Retooling for Wind – Onshore to Offshore -- SECWC March 8-9, 2012

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Agenda Manufacturing Workshop

March 8, 1:30 – 3:00

- 1:30 Offshore/Onshore Wind Business Opportunities for Manufacturers in Southeast Region and Global Trends Driving Market Demand for Key Components – Patrick Fullenkamp, GLWN
- 2:15 Gamesa Offshore Wind Turbine Project – Dan Renshaw

March 9, 8:30 – 10:00

- 8:30 Offshore/Onshore Wind Supply Chain Structure, How to get engaged – Ed Weston, GLWN
- 9:15 Round Table Discussions: "What are manufacturers needs and concerns to prepare for this new Offshore Business?
  - Wind Turbine OEM – Gamesa, Dan Renshaw
  - Offshore Developer – APEX Offshore Wind, Tim Ryan
  - Engineering – SAIC, Neil Rondorf
  - Vessels – Stevens Towing, Benjamin Smith
  - Electrical Infrastructure – ABB, Tom Weinandy at Baldor Industry
  - Heavy Fabrication

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Topics to be covered

- Onshore
  - History
  - Update on What's Happening Now
  - Description of Forces and Major Players
- Offshore
  - OEM and Manufacturing Drivers – Offshore vs Onshore
  - Opportunities: Ports, Foundations, Vessels, Turbines
  - USA Offshore Project Summary
  - SE Region Offshore Projects
  - How to maximize US SE Regional Supply Chain

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GLWN……*Call us Global*

- **Membership-based, Non-Profit**
- **International Supply Chain Advisory Group**
- **1600 companies across 35 States + Canada**
- **Supplier Headhunters for the Wind Industry**
- ***Resource* for Suppliers and Service Providers**
- **Mission:**

  -Localize New Business Opportunities

  -Increase the Domestic Content of North America's Wind Turbines

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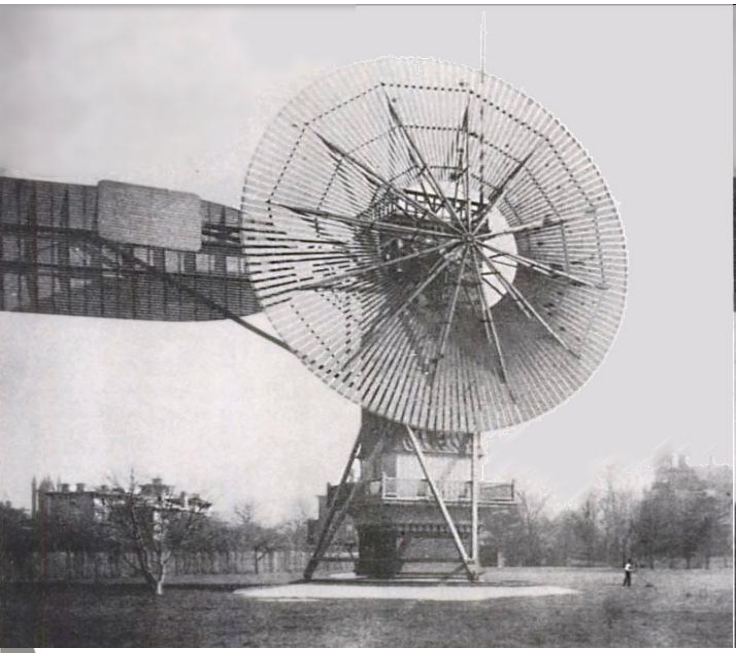
Wind Turbines: An American Invention



Charles Brush Cleveland, OH
12 Kilowatts 1888

NASA Oahu, HI
3.2 Megawatts 1980

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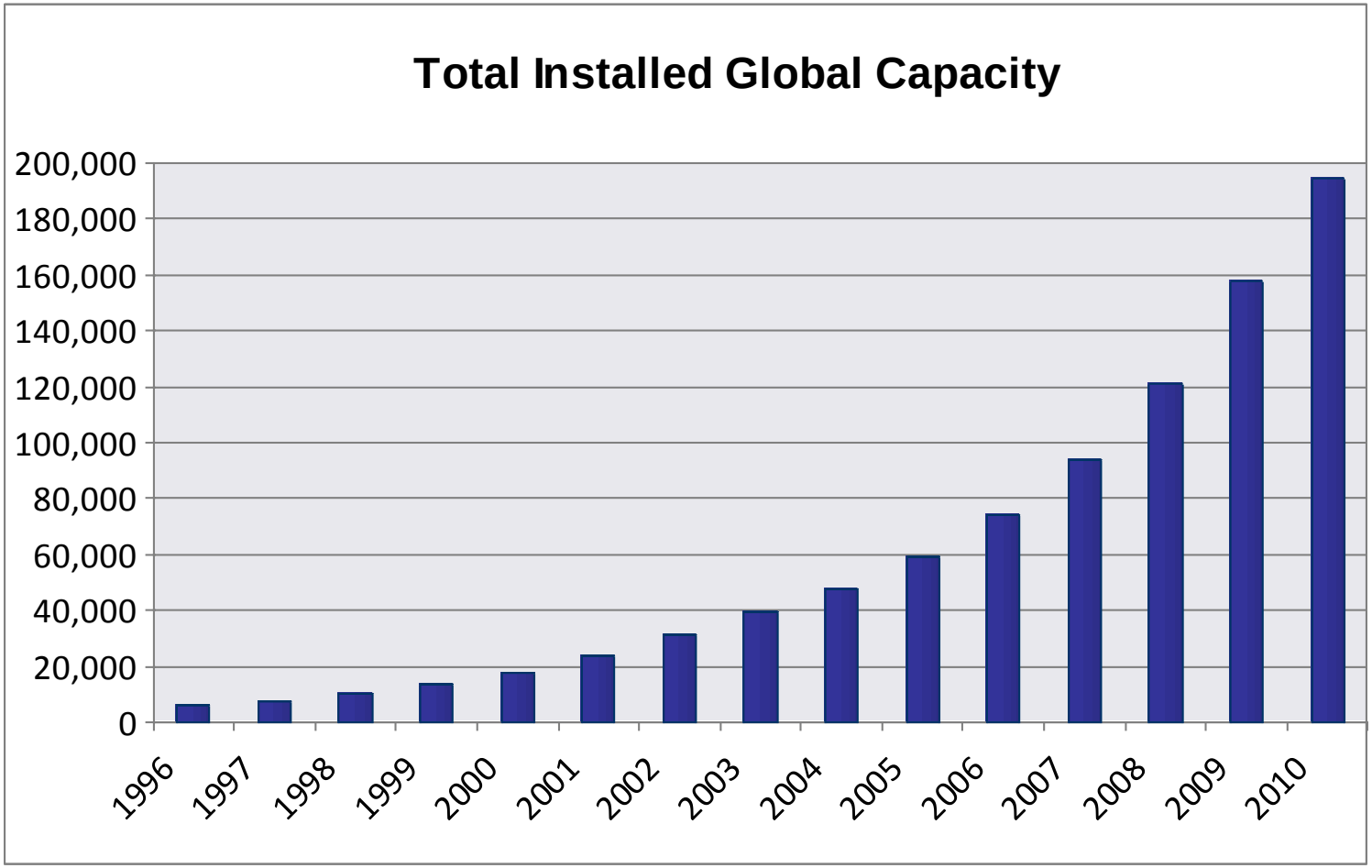
People Want Windpower



Source: *GWEC*

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US and China Lead World

New Installed Capacity (2011)

	MW	%
China	18,000	43.6
USA	6,810	16.5
India	3,019	7.3
Germany	2,086	5.0
UK	1,293	3.1
Canada	1,267	3.1
Spain	1,050	2.5
Italy	950	2.3
France	830	2.0
Sweden	763	1.9
Rest of the World	5,168	12.5
World Total	41,236	100

Cumulative Capacity (2011)

	MW	%
China	62,733	26.3
USA	46,919	19.7
Germany	29,060	12.2
Spain	21,674	9.1
India	16,084	6.7
France	6,800	2.9
Italy	6,747	2.8
UK	6,540	2.7
Canada	5,265	2.2
Portugal	4,083	1.7
Rest of the World	32,446	13.6
World Total	238,351	100.0

Source:GWEC

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How much is 6.81 Gigawatts?

