
ECE 333 – GREEN ELECTRIC ENERGY

8. Wind Status

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2016 WIND STATUS

- **Wind power rebounded in 2016: 8,203 *MW* of new capacity was added – approximately 95.4 % of the wind resource capacity added in 2015; the added capacity represents**
 - **circa 27 % of the *US* 2016 capacity additions**
 - **a 11 % increase in the cumulative wind capacity in 2015**

2016 WIND STATUS

- ❑ The cumulative *US* wind capacity by the end of 2016 reached 82.1 *GW*
- ❑ *TX* remains the leading state in cumulative wind capacity:
 - *TX* added more capacity than every other state in 2016 with 2,611 *MW*
 - *TX* has more than nearly three times as much installed wind capacity than any other state

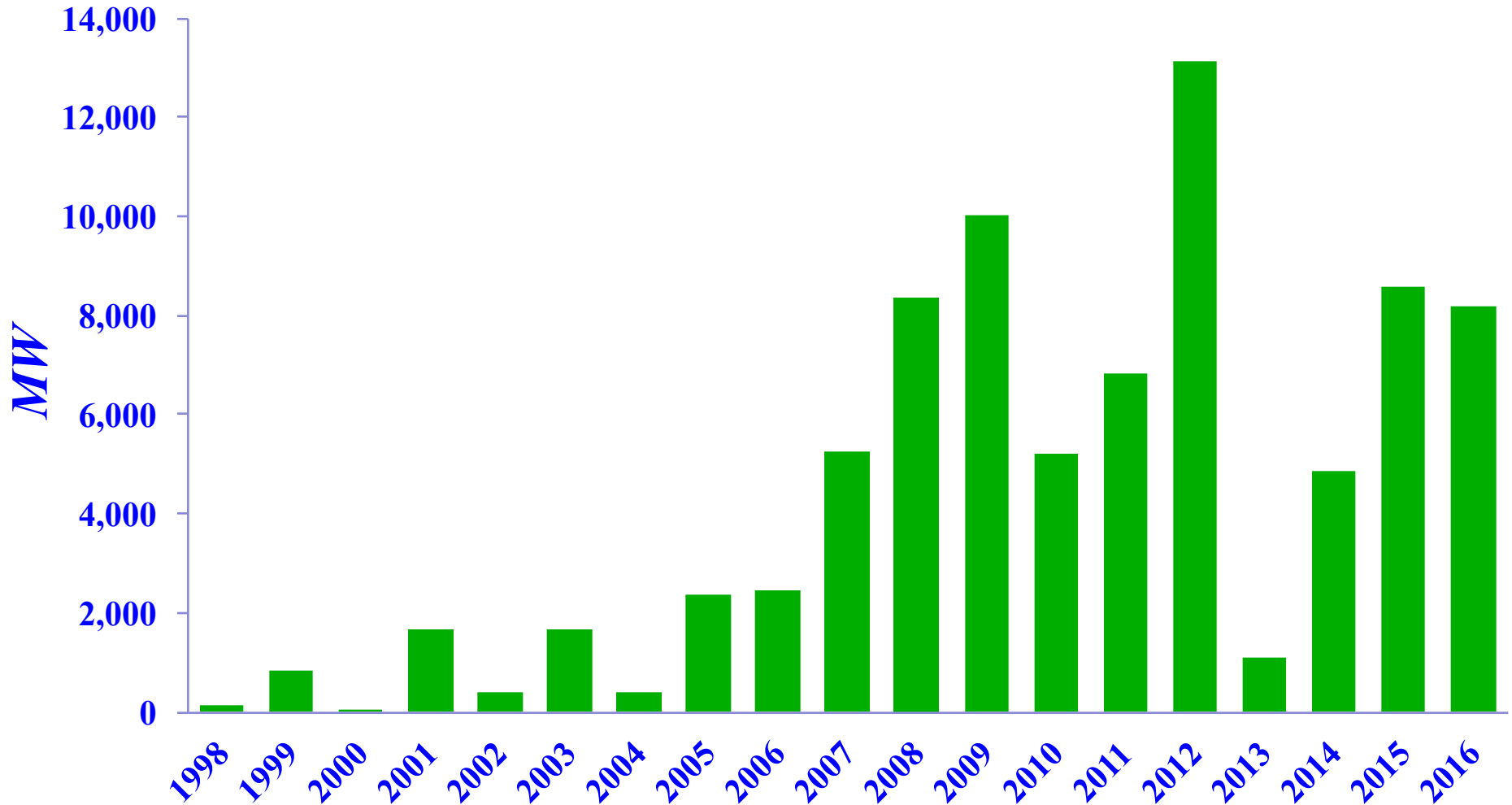
2016 WIND STATUS

- ❑ Overall, wind power ranked as the third largest source of new generation capacity in 2016 – behind solar and natural gas
- ❑ *AWEA* reports wind energy is off to a good start in 2017, with approximately 21 *GW* of wind power capacity was under construction or at an advanced stage of development

CAUSAL FACTORS OF 2016 DEVELOPMENTS

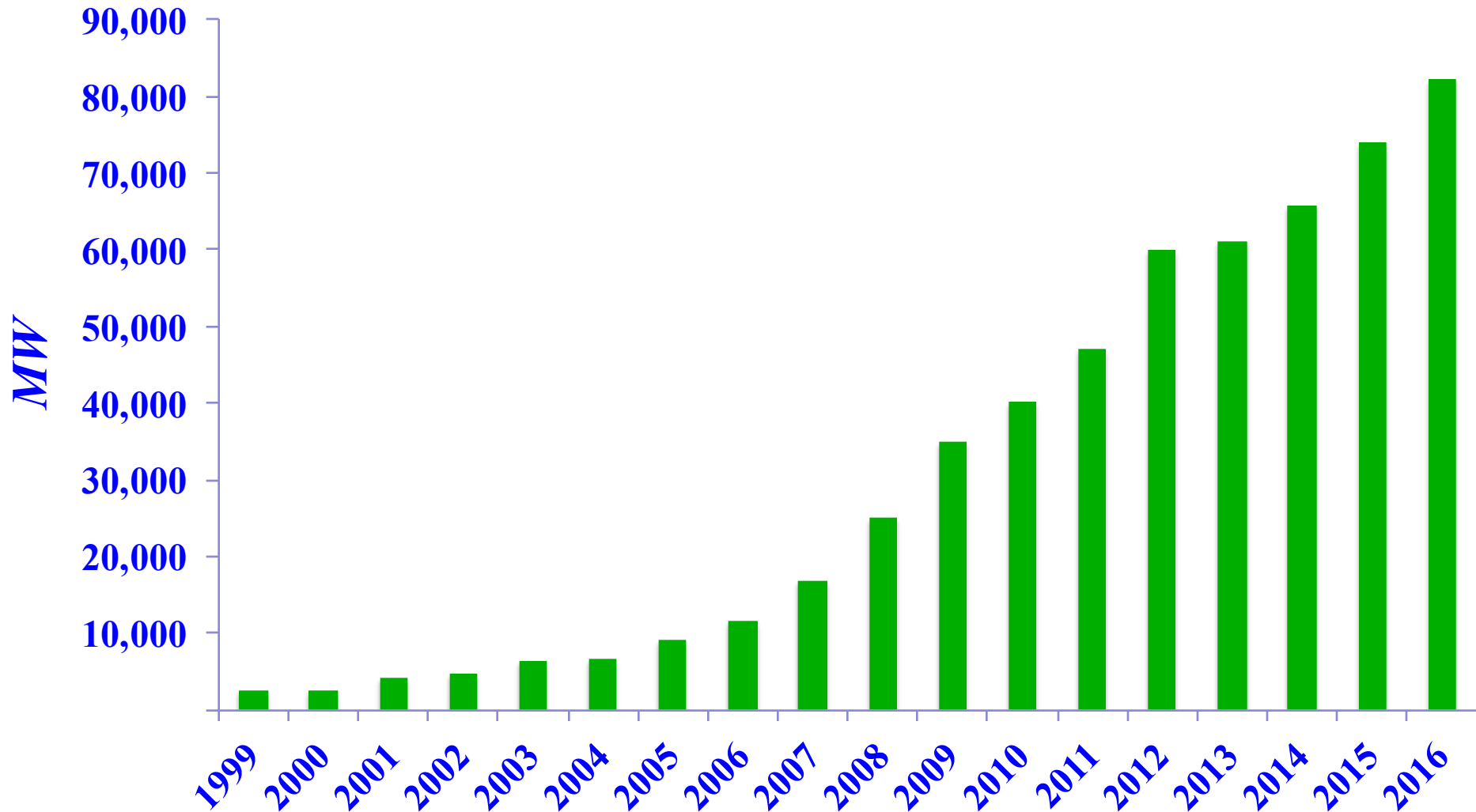
- ❑ Wind projects had to start construction by the end of 2016 in order to qualify for the *PTC* at 100 % of its nominal value
- ❑ Wind sector employment increased from 88,000 at the end of 2015 to 101,000 at the end of 2016

