

Wind Energy

challenges and opportunities

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GW Energy Institute

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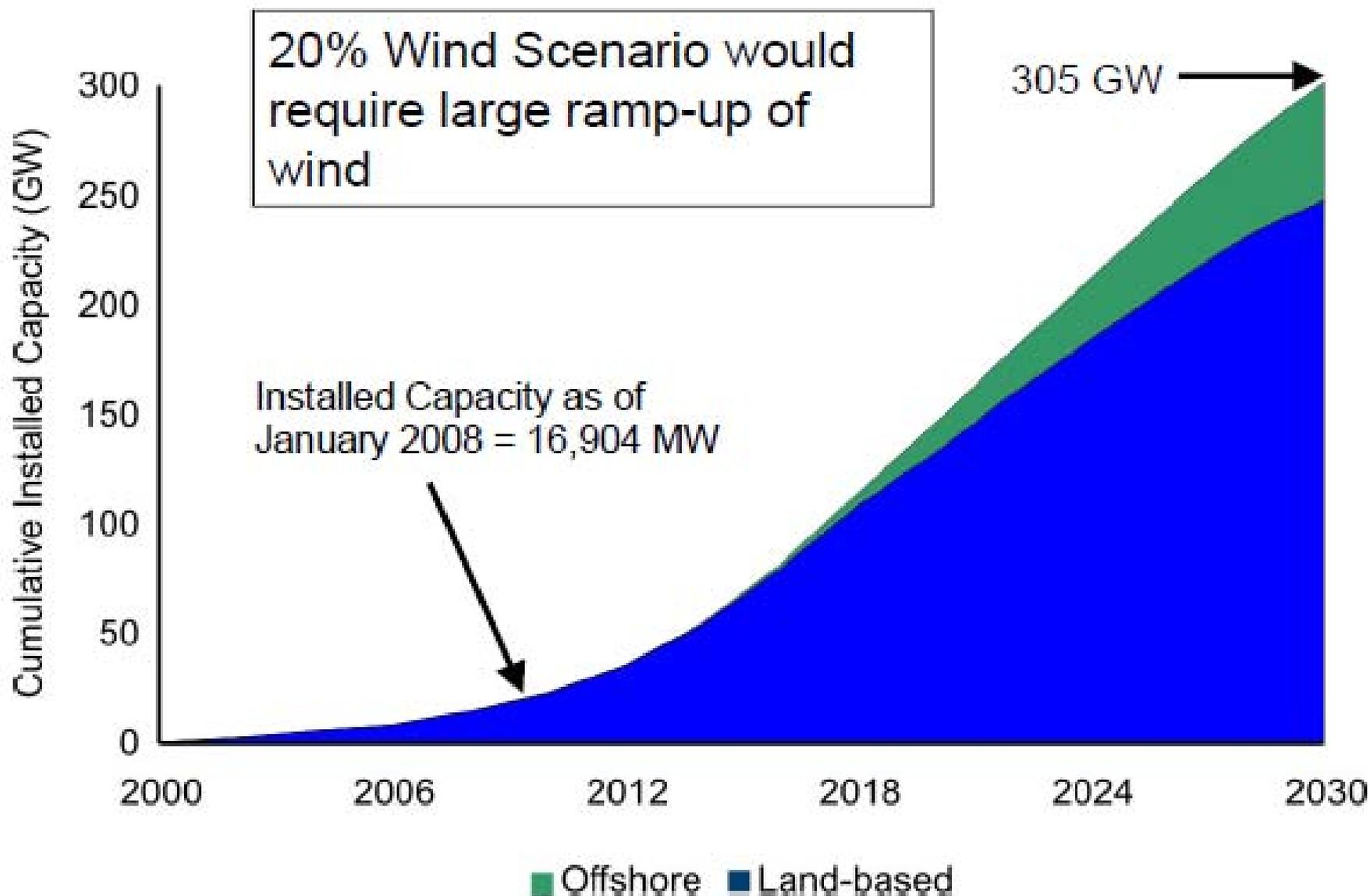