- 6,810 MW or 6,810,000 kW **1.8 million homes**
- OE Parts for 3,680 Turbines **$4,750,000,000**
  - New Towers **$ 1,287,000,000**
  - Gears, Shafts **$ 257,000,000**
  - Fabricated Frames **$ 44,000,000**
  - Roll-threaded studs **$ 37,000,000**
- Balance of Plant
  - Cubic Yds Concrete **1,080,000**
  - Pounds of Rebar **204,000,000**

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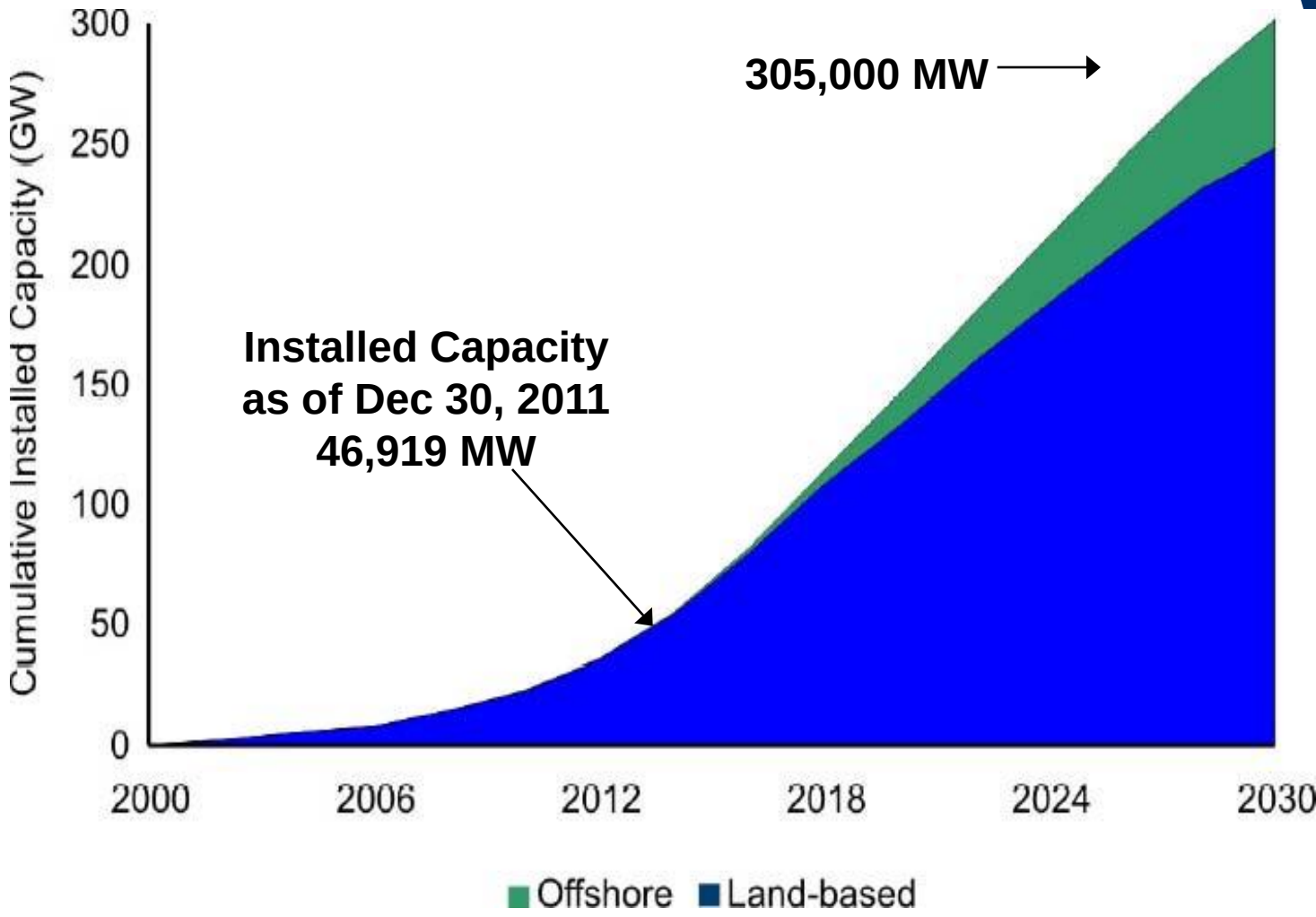
U.S. 20% Wind Scenario



Source: US DOE: 20% by 2030

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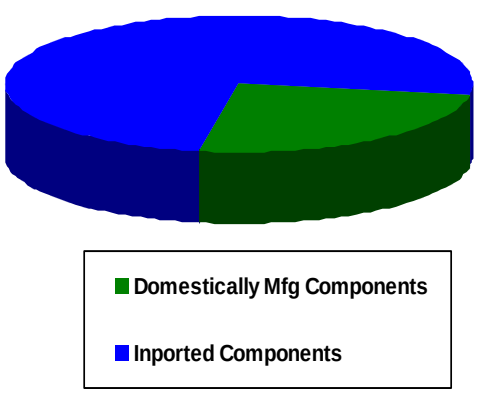
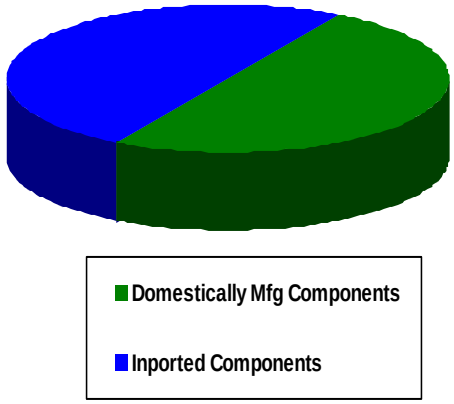
Domestic Content of America's Turbines

2005



~25% domestic components
~2,500 MW installed

2009 / 2010



~50% domestic components
~10,000 / 5,000 MW installed

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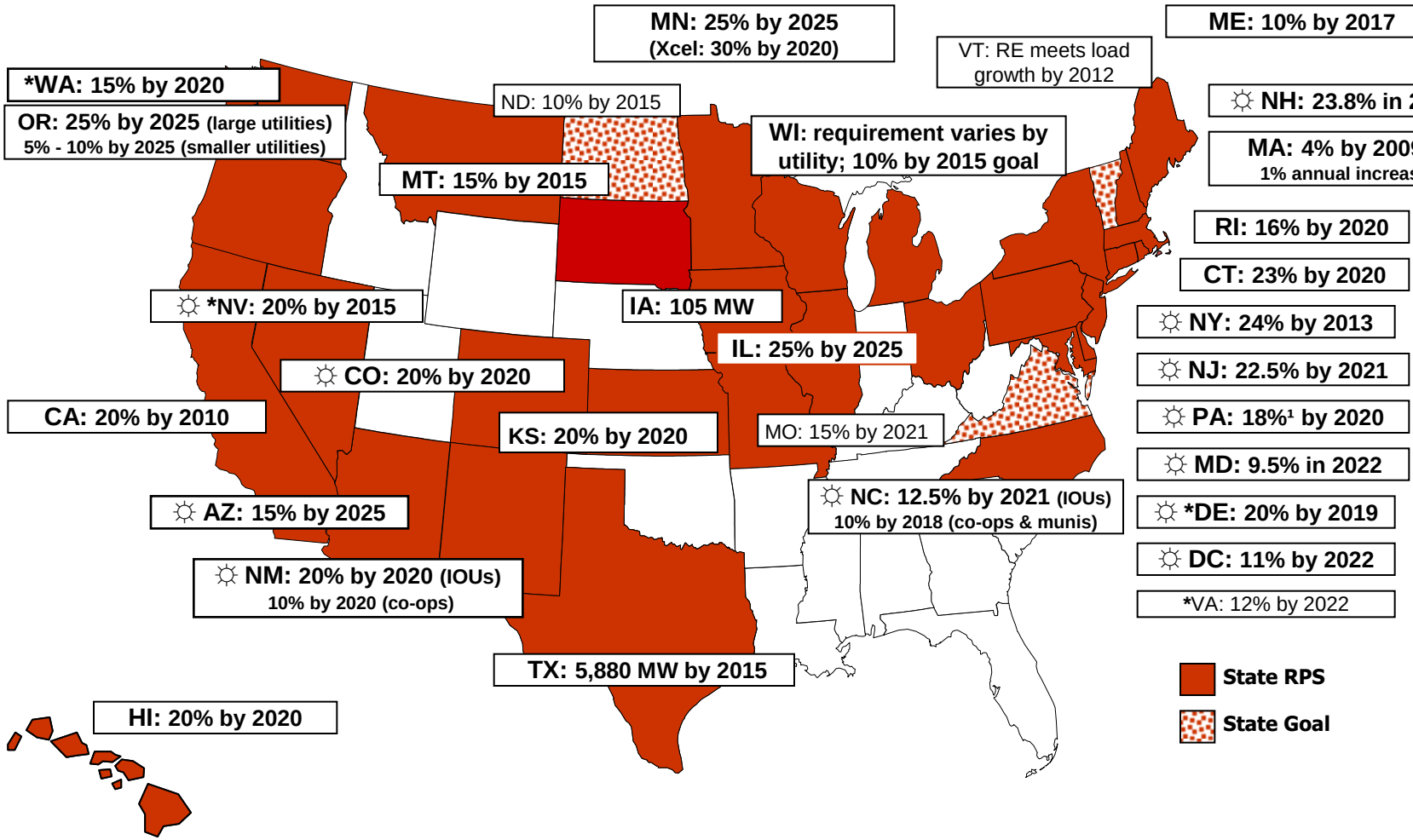
State Renewable Energy Standards