1998 –2016 INSTALLED *US* WIND CAPACITY ADDITIONS



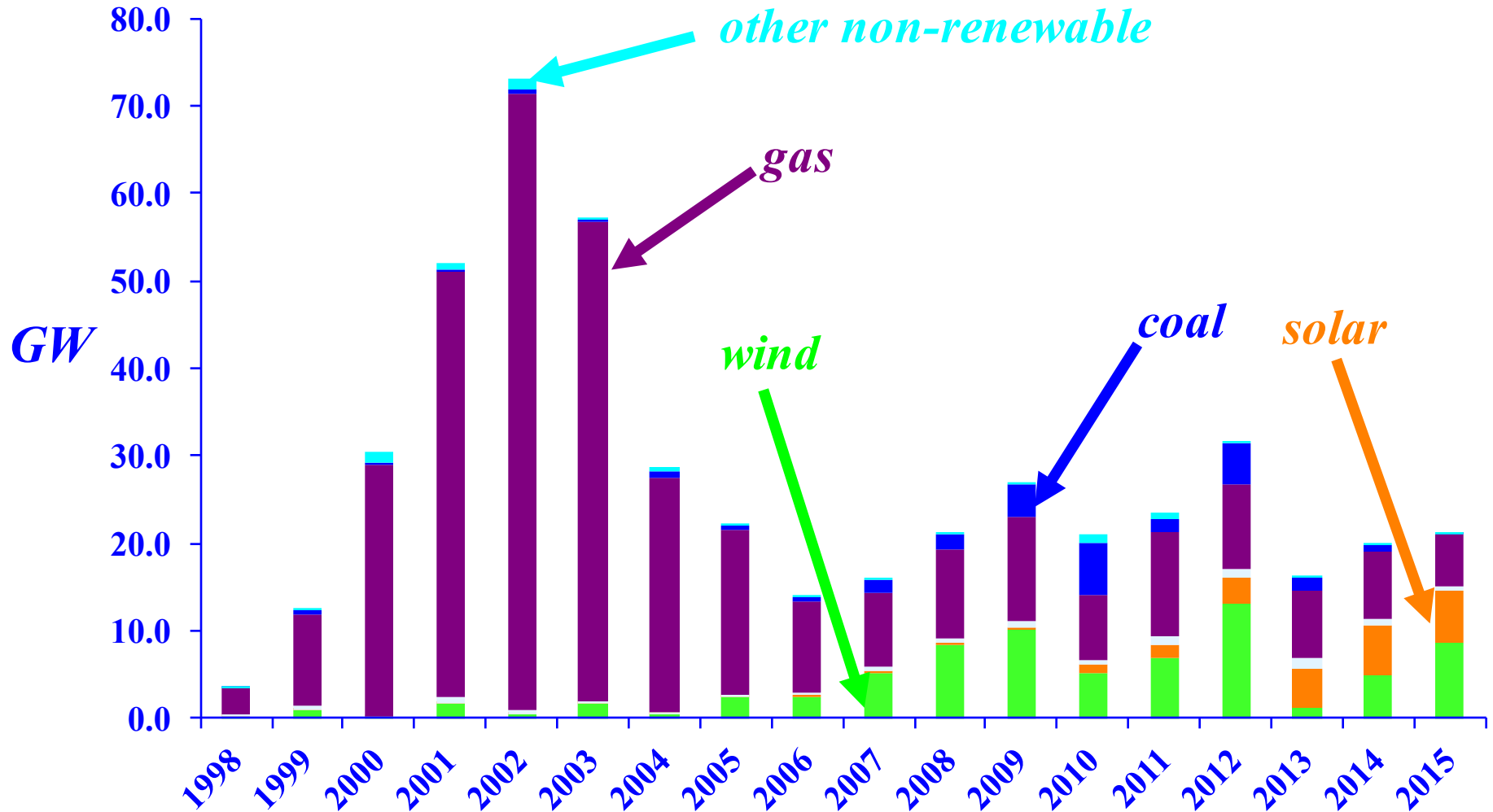
Source: GWEC Global Wind Report Annual Market Update 2016. Page: 74.

US CUMMULATIVE WIND CAPACITY



Source: GWEC Global Wind Report Annual Market Update 2016. Page: 74.