DOE Wind 2030 vision

- DOE sets a goal to reach 20% (current 1.6% by wind) of electricity generated by the year 2030 by wind energy
- The pending senate energy bill (American Clean Energy Leadership Act) will further require 15% of electricity generated by utility companies from renewable energy sources by 2021 (1/4 can be from energy saving measures). (6% in 2014)
- The house bill requires (6% in 2012) 20% renewable by 2020 and 8% can be from conservation
- Current wind industry enjoys 30% tax credit or loan provisions when installing wind turbines

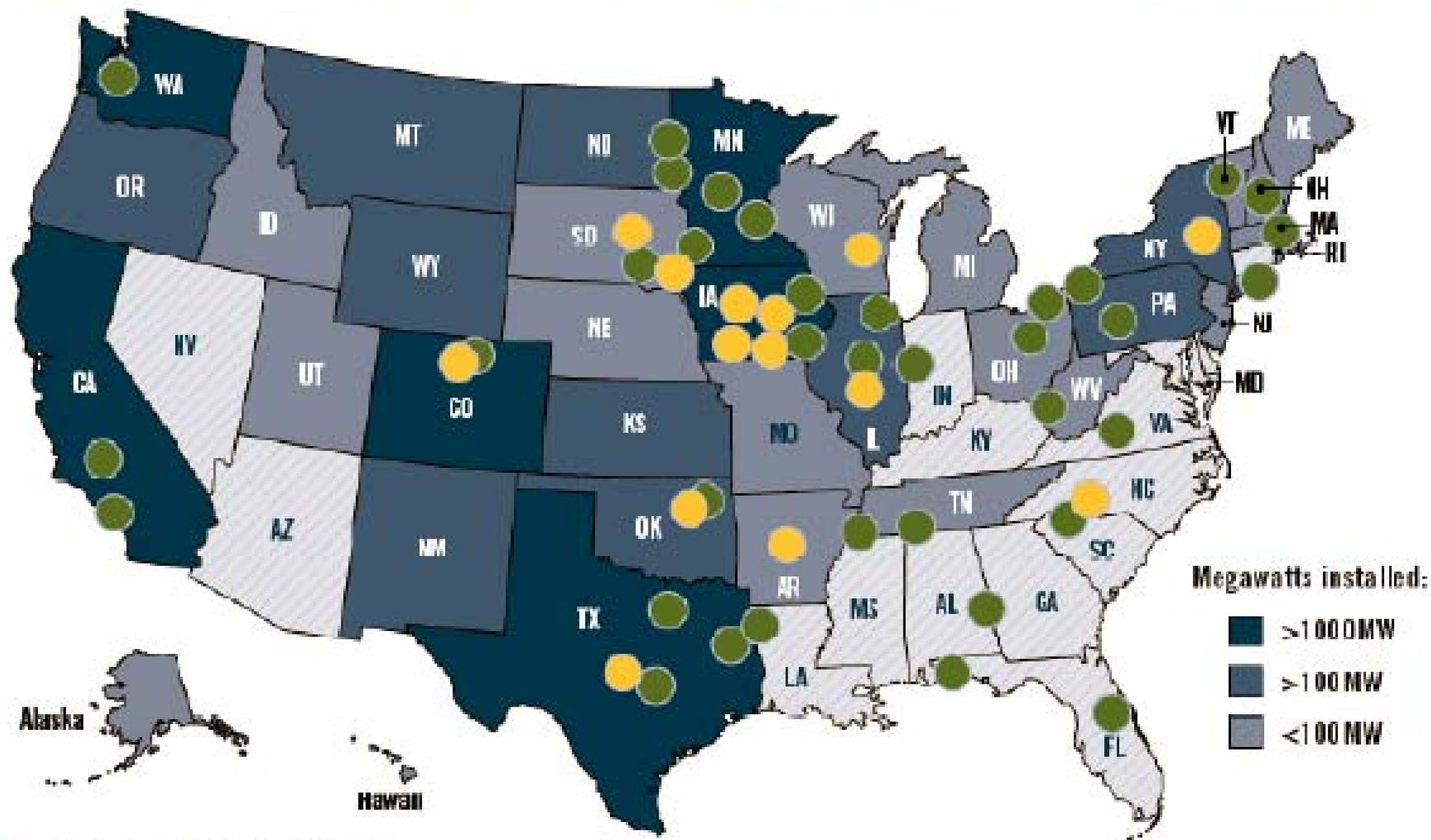


20% Wind Scenario





Selected examples* of Manufacturers Supplying Wind Equipment Across United States