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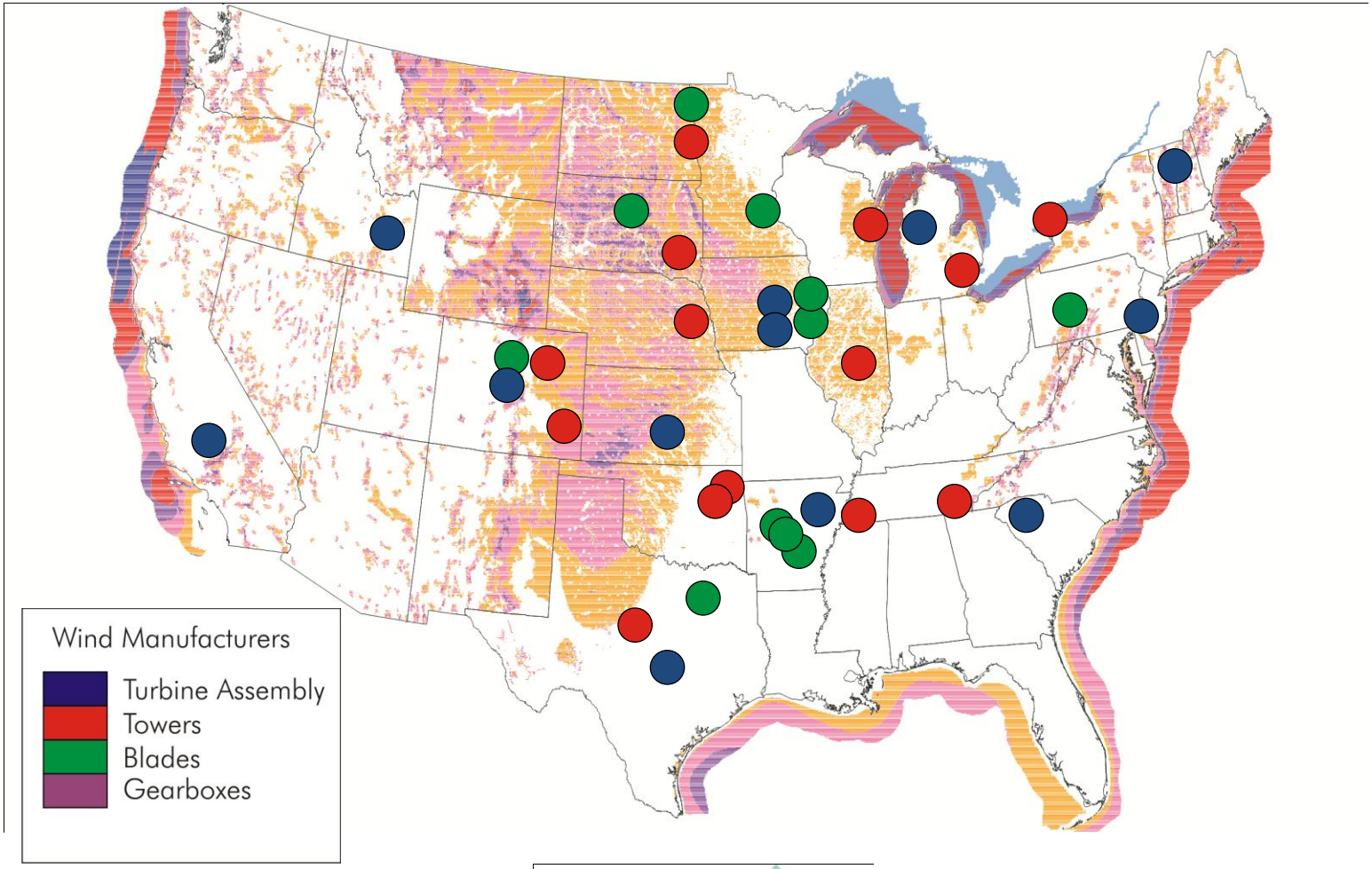
Turbines, Towers, and Blades



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U.S. Department of Energy
National Renewable Energy Laboratory

NA Mfgs Operating Today

Wind Turbine OEMs

- General Electric
- Gamesa
- Clipper Windpower
- Acciona
- DeWind
- Nordic Windpower
- Northern Power
- Vestas
- Nordex
- Aeronautica Windpower

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What's Exciting?

New Assembly Plants

- **Siemens**
  - Kansas, 600 turbines/yr
- **Nordex**
  - Arkansas, 300 turbines/yr
- **Vestas**
  - Colorado, 1,400 turbines/yr
- **Aeronautica Windpower**
  - New Hampshire

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WTG OEMs on the Way

- Alstom : Amarillo, TX
- Mitsubishi: Ft. Smith, AR
- Fuhrlander (Germany)
- Kenersys (Germany)
- M. Torres (Spain)
- REpower (Germany)
- Areva (Germany)
- Hyundai (Korea)
- Sinovel (China)
- Goldwind (China)
- Mingyang (China)

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Towers Facilities

- Trinity Structural Towers (Clinton IL; Tulsa, OK)
- SIAG Aerisyn (Chattanooga, TN)
- Ventower (Monroe, MI)
- Thomas & Betts (Memphis, TN)
- Tower Tech (Manitowoc, WI, Abilene, TX)
- Katana Summit (Columbus, NE)
- DMI (West Fargo, ND; Tulsa, OK, Ft. Erie, ON)
- Dragon Wind (Lamar, CO)
- Vestas (Windsor, CO)
- SMI & Hydraulics (Porter, MN)
- Ameron (Rancho Cucamonga, CA)
- Ventower (Monroe, MI)

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Blades Operations

- **Suzlon (Pipestone, MN)**
- **LM Windpower (Grand Forks, ND; Little Rock, AR)**
- **Siemens (Fort Madison, IA)**
- **Gamesa (Ebensburg, PA)**
- **Molded Fiberglass (Gainesville, TX, Aberdeen, SD)**
- **TPI Composites (Newton, IA)**

- ***Vestas (Brighton, CO)***
- ***Nordex (Jonesboro, AR)***
- ***Energy Composites Corp (Wisconsin Rapids, WI)***

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Gearbox OEMs

- Winergy Drive Systems (Elgin, IL)
- GE Transportation (Erie, PA)
- Clipper Windpower (Cedar Rapids, IA)
- *Z-F (Gainesville, GA)*

- *Brevini (Muncie, IN)*
- *Moventas (Faribault, MN)*
- *Bosch-Rexroth (TBD)*

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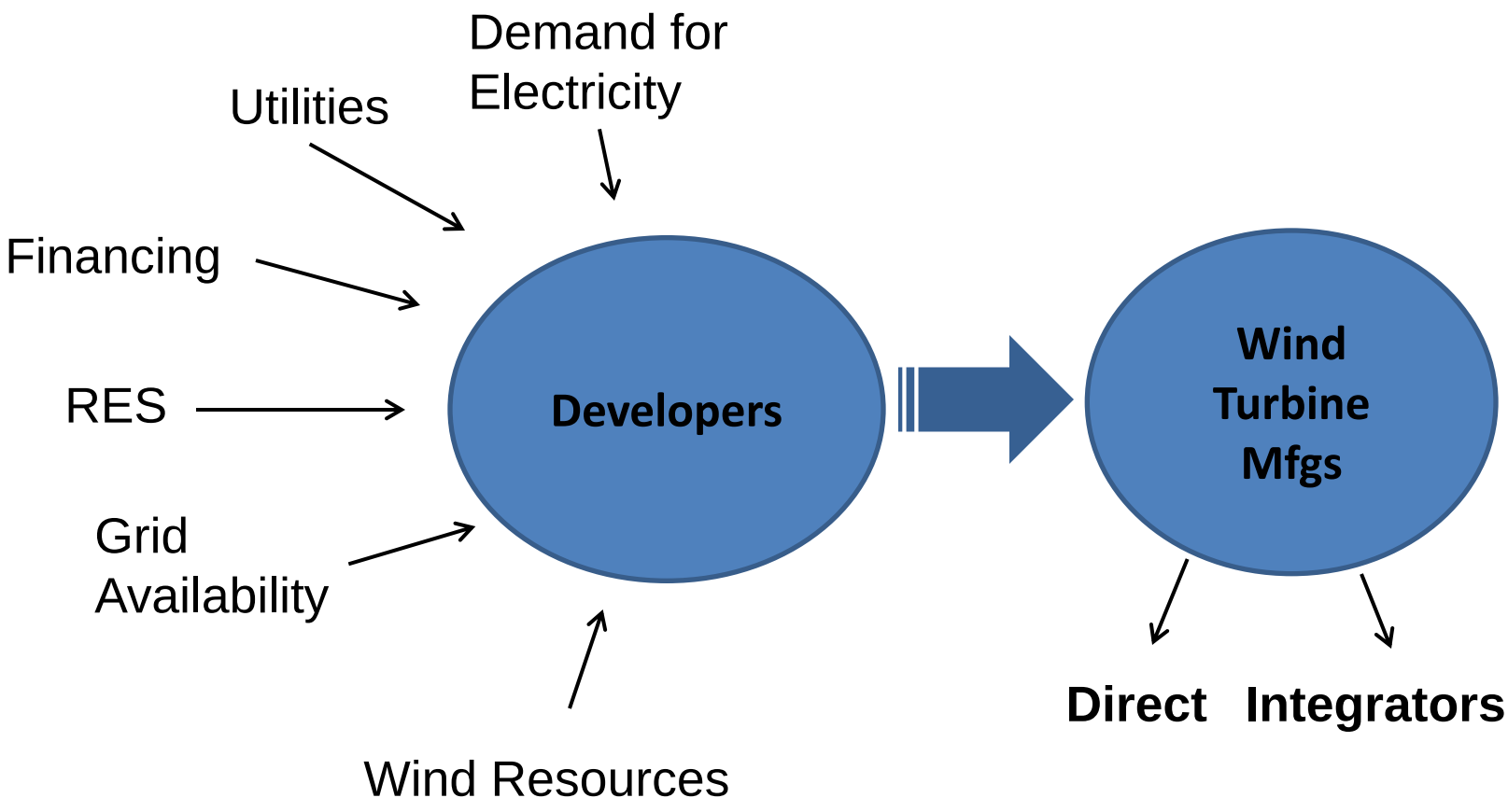
Driving Forces in Wind