1998 – 2015 *US* CAPACITY ADDITIONS

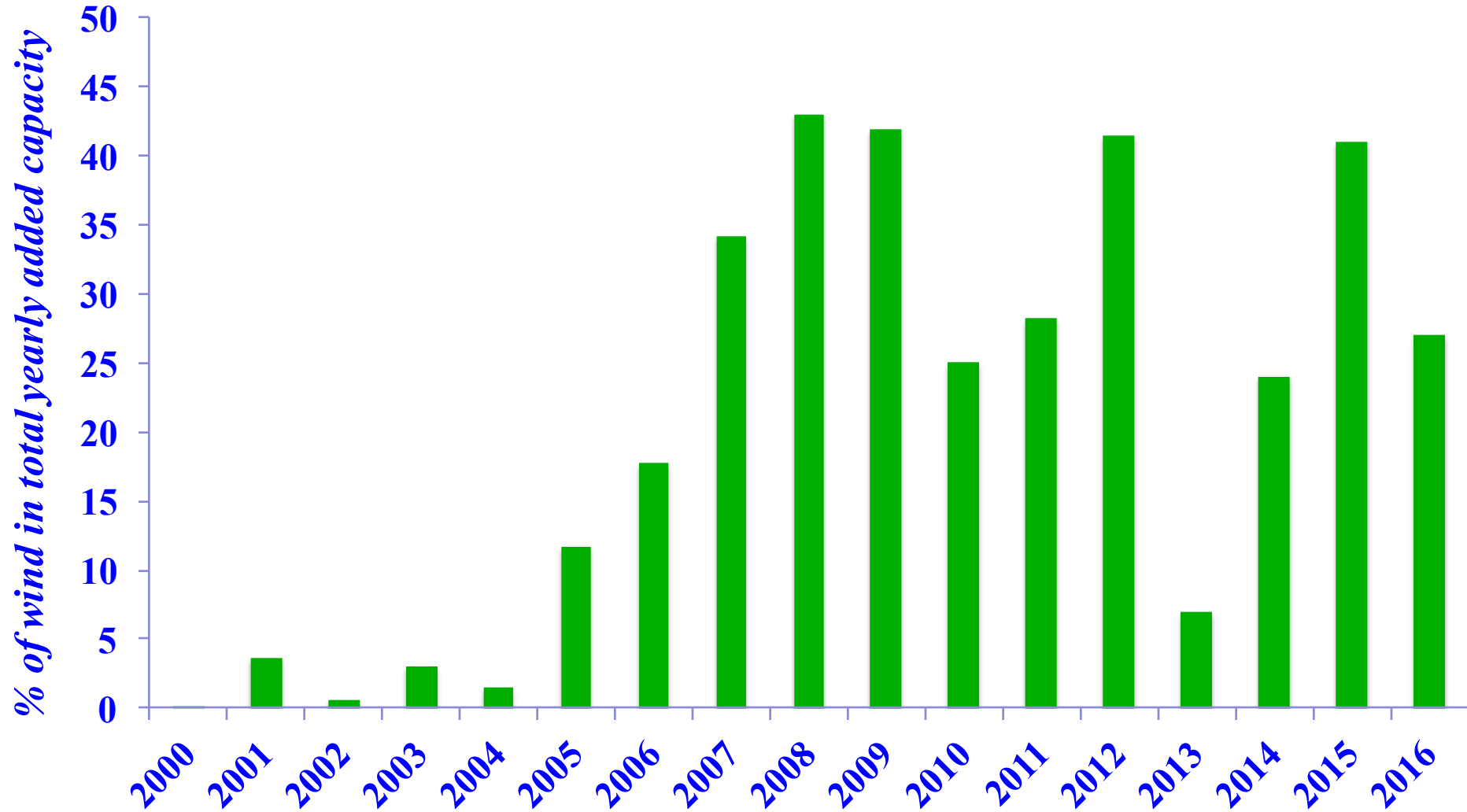


Source: 2015 Wind Technologies Market Report, US Department of Energy, page 4.

<https://energy.gov/sites/prod/files/2016/08/f33/2015-Wind-Technologies-Market-Report-08162016.pdf>

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PERCENTAGE OF WIND IN TOTAL ADDED CAPACITY IN 2000 – 2016



Source: 2016 Wind Technologies Market Report, US Department of Energy, page 16.
https://energy.gov/sites/prod/files/2017/08/f35/2016_Wind_Technologies_Market_Report_0.pdf

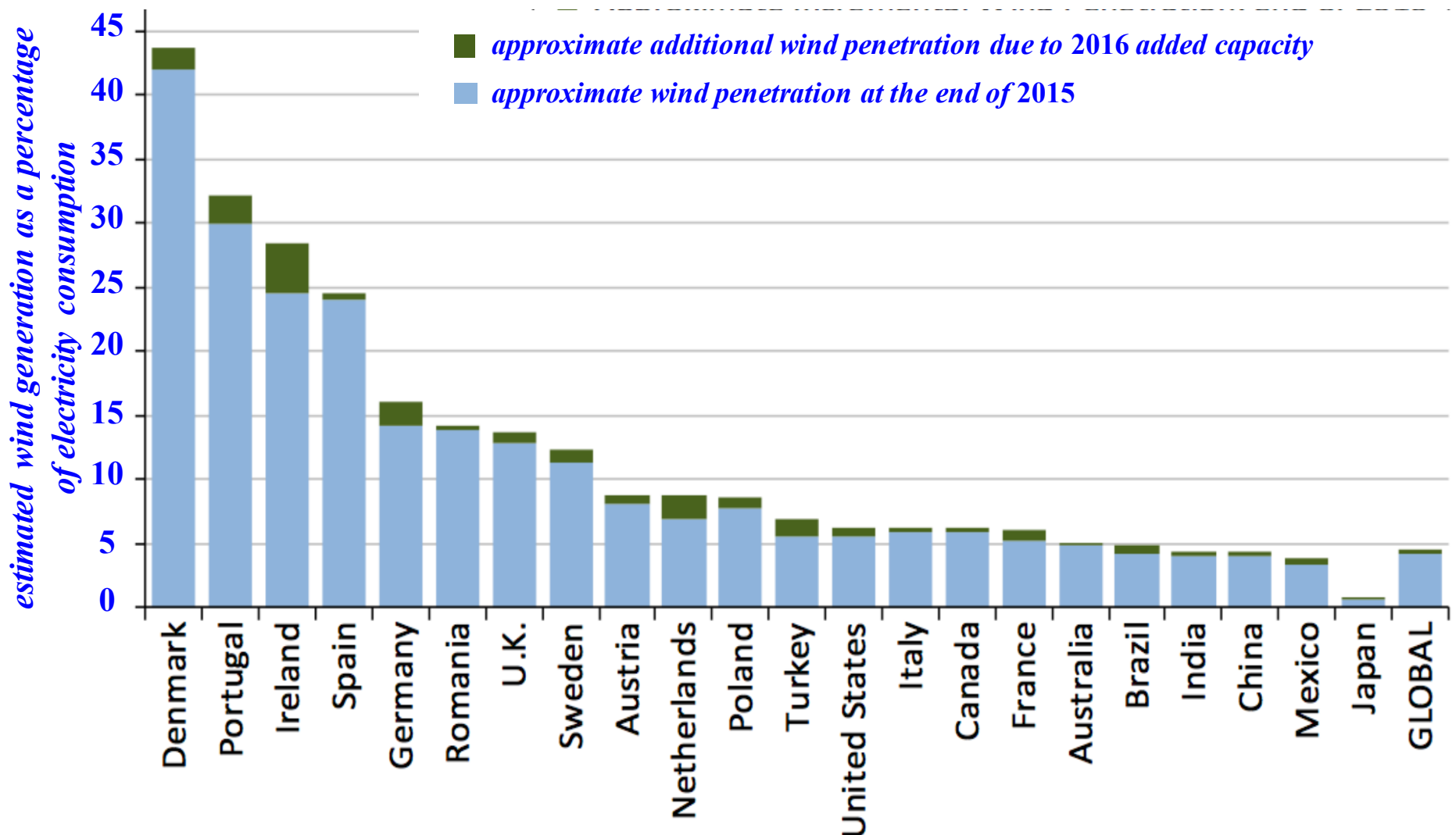
2016 WIND CAPACITY ADDITION AND CUMULATIVE WIND TOTAL

<i>annual capacity in MW</i>		<i>cumulative capacity in MW</i>	
<i>China</i>	23,370	<i>China</i>	168,732
<i>United States</i>	8,203	<i>United States</i>	82,143
<i>Germany</i>	5,443	<i>Germany</i>	50,018
<i>India</i>	3,612	<i>India</i>	28,700
<i>Brazil</i>	2,014	<i>Spain</i>	23,074
<i>France</i>	1,561	<i>United Kingdom</i>	14,543
<i>Turkey</i>	1,387	<i>France</i>	12,066
<i>Netherlands</i>	887	<i>Canada</i>	11,900
<i>United Kingdom</i>	736	<i>Brazil</i>	10,740
<i>Canada</i>	702	<i>Italy</i>	9,257
<i>Rest of the World</i>	6,727	<i>Rest of the World</i>	75,576
<i>total</i>	54,642	<i>total</i>	486,749