- Examples of facilities opened or announced in 2007
- Examples of facilities in operation in 2006

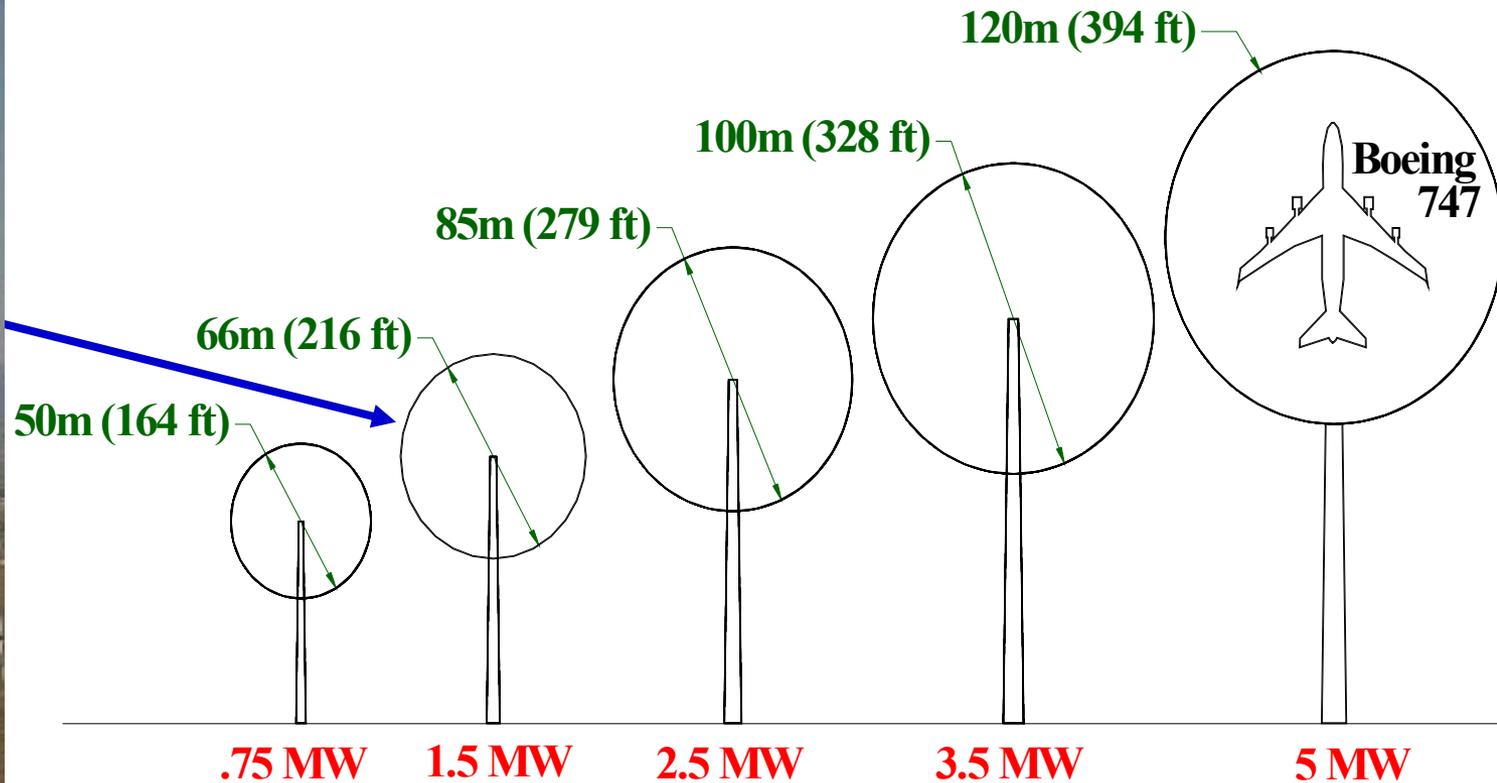
* Not exhaustive

Source: AWEA

Big Machines, and Growing...