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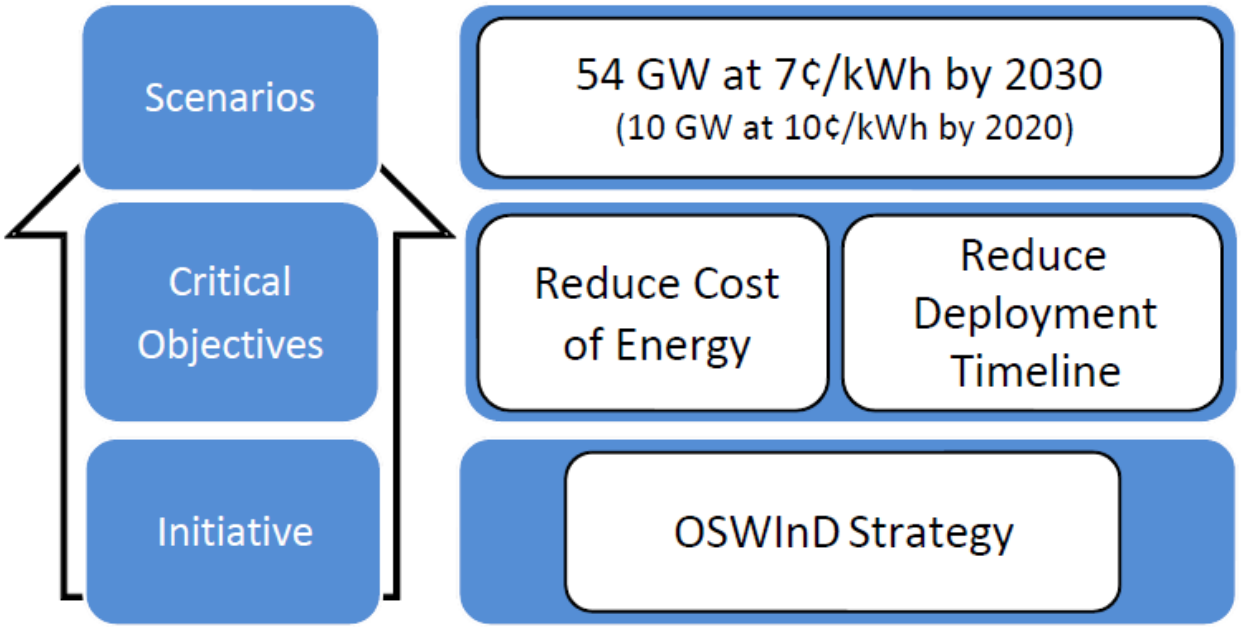
Off-Shore Wind DOE Strategy

DOE Offshore Wind Innovation and Demonstration (OSWind) Program:



- **Off-shore Projected Cost: Must be cut by 50%**
- **Strategies:**
  - **Technology Development: Applied Research to Reduce Inputs**
  - **Reduce Wind Deployment Timeline: Thru Resource Planning, etc.**
  - **Advanced Technology Demonstration: $90M Fed Funds Allocated**

USDOE National Offshore Wind Strategy, February 2011

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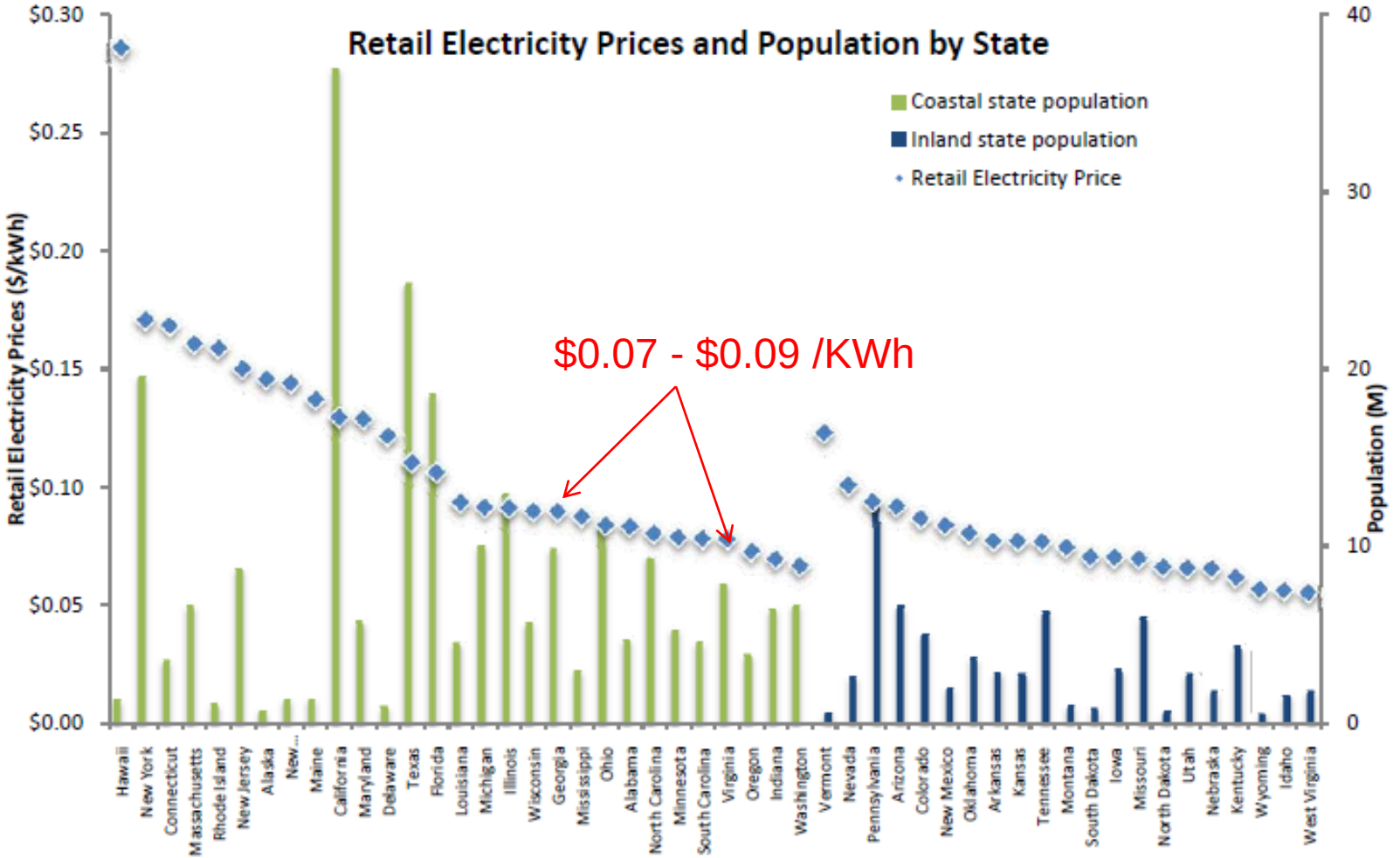
Coastal vs. Inland State Electricity Pricing



USDOE National Offshore Wind Strategy, February 2011

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Offshore Section Topics

- European Ports
- European Foundations
- European Vessels
- USA Math to 54 GW and Wind Potential
- USA Offshore Project Summary
- SE Region Wind Potential