Source: 2016 Wind Technologies Market Report, US Department of Energy, page 7.

https://energy.gov/sites/prod/files/2017/08/f35/2016_Wind_Technologies_Market_Report_0.pdf

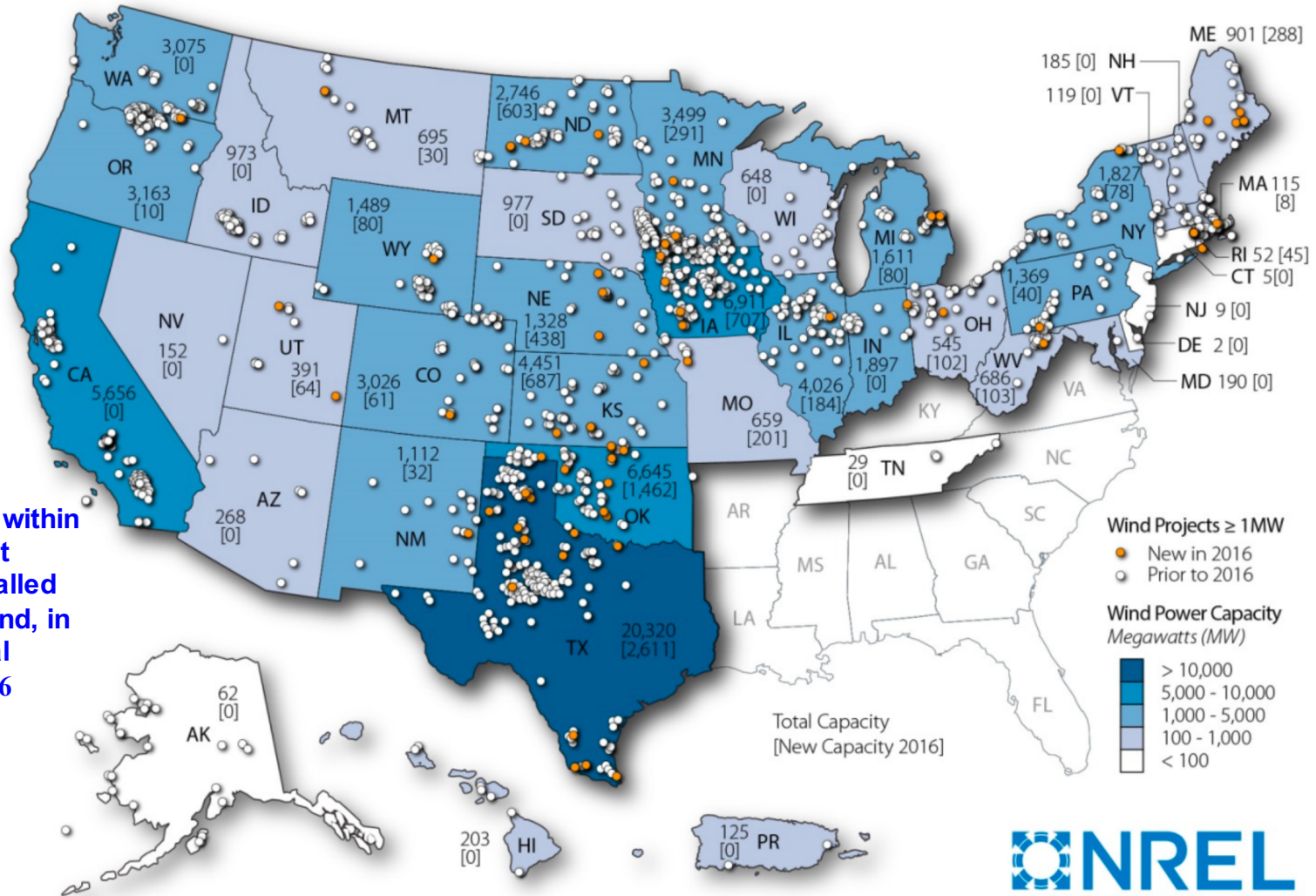
LEADING NATIONS IN WIND ENERGY CONSUMPTION IN 2016



Source: 2016 Wind Technologies Market Report, US Department of Energy, page 7.

https://energy.gov/sites/prod/files/2017/08/f35/2016_Wind_Technologies_Market_Report_0.pdf