Typical Rotor Diameters



GE Wind 1.5 MW

The practical issues with Big wind machines and the scale of things :

- Installation
- logistics and access
- Scale reflected in cost and available suppliers; their capacity and location, logistics
- Unscheduled maintainance



Wind Energy Key Issues

- Lack of trained technical professionals
- Automation of manufacturing process
- High cost of maintenance and repair
- Light-weighting of wind systems

Goal: to reduce life cycle cost by 30-50%

- Asia and Europe have feed-in tariffs requiring utility to buy higher priced renewable energy
- Congress in enacting laws to require utility companies to generate 15%-20% electricity from renewable by 2020 (6% in 2012-2014)

Transformative research in wind being pursued

- Nanocomposites for blades (1/2 the weight, injection molded, modern mass production technology)
- Cold spray of nanoparticles onto surfaces to form advanced coatings for large structures without deposition chamber
- Self-repairing technology for wind turbine gears and drive train
- Smart Blade;-Biomimetic surface textures, actuators, active aerodynamic control

Micropitting of wind turbine gears

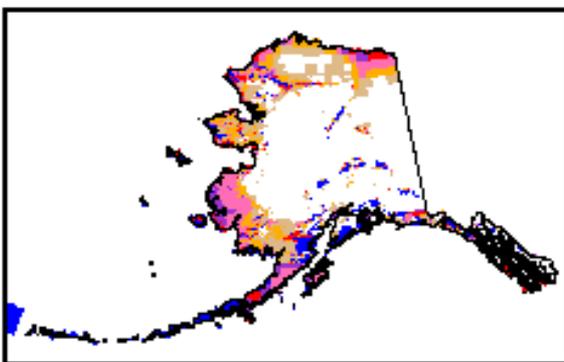
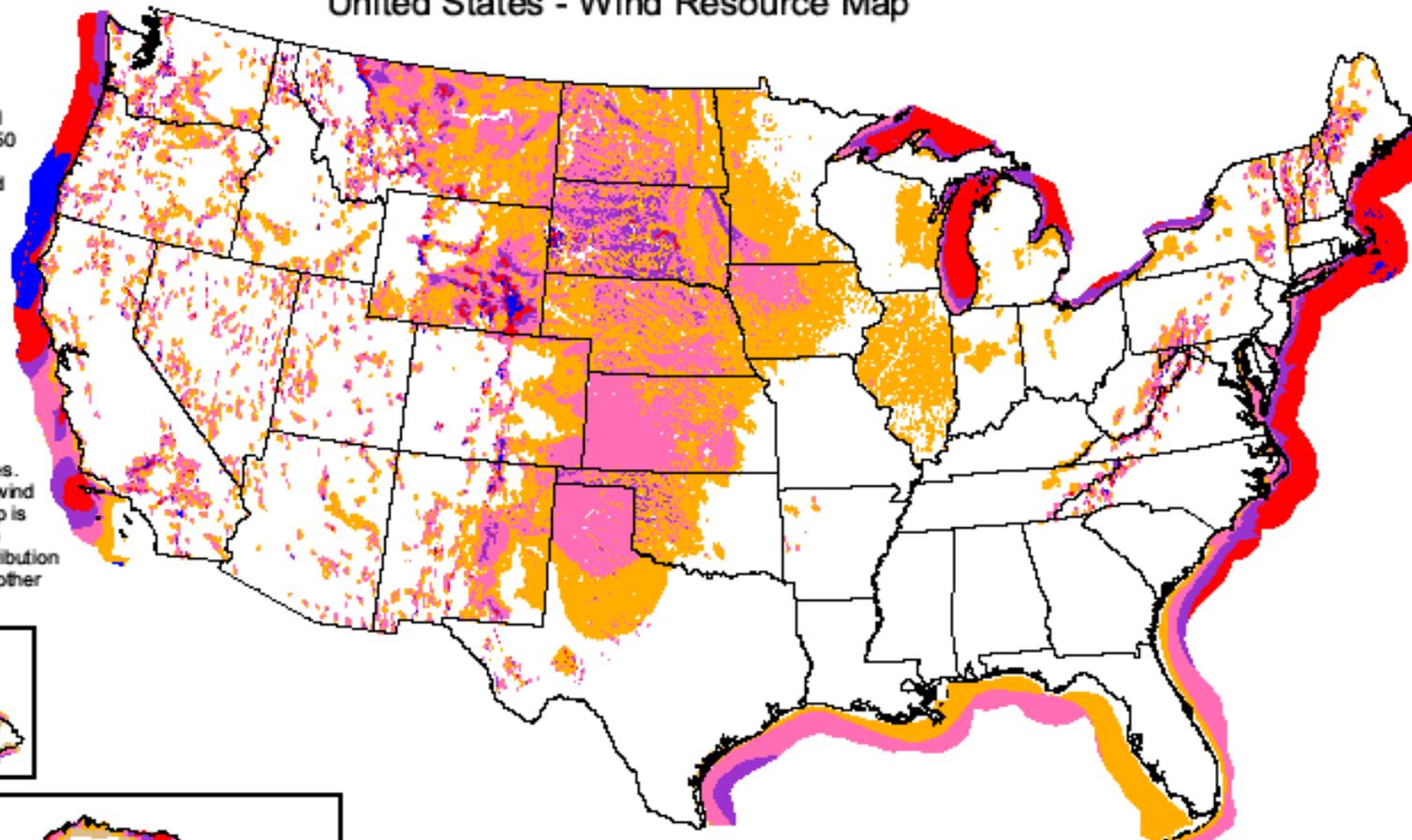