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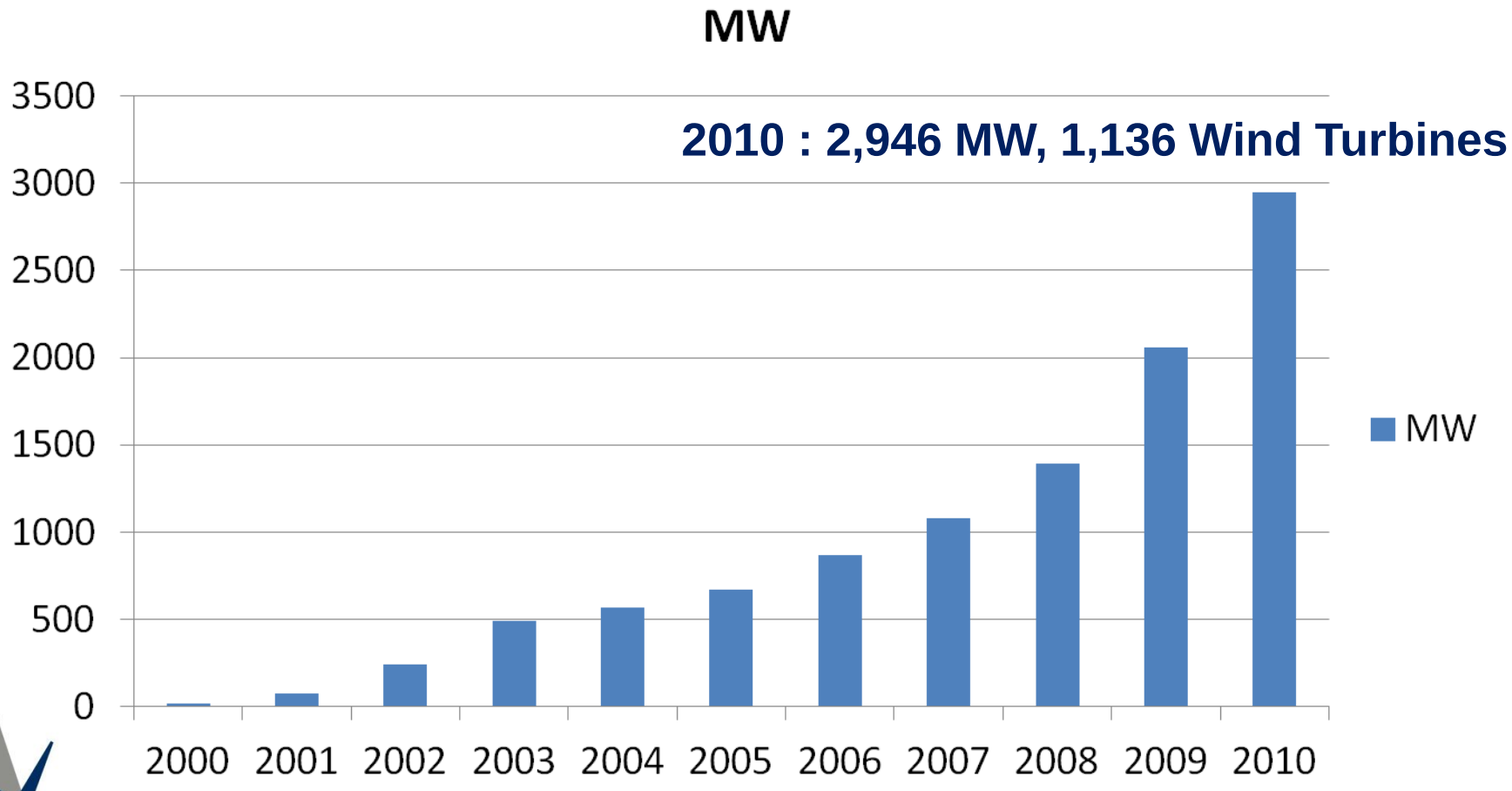
Europe Offshore Wind Cumulative



Thru July 2011 added 101 Turbines 348 MW

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Offshore Goals

- Europe 55 GW by 2020, 3.2 GW in 2011
- Europe 150 GW by 2030
- USA 10 GW by 2020, 0 GW in 2011
- USA 54 GW by 2030

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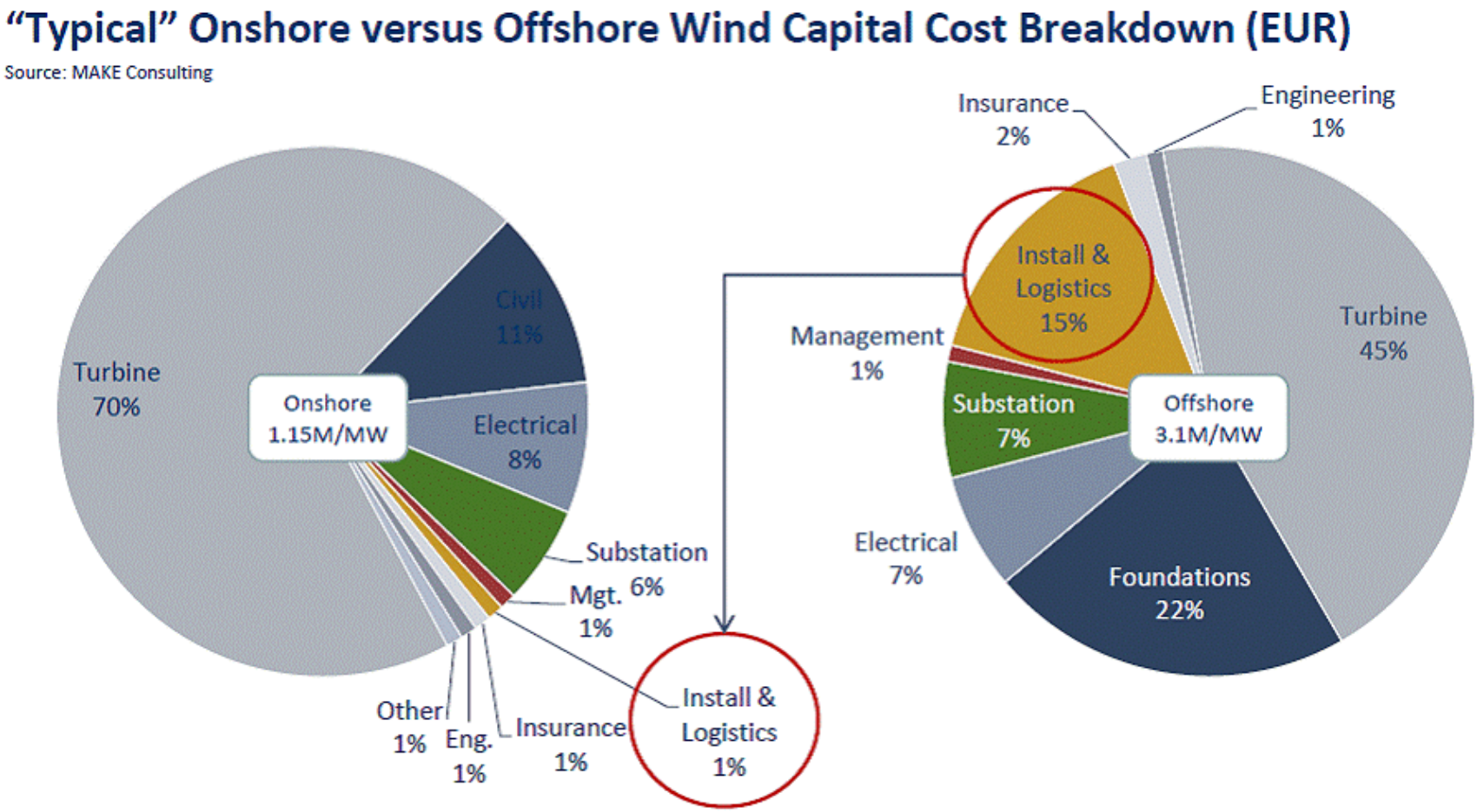
Onshore vs Offshore CAPEX