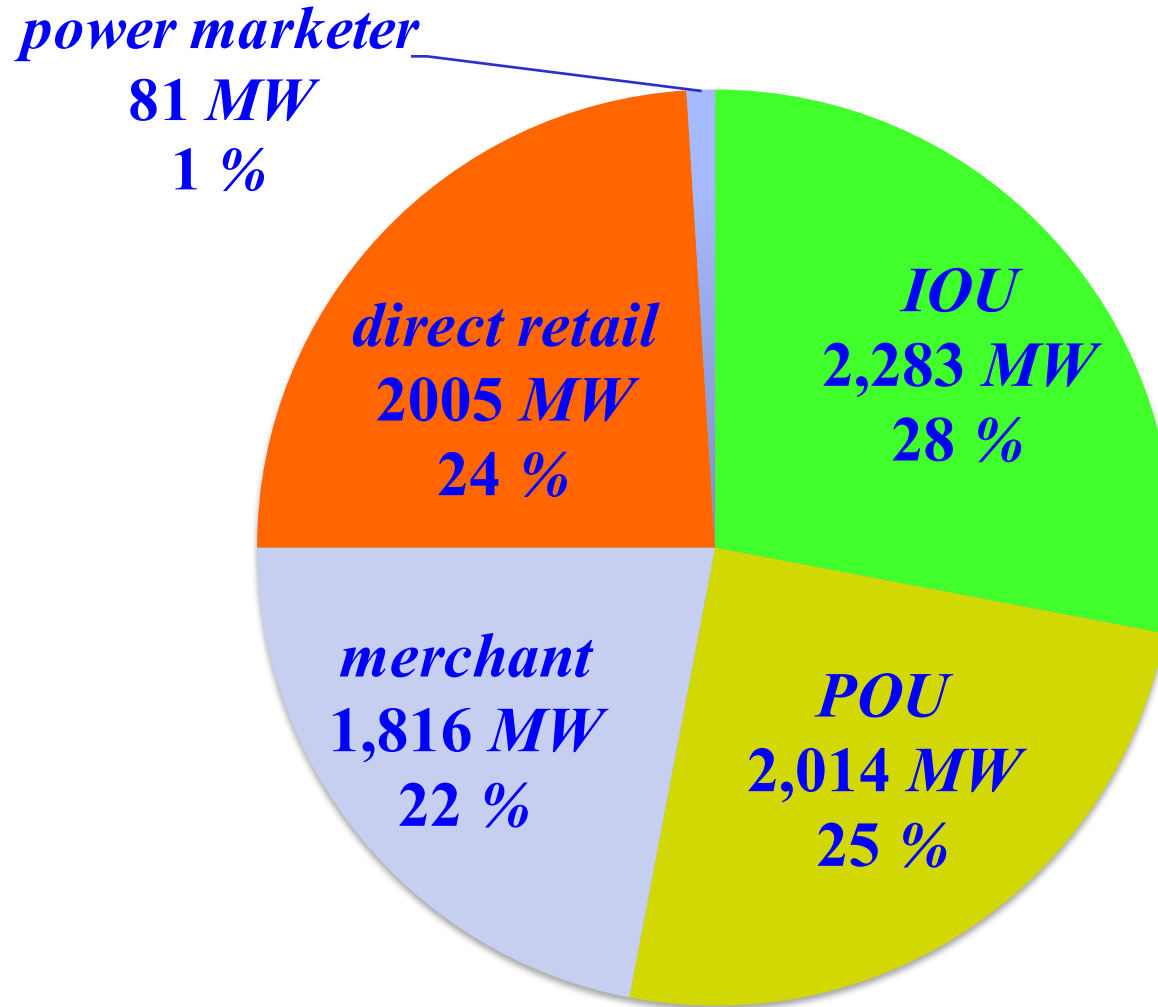
2016 US WIND POWER PROJECTS STATUS



Note: numbers within states represent cumulative installed wind capacity and, in brackets, annual additions in 2016

Source: 2016 Wind Technologies Market Report, US Department of Energy, page 8.
https://energy.gov/sites/prod/files/2017/08/f35/2016_Wind_Technologies_Market_Report_0.pdf

2016 WIND CAPACITY ADDITIONS BY OFF-TAKE CATEGORY



Source: 2016 Wind Technologies Market Report, US Department of Energy, page 36.
https://energy.gov/sites/prod/files/2017/08/f35/2016_Wind_Technologies_Market_Report_0.pdf

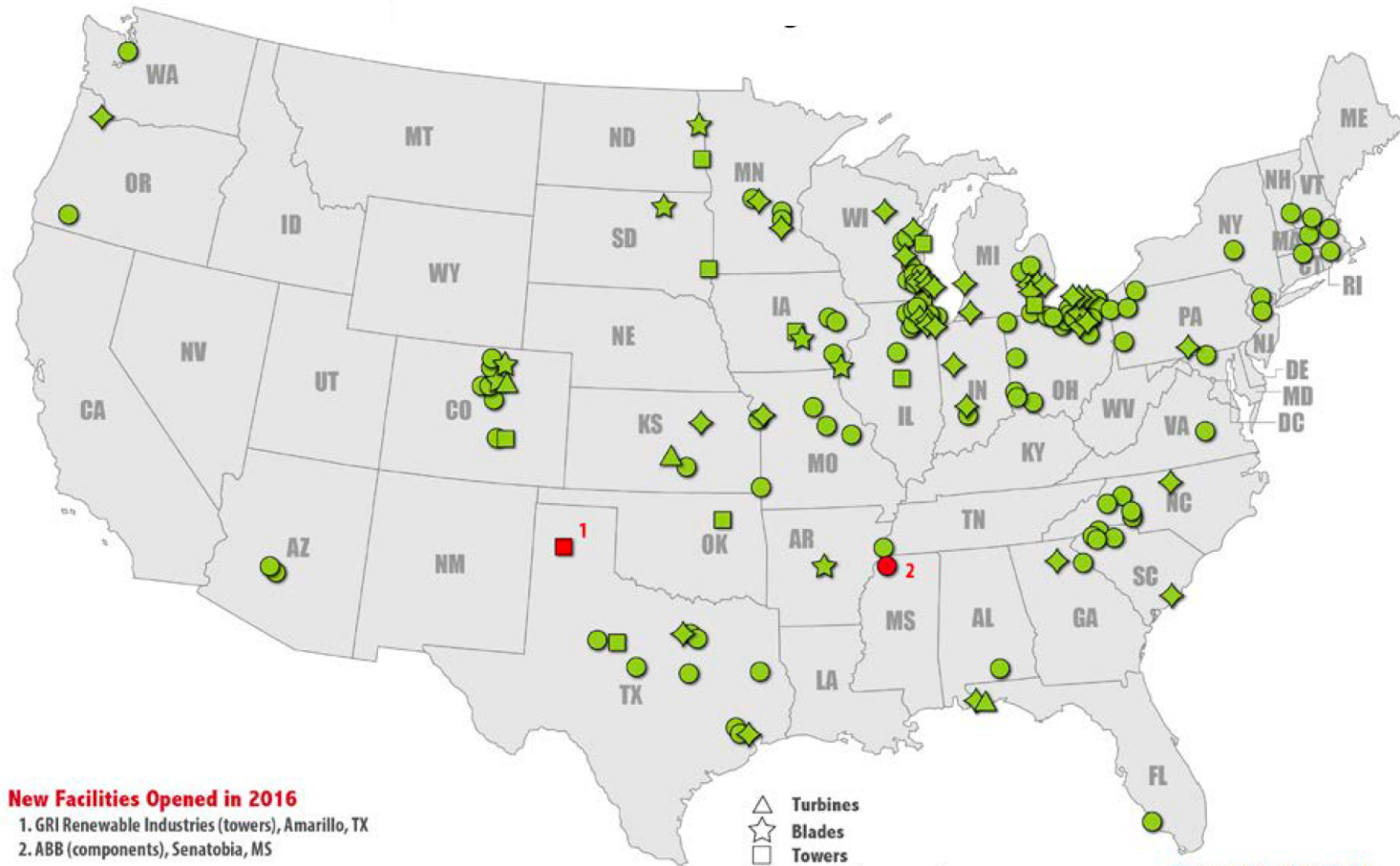
US WIND MANUFACTURER STATUS

- ❑ The manufacturing supply chain continued to adjust to swings in demand for wind equipment
- ❑ Of the 8,203 *MW* of wind installed in 2016, 43 % (3,530 *MW*) used turbines from Vestas, 42 % (3,415 *MW*) from *GE* Wind, and 10 % (829 *MW*) from Siemens
- ❑ Other suppliers included Gamesa (318 *MW*), Nordex (93 *MW*), Vensys (15 *MW*), and Goldwind (1.5 *MW*)

US WIND MANUFACTURER STATUS

- ❑ In 2016, domestic nacelle assembly capability was about 11.7 *GW*, and the *US* had the capability to produce approximately 8 *GW* of blades and 7 *GW* of towers annually
- ❑ *US* exports of wind-powered generating sets has been declining from \$ 488 million in 2014 to \$ 151 million in 2015 and \$ 17 million in 2016
- ❑ The sharp decrease in exports since 2014 may indicate that the fast-rising *US* wind market absorbed much of the local production of wind turbine equipment

US WIND MANUFACTURER SITES




New Facilities Opened in 2016

1. GRI Renewable Industries (towers), Amarillo, TX
2. ABB (components), Senatobia, MS

Figure includes wind turbine and component manufacturing facilities, as well as other supply chain facilities, but excludes corporate headquarters and service-oriented facilities. The facilities shown here are not intended to be exhaustive. Those facilities designated as "Turbines" may include turbine and/or nacelle assembly and in some cases the manufacturing of towers, nacelle components, blades or other components.