Pending Energy Legislation

- The pending Senate Energy Bill (American Clean Energy Leadership Act) will require 15% of electricity generated by **utility companies** from renewable energy sources by 2021 (**6% in 2014**)
- The House Bill requires (**6% in 2012**) and 20% renewable by 2020

United States - Wind Resource Map

This map shows the annual average wind power estimates at 50 meters above the surface of the United States. It is a combination of high resolution and low resolution datasets produced by NREL and other organizations. The data was screened to eliminate areas unlikely to be developed onshore due to land use or environmental issues. In many states, the wind resource on this map is visually enhanced to better show the distribution on ridge crests and other features.



Wind Power Classification

Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m^2	Wind Speed ^a at 50 m m/s	Wind Speed ^a at 50 m mph
3	Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
4	Good	400 - 500	7.0 - 7.5	15.7 - 16.8
5	Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
6	Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
7	Superb	800 - 1600	8.8 - 11.1	19.7 - 24.8

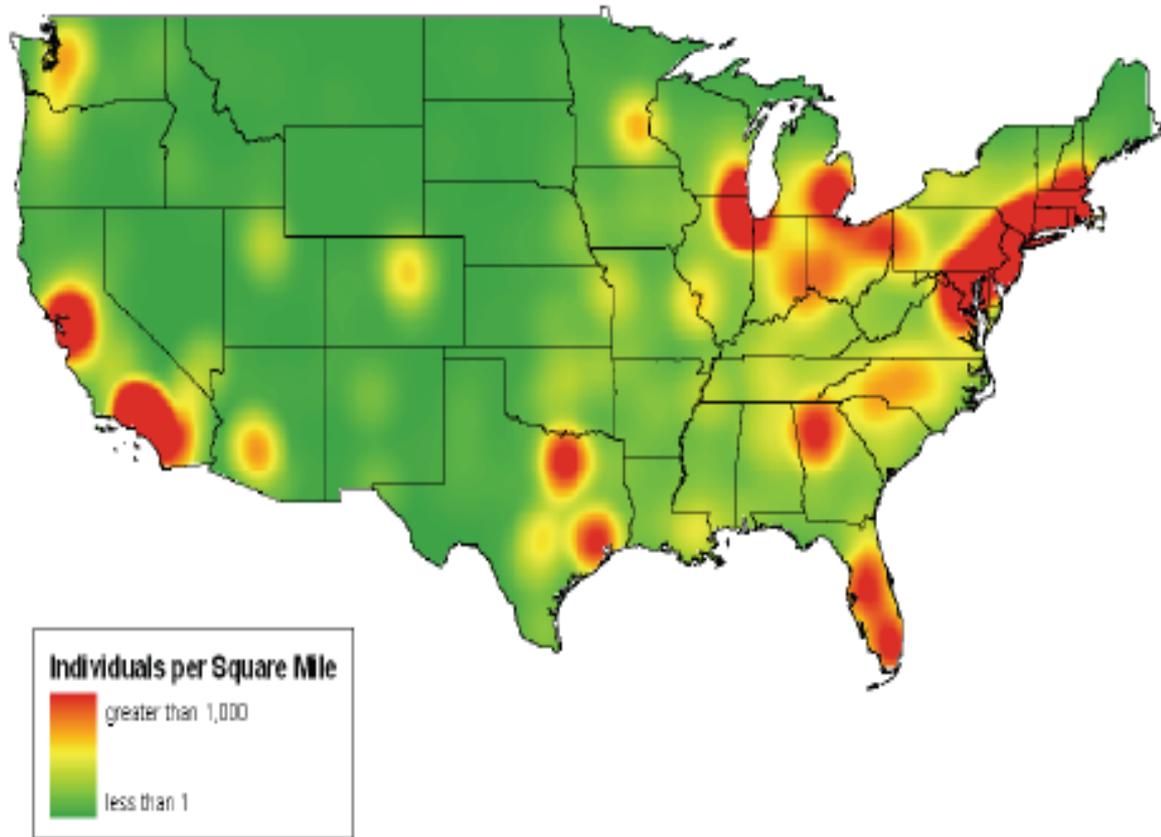
^aWind speeds are based on a Weibull k value of 2.0