Source: MAKE Consulting

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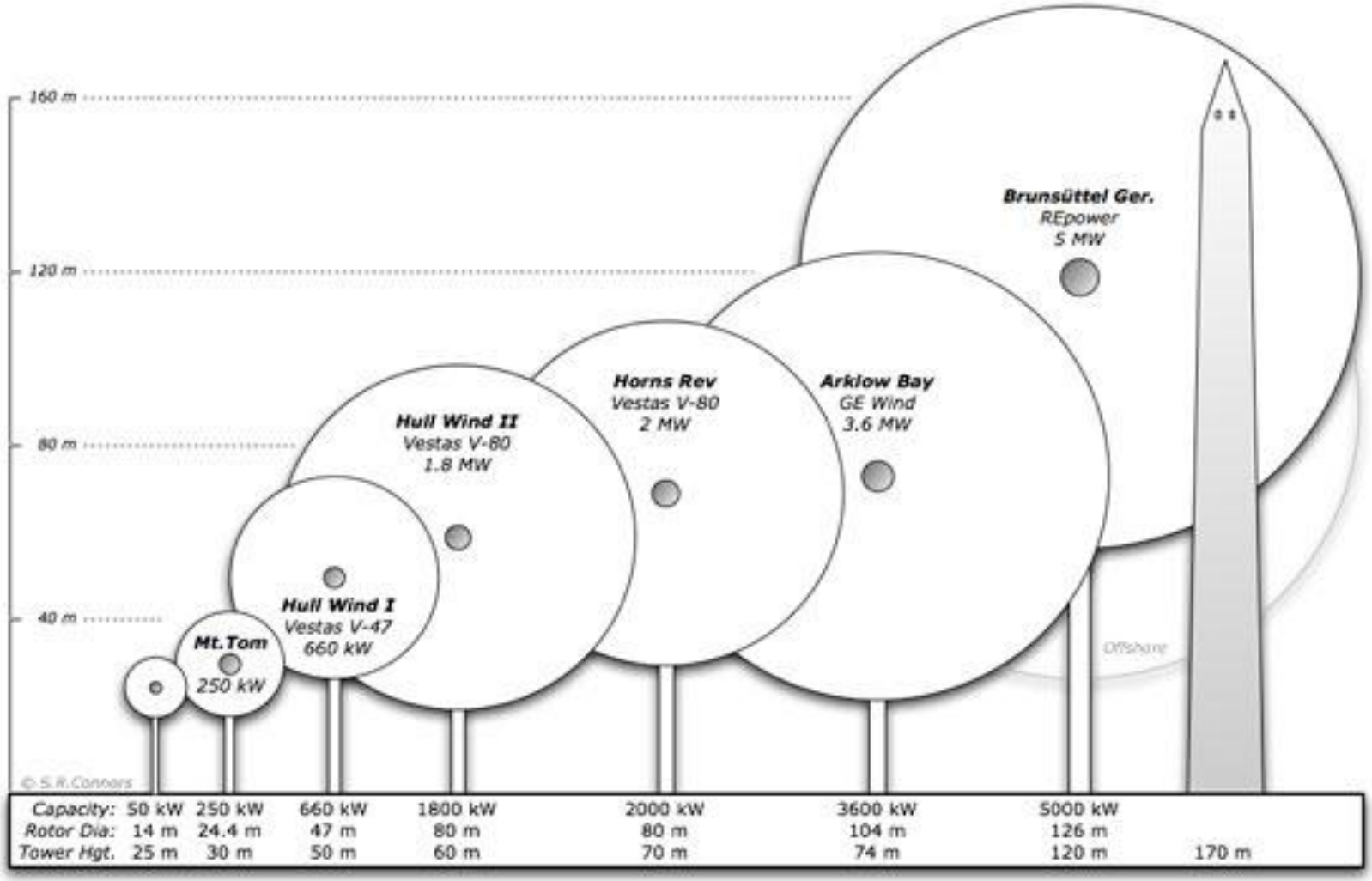
Wind Turbine Size



Courtesy - AWEA

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Key European Ports

- U.K. - Harwich International Port and Ramsgate
- Netherlands – Vlissingen
- Germany - Bremerhaven and Cuxhaven
- France - Dunkirk

General rule 100 – 150 WT Units/yr/ Port

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Cuxhaven Germany Offshore 2010 Laydown Area

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Cuxhaven Germany Lay Down Yard 2011 and Port Vessel Loading

200M € Initial Investment

350M € Future Investment

4,500 jobs in 5 yrs

~150 units/yr

Towers (Dia. 6-7m, L 30-40m 150 ton / section)

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Germany 25 GW Offshore by 2030

Footprint Example for USA Port

- 3 to 4 Offshore Wind Energy Ports in North Sea (service 200 sea mile radius from port)
- 300 Wind Turbines Annually in North Sea Projects
- 100-150 complete units (foundation structures, towers, nacelles, hubs, and rotor blades) a year via the Offshore Terminal Bremerhaven (OTB)
  - Bremerhaven has 200 hectares for further manufacturing and supplier production facilities
- OTB (Offshore Terminal Bremerhaven) Technical Data
  - PURPOSE – Handling, pre-assembly and storage of offshore wind turbines; exporting of components; logistics centre for the transportation / transshipment of large industrial components
  - OPERATING TIME -24 hours a day, 365 days a year
  - TARGET – UP to 160 wind turbines and foundation structures of wind farms per season
  - QUAY LENGTH – 500m
  - NAVIGABLE DEPTH – 14.5m
  - HEAVY DUTY SLAB AT THE QUAY – 70m wide, 500m in Length
  - TERMINAL DEPTH – 498m
  - AREA – approx 25 hectares (2.48 acres or 1.86 football fields per hectare)
  - CAPACITY – 160 units per season

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OTB-Offshore Terminal Bremerhaven

- Primary Port for Alpha Ventus Wind Farm
- AREVA & REpower Turbine Assembly – 100 units per year
- WesserWind GmbH – Foundations
- Power Blades GmbH- Blades
- Plus 200 hectares for other manufacturers and suppliers

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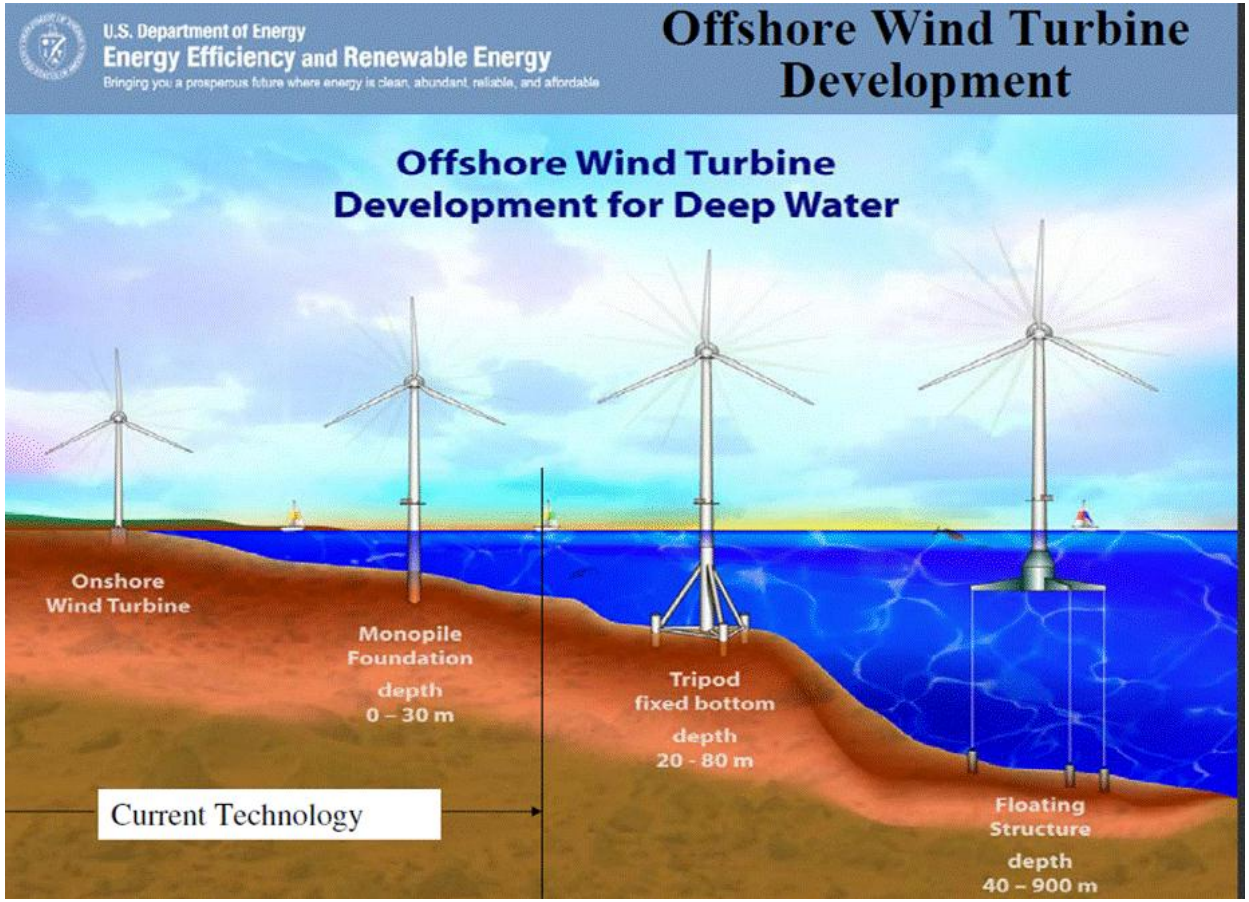
Offshore Foundation Types

- Monopile 300 – 500 t
- Gravity Base 6000 t
- Jackets 550 t
- Tripods 950 t
- Tripiles 490 t
- Floaters 1000 t
  - Upright
  - Spar



Mass 1X 2X 3X 4X

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WesserWind GmbH Tripods & Jackets

L/W/H up to 32/32/60 m 950 ton

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CSC Cuxhaven Steel Construction

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Offshore Gravity Test Foundation

40m x 40m legs x 8m ht – 1m wall Thickness
65m tower height
6000 t with base & tower
900 wheel transport unit – plant to dock loading area