- △ Turbines
- ☆ Blades
- Towers
- ◇ Nacelle Components
- Other
- New facilities opened in 2016
- New facilities announced in 2016
- Existing facilities online prior to 2016

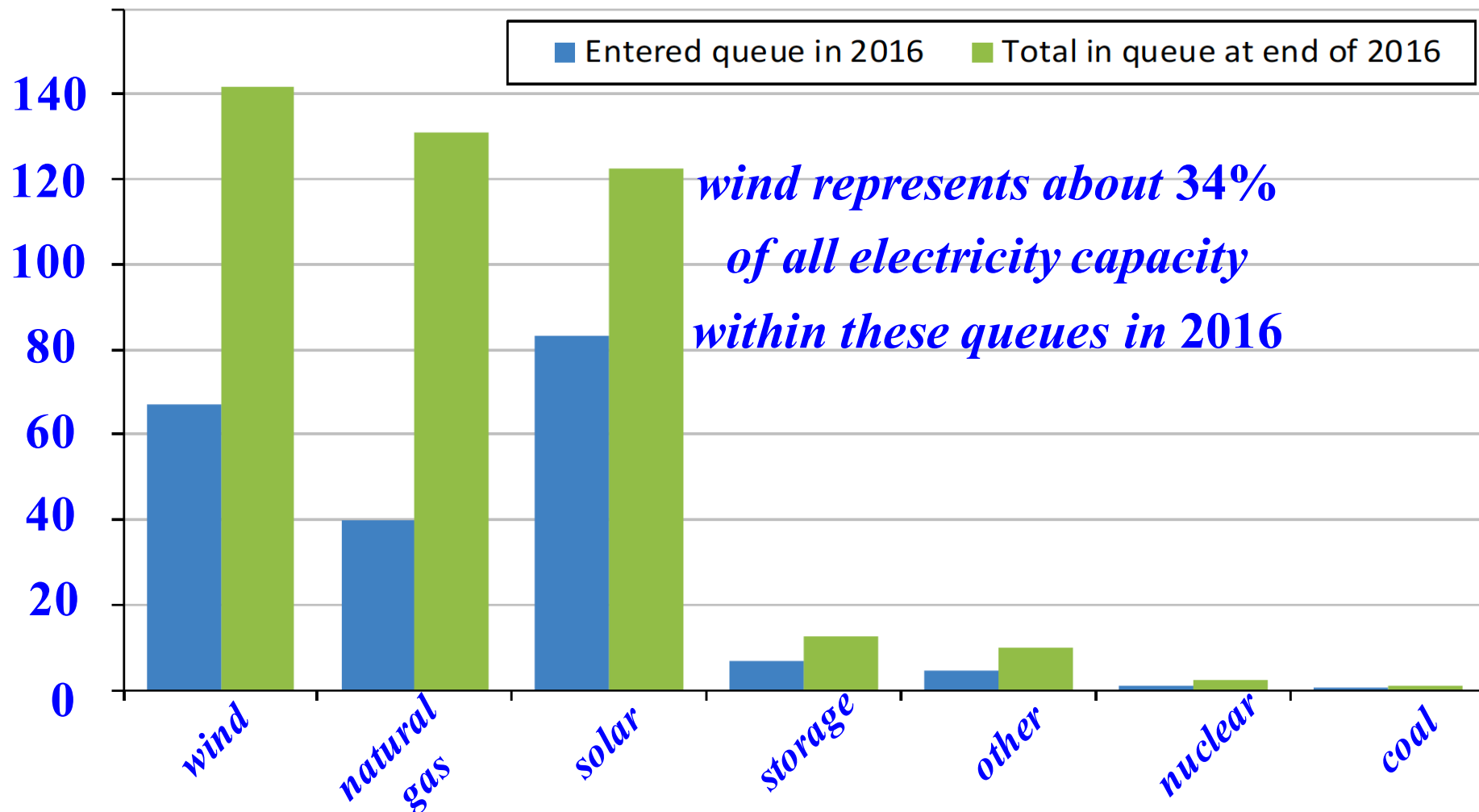
This map was produced by the
National Renewable Energy Laboratory
for the US Department of Energy.
Billy J. Roberts | June 1 2017



NATIONAL RENEWABLE ENERGY LABORATORY

INTERCONNECTION QUEUES

GW



Source: 2016 Wind Technologies Market Report, US Department of Energy, page 21.

https://energy.gov/sites/prod/files/2017/08/f35/2016_Wind_Technologies_Market_Report_0.pdf

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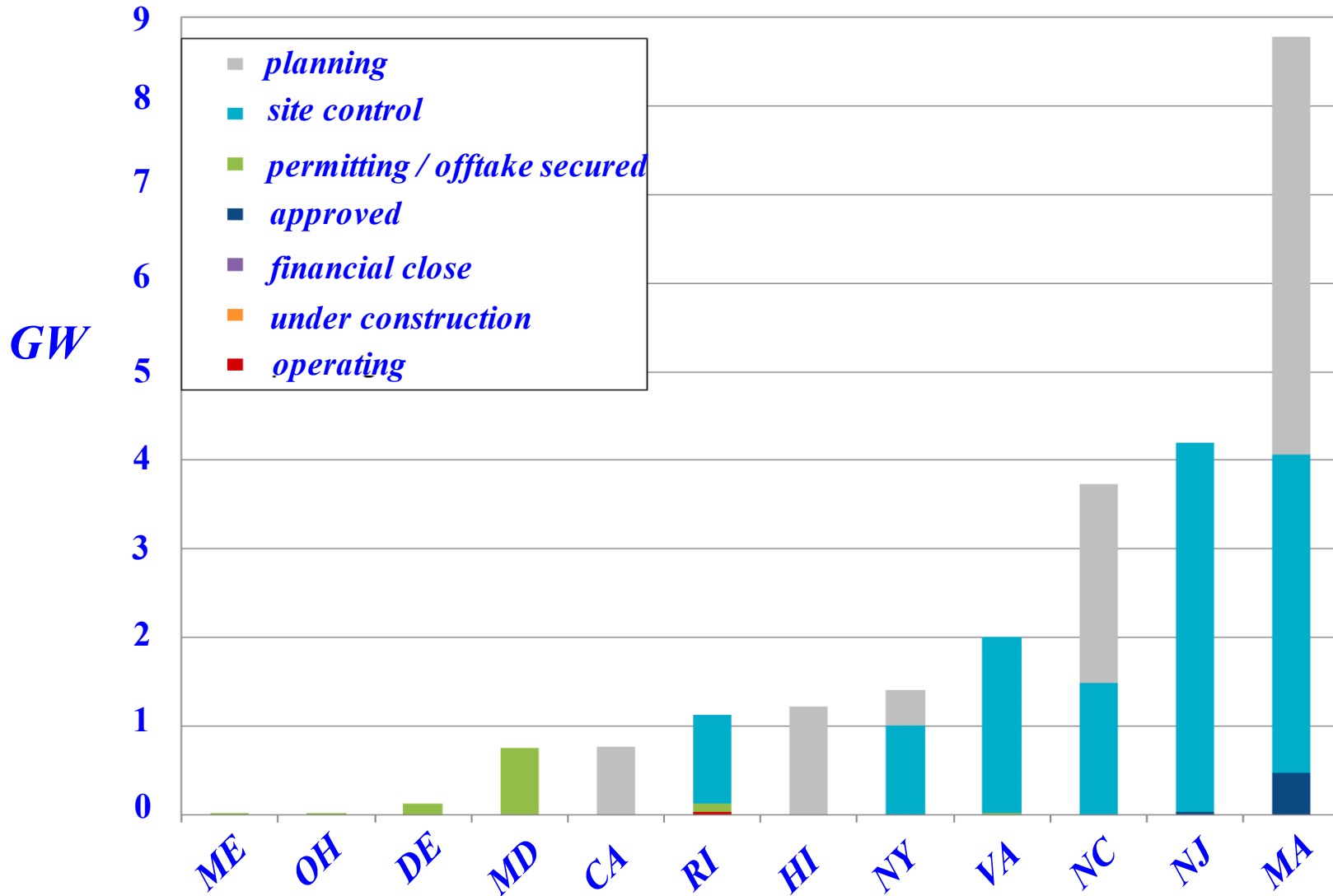
OFFSHORE WIND POWER