U.S. Department of Energy
National Renewable Energy Laboratory

Matching wind resources with population

- Off-shore wind resources highest
- Mid-west area
- Population centers and wind resources do not match
- Transmission issue
- Off-shore wind matches better



Offshore Wind Turbine Development for Deep Water



Onshore
Wind Turbine



Monopile
Foundation
depth
0 - 30 m

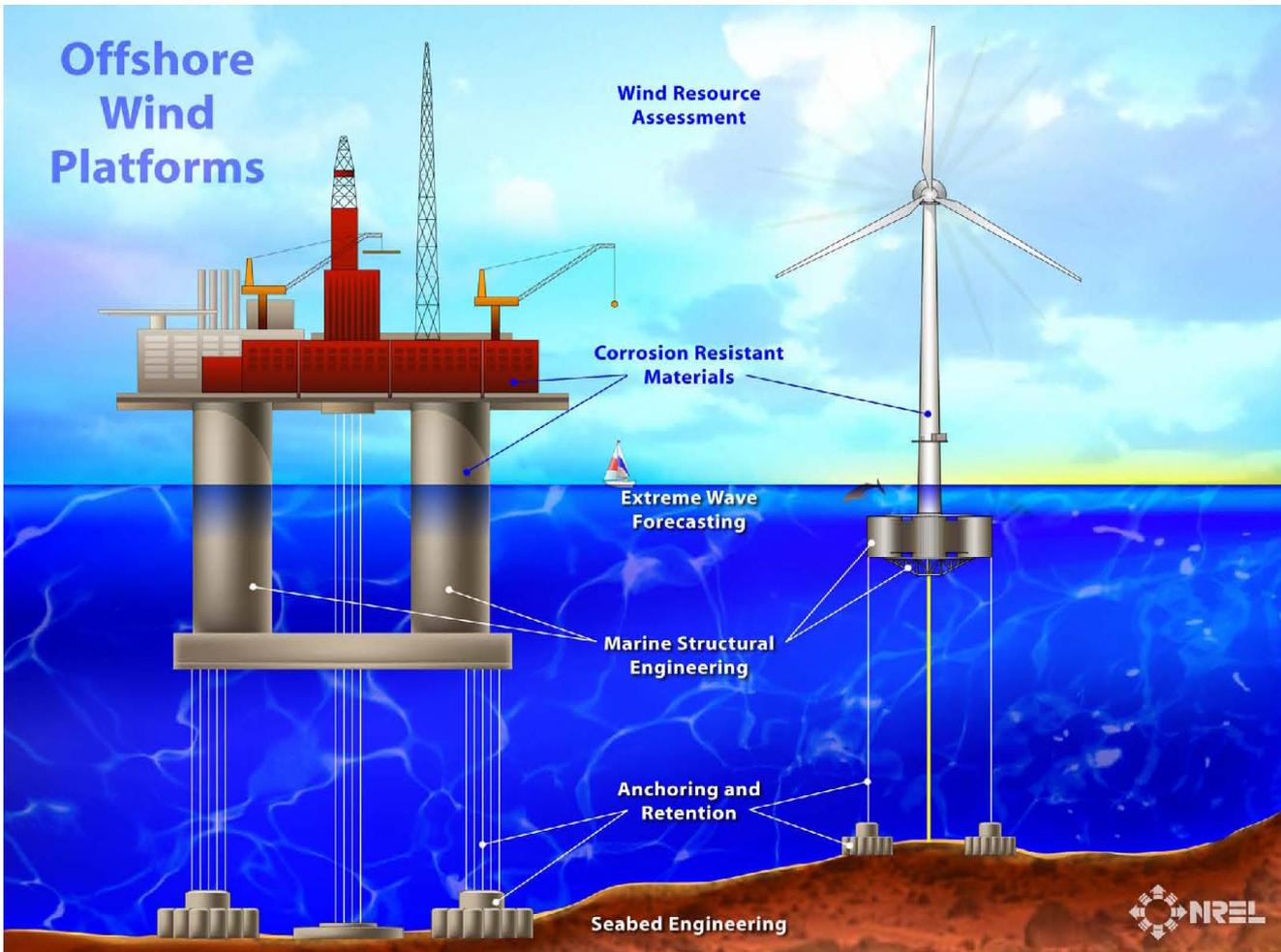


Tripod
fixed bottom
depth
20 - 60 m



Floating
Structure
depth
40 - 900 m

NREL predicts Tension Legged Platforms for floating wind turbines



Small Wind Industry



100 KW



50 KW



10 KW



5 KW



2.5 KW



2.0 KW

Siting issues

- Site Screening
- Permits & Guidelines
- Public Perception & Opinion
- Environmental Concerns
- Local Siting Issues & Project Construction

What are the initial steps in site selection & evaluation?

- Wind resource
- Transmission
- Community acceptance & land control
- Environmental screening (red flags, fatal flaws, critical issues analyses)

Siting of wind turbines

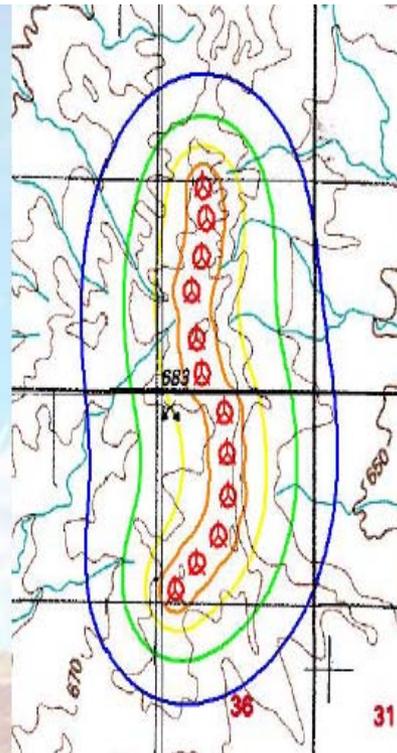