Side load cyclic testing on tower above

Base testing in standing water right

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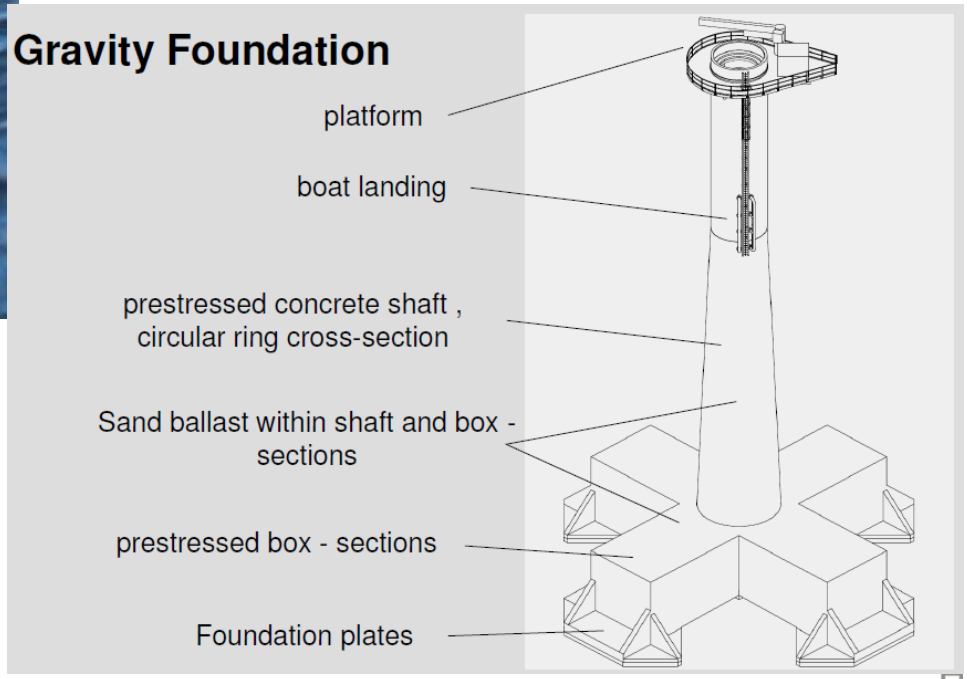
Gravity Foundation

Source: Strabag Images

U-shaped Transport Vessel – 160m long x 65m wide



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Offshore Assembly

Source: Nordex SE

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Vessels

Transport Vessels – Foundations, Towers, Blades, Nacelle

Installation Vessels:

Jack-up or Regular

- 5000 ton, 2000 ton payload
- 93m L, 36m W, 7m D

Crew Transport Vessels

670 Vessels Worldwide, 32 cross-over to Wind (ODS Pertrodata)

-10 Turbine Installation (4 in O&G)

-12 Foundation Install. (5 in O&G)

- 10 Turbine and Foundation Installation with no cross-over

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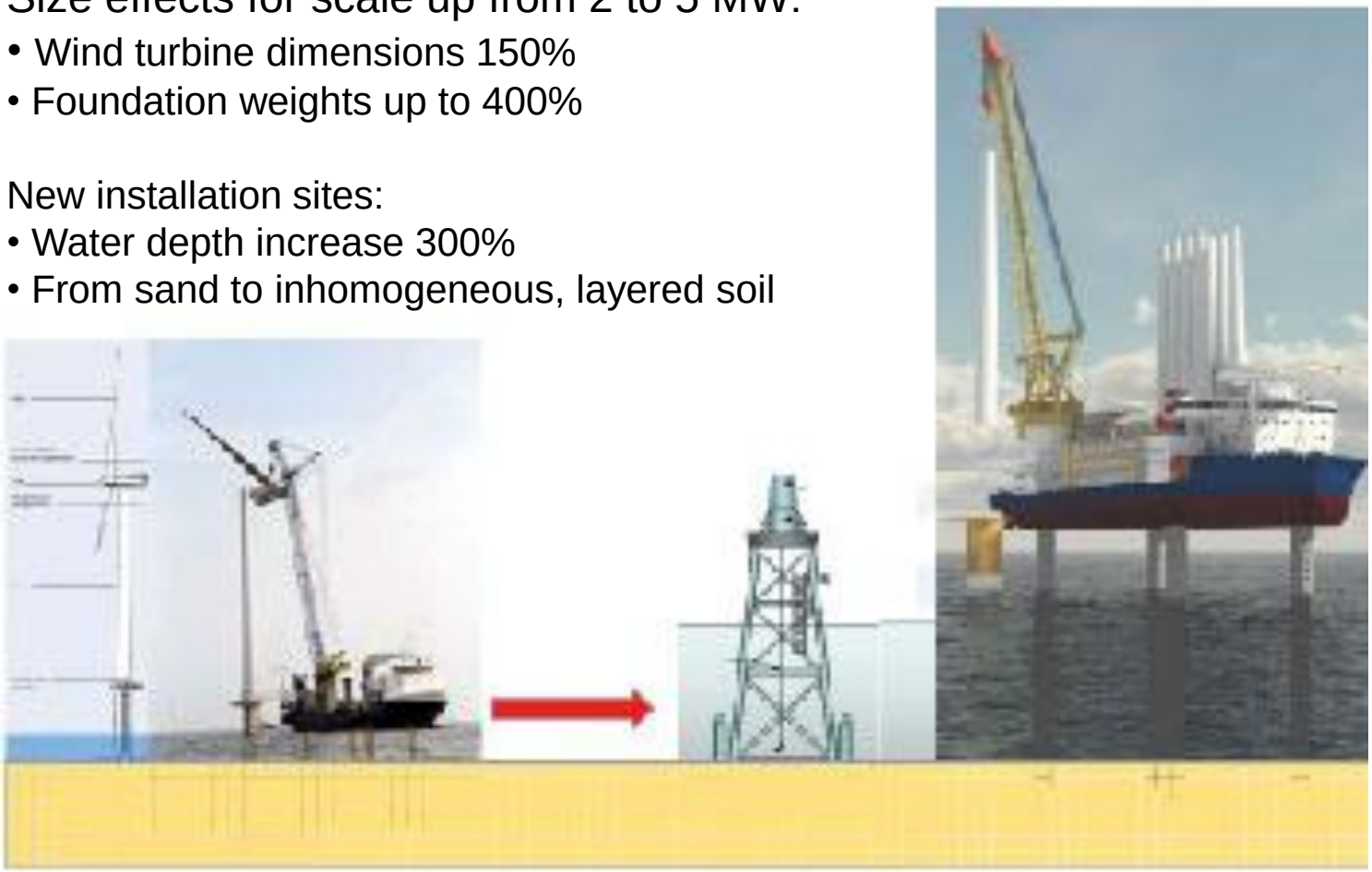
Offshore Assembly

Size effects for scale up from 2 to 5 MW:

- Wind turbine dimensions 150%
- Foundation weights up to 400%

New installation sites:

- Water depth increase 300%
- From sand to inhomogeneous, layered soil



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SBM OFFSHORE GustoMSC

Wind Farm Construction Offshore

- Wind Turbines
- Foundations – Monopile, Tripile, Floating
- Vessels – Transport, Assembly, Crew Transport
- Electrical Infrastructure – Cable, Transformers-Substations

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5 MW Blade Production Germany

5 MW Turbine Blade

56.5 m length
16 ton
4800 kg resin
~$25 / kg resin
Lightning Protection

1 Blade per day
80 people

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Simple Math: All 5MW Units-54 GW

- 10,000 MW by 2020
  - 2,500 MW / Yr 2017 – 2020
  - 500 – 5 MW units / Yr
  - 3+ Ports @150 WT / Port
- 44,000 MW by 2030
  - 4,400 MW / Yr 2021 – 2030
  - 880 – 5 MW units / Yr
  - 6 Ports @150 WT / Port