- ❑ Offshore wind is typically **faster** and **steadier** than onshore wind
- ❑ Offshore wind entails higher construction and maintenance **costs** than onshore wind
- ❑ Offshore wind may be an unwelcome sight for local residents and impacts the marine life

2016 STATUS OF *US* OFFSHORE WIND POWER

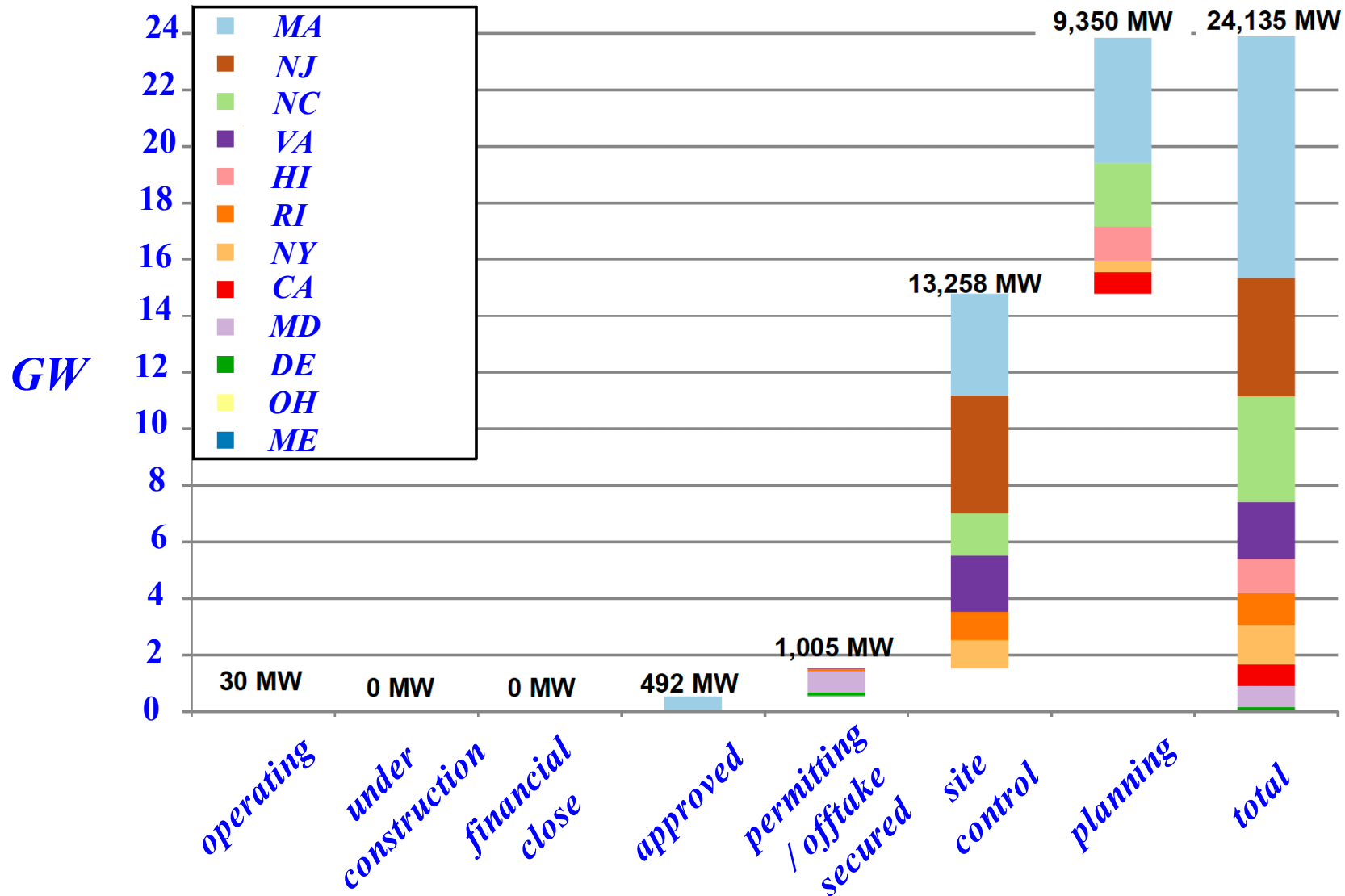
- ❑ In December 2016, Deepwater Wind completed the commissioning of the first commercial offshore wind project in the *US*
- ❑ As of June 2017, a total of 26 offshore wind projects totaling more than 24.1 *GW* are in various stages of development in the *US*

2016 US OFFSHORE WIND PROJECT PIPELINE BY STATE



Source: 2016 Offshore Wind Technologies Market Report, US Department of Energy, page 31.
<https://energy.gov/sites/prod/files/2017/08/f35/2016%20Offshore%20Wind%20Technologies%20Market%20Report.pdf>

2016 US OFFSHORE WIND PROJECT PIPELINE BY PROJECT STATUS



Source: 2016 Offshore Wind Technologies Market Report, US Department of Energy, page 30.
 files/2017/08/f35/2016%20Offshore%20Wind%20Technologies%20Market%20Report.pdf

NREL REPORT ON US OFFSHORE WIND POTENTIAL

- ❑ Offshore wind turbines currently need to be in relatively shallow water and the maximum distance from the shore depends on the nature of the seabed
- ❑ Capacity factors tend to increase as turbines move further offshore into deeper waters