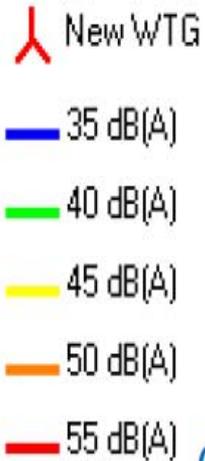
- NEPA/federal regulatory compliance
- State-level (“little”) NEPA
- Regional (e.g. WAPA)
- State Siting Certificates (e.g. PUC, PSB, PSC)
- Local/state permitting zoning, siting restrictions, ordinances

- Visual Impacts
 - Aesthetics
 - Shadow flicker
 - “Viewshed”
- Noise

Underlying concerns:

- Perceived nuisance
- Effects to property value
- Health issues

Environmental concerns



Compare to other sources of sound?



- Endangered Species Act
- Bald and Golden Eagle Protection Act
- Migratory Bird Treaty Act
- USFWS Draft Guidance, FAC
- State endangered species and wildlife laws



- Wildlife may be harmed at utility-scale, modern wind farms



- What are the big concerns?

- Rotor-swept area
- Effects to habitat

- What species are affected?

- Birds
- Bats
- Other wildlife
- Threatened & endangered species



- Which birds are affected?

- Raptors
- Songbirds
- Ground-nesting birds
- Others

- How birds are affected

- Migration
- Habitat loss & degradation



Thank you for your attention

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