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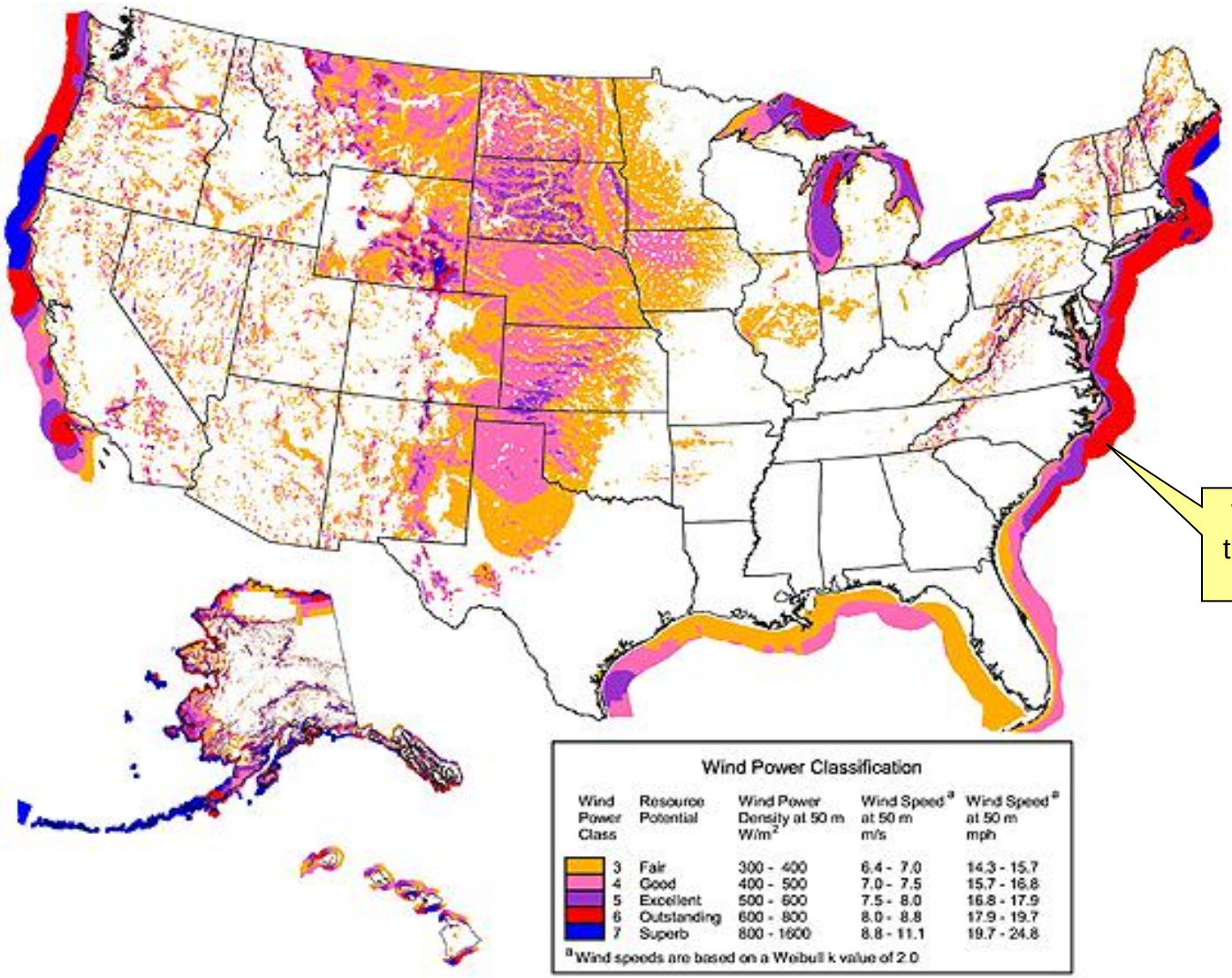
Offshore Wind



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Off-Shore Wind Potential

Region	0–30 m depth	30–60 m depth	>60 m depth	Total
New England	100.2	136.2	250.4	486.8
Mid-Atlantic	298.1	179.1	92.5	569.7
South Atlantic Bight	134.1	48.8	7.7	190.7
California	4.4	10.5	573	587.8
Pacific Northwest	15.1	21.3	305.3	341.7
Great Lakes	176.7	106.4	459.4	742.5
Gulf of Mexico	340.3	120.1	133.3	593.7
Hawaii	2.3	5.5	629.6	637.4
Total	**1,071.2 GW**	**628.0 GW**	**2,451.1 GW**	**4,150.3 GW**

Mid-Atlantic States

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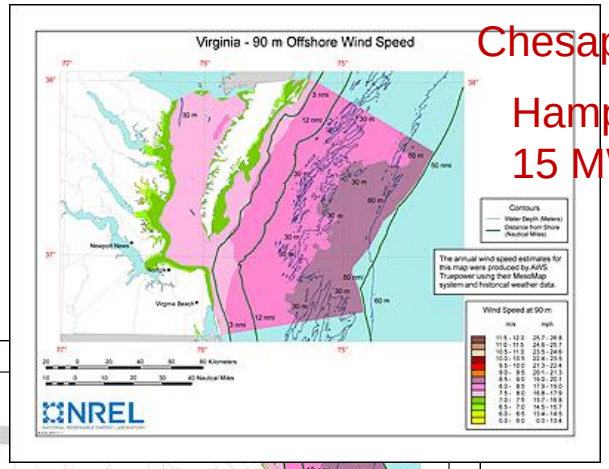
USDOE National Offshore Wind Strategy, February 2011

Offshore Wind Resource & Farms

Virginia



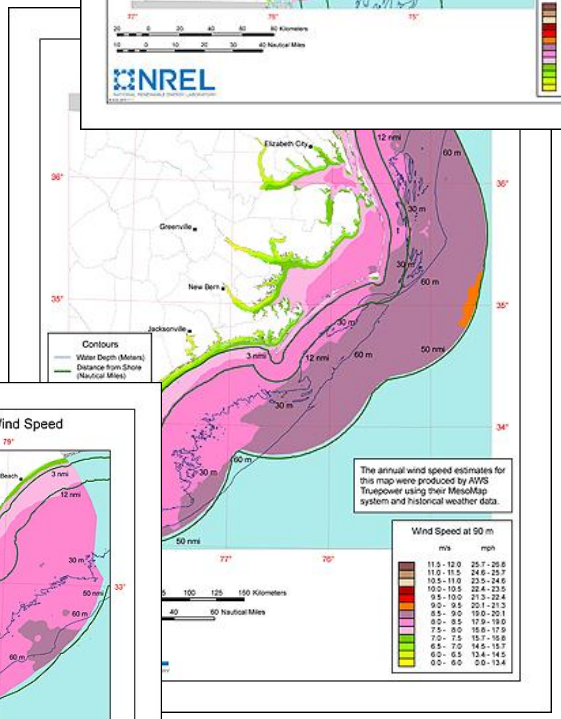
Chesapeake Bay Test Site, 5MW, Gamesa

Hampton Roads Offshore Wind Project, 15 MW – 3 T, APEX Wind Energy

Seawind, 800MW – 240T, Seawind Renewable Energy

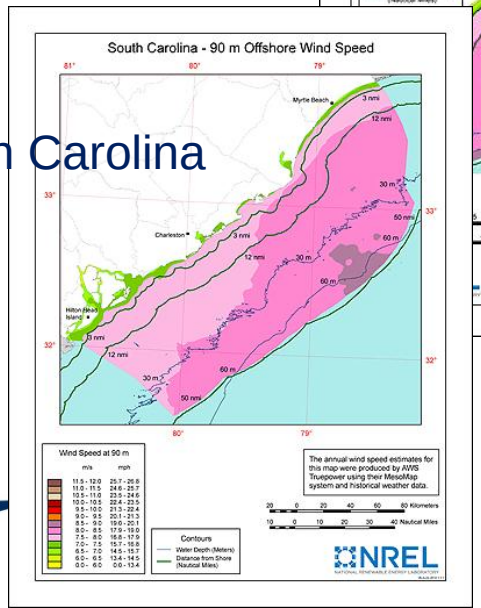
APEX Offshore Wind VA, 1,500MW

North Carolina



APEX Offshore Wind North Carolina,
Phase 1: 600MW – 165T
Phase 2: 1,300MW – 360T
Outer Banks Ocean Energy Corp

South Carolina



Palmetto Wind Research Project, 80MW,
SC Energy Office, Coastal Carolina Univ, Santee Cooper

Off-Shore Wind - Status

- Currently 45+ Active Wind Farms:
  - Denmark, Belgium, China, Sweden, Finland, Germany, UK, the Netherlands, Norway, and Ireland
- US projects under development (26+ Active) partial list:
  - Cape Wind (420MW) – Mass. Nantucket Sound
  - Garden State Offshore Energy (345MW) – Atlantic City
  - Delaware Wind Project (450 MW) – Delaware Coast
  - Block Island Wind Farm (29 MW) – Rhode Island Coast
  - APEX Offshore Wind Virginia (1500 MW)
  - Gamesa Chesapeake Test Site (5MW)
  - Hampton Roads Demonstration Project Virginia (15 MW)
  - APEX Offshore Wind North Carolina (1900 MW)

http://www.linycoffshorewind.com/faq.html
http://www.tthewindpower.net/

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Offshore Wind Supply Chain Opportunities for SE Region

DOE Goal 54 GW by 2030 = 10,800 Units if all are 5 MW

- Logistic & Port Infrastructure Impact
- Foundations - fabrication-machining-coatings
- Towers – fabrication-forging-machining-coatings
- Blades – composites-processing-machining
- Support Bases and Hubs – casting/fabrication-machining-coatings
- Vessels – fabrication-casting-forging-machining-electrical-hydraulics-coatings
- Cable & Substation – all major manufacturing sectors

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What should states be working on together - optimizing supply chain?

- Goal → Lowest Cost Of Energy
- Utilizing & Share most efficient existing resources
  - Ports
  - Shipyard vessel manufacture
  - Large Tower and Monopile Manufacture
  - Foundation Manufacture
- Best Laydown Areas to serve Multiple Wind Farms
- Manufacturing Parks for Foundations, Towers, Blades and Nacelle Assembly – Port Brownfield sites

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THANK YOU!

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