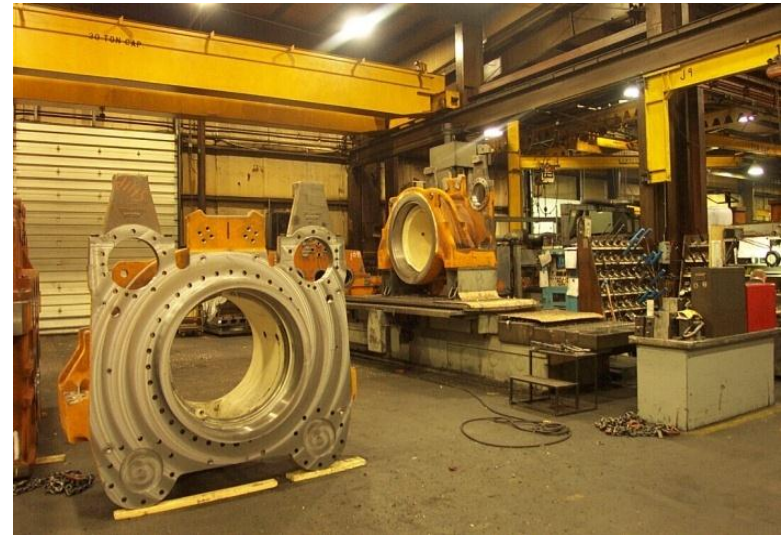
- What's needed?
- What can we make?
- Which Markets/Tiers are best for us?

Invest in Robust Operations

- Quality Systems
- Multiple Processes
- Flexible & Responsive
- Location-Location-Location

Market your company

- ID the buyers (events, networking, websites)
- Differentiate yourself (what makes us special?)
- Develop Partners
- DIG DIG DIG**



Roundtable Q&A Session

Leaders-topics

- ◆ Dan Renshaw-Turbines
- ◆ Tim Ryan-Developer
- ◆ Neil Rondorf-Maritime Engineering
- ◆ Tom Weinandy-Electrical
- ◆ Joe Cerchiaro-Steel and Fabrications
- ◆ Hank Reichart-O &M

Rules

- Introduce yourself
- Share your interests
- Openly discuss
- Law of Two Feet:
 - ***Move when its time***



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