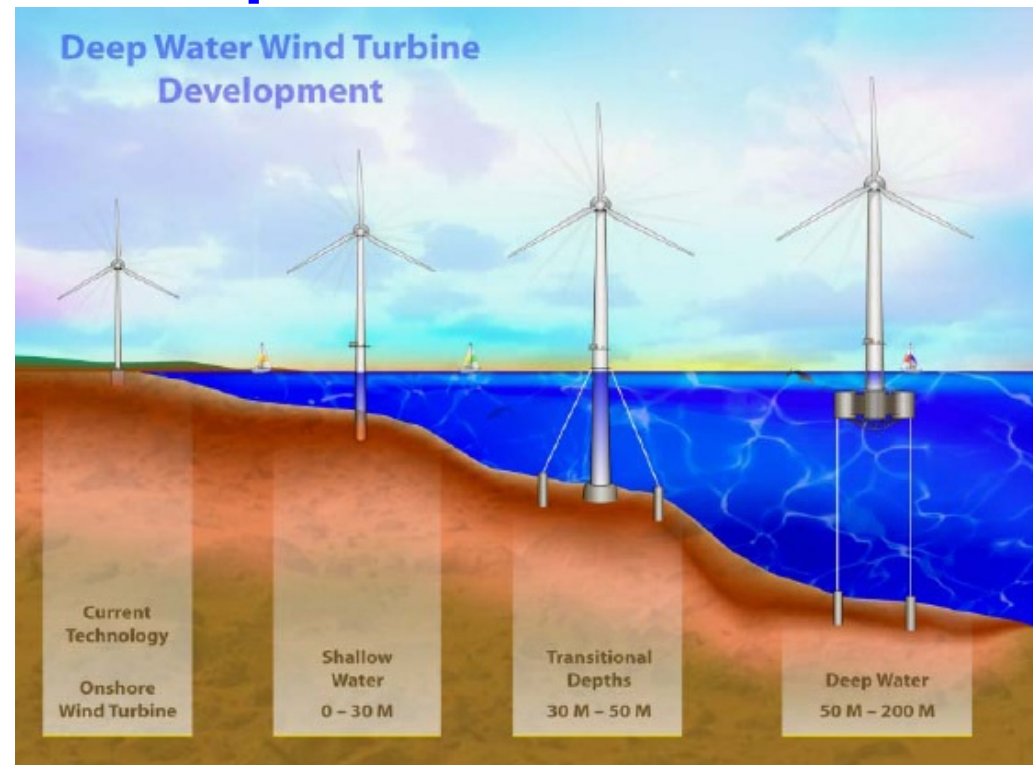
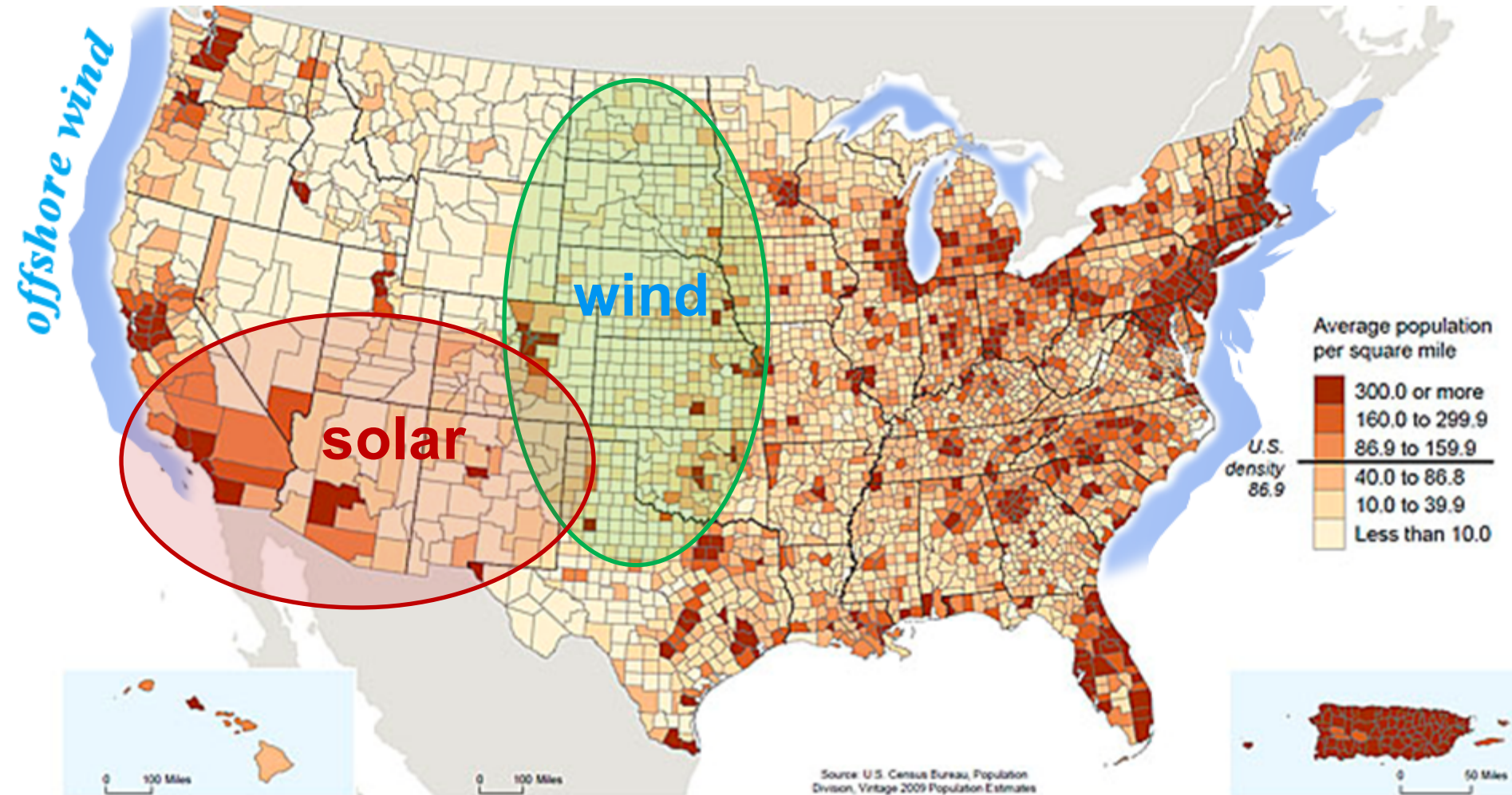


Image Source: National Renewable Energy Laboratory

NREL REPORT ON US OFFSHORE WIND POTENTIAL

- ❑ *NREL* issued a report discussing *US* offshore wind potential, with its key conclusion being that *US* could get about 54 *GW* of new offshore wind by 2030
- ❑ Offshore wind has a significant advantage that the **supply** is located relatively close to the high-density load regions in urban areas
- ❑ The leading offshore wind producers are *Great Britain, Denmark, and Holland*

US POPULATION DENSITY AND RENEWABLE RESOURCE LOCATIONS



Source: http://www.census.gov/popest/data/maps/2009/PopDensity_09.jpg

BLOCK ISLAND WIND FARM

- ❑ **First** commercial *US* offshore wind farm
- ❑ Installed capacity: **30 MW** (5 turbines)
- ❑ **5 6-MW** Halidae turbines produced by *GE*
- ❑ **21 miles** submarine power cable
- ❑ *PPA* initial price: **24.4 ¢/kWh**

PROJECT KEY CHARACTERISTICS

- ❑ Absence of **economies of scale**
- ❑ **Large investment**
- ❑ **Uncompetitive prices**
- ❑ **Imported technology**
- ❑ **Long delays from September 2008 start date**
- ❑ **Major breakthrough for offshore wind in the *US***

LARGEST OFFSHORE WIND FARM

- ❑ **UK ministry approved the proposal for *East Anglia***

***One* offshore wind farm, comprising 240 turbines**

with a cumulative capacity of 1,200 *MW*

- ❑ **The project will be more than double the size of**

the *London Array*, the largest offshore wind farm

currently in existence

LARGEST OFFSHORE WIND FARM

- ❑ *East Anglia One* is located about 45 *km* from the *Suffolk* coast and will have up to 4 submarine *DC* cables for interconnection with the National Grid's transmission network
- ❑ The project area will cover roughly 300 *km*² and will be able to generate energy to supply 820,000 British households