Introduction to Offshore Wind in the U.S.

AADE New Orleans Chapter
2022 Technical Forum
May 19, 2022

David Hasselbeck

Project Engineering and Value Management Lead
Atlantic Shores Offshore Wind

Agenda

- My background
- Why Offshore Wind
- US Outlook
- Scope of a Project
- Project Development Roadmap


Rampiom Offshore Wind Farm - Courtesy of Kent

A bit about me… David Hasselbeck

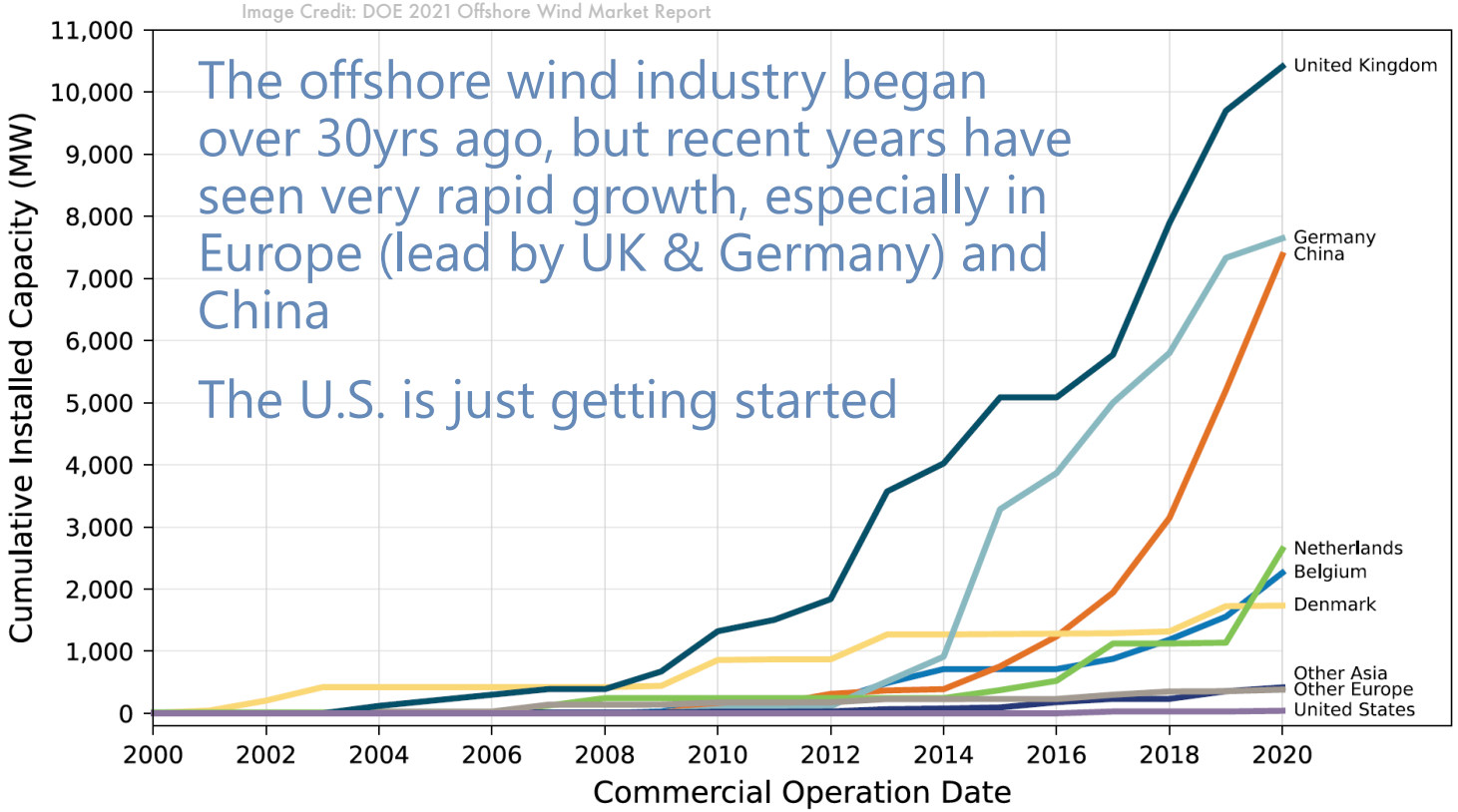
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
New Hire / NTP	~7 mo												
Offshore (14/14 rotation)		~18 mo											
Asset Focal Point				~2.5 yrs									
New Major Project Define/Execute/Operate											~4.5 yrs		
Offshore Wind – Early Phase													3 yrs

- Born in PA, raised in MI – Chemical Engineering BS – Michigan State Univ
- ~22 months of internships during university in Automotive Coatings (PPG), Extruded Flexible Packaging (Bemis), Biotech scale-up (Genentech), Microprocessor Fab (IBM), Refinery process controls (Shell Motiva)
- ~12 years into professional career with Shell, 5 discrete roles across 5 assets. NOLA → Offshore → NOLA → Boston
- Moved to Boston with my wife and our yorkie in 2019 to support offshore wind development in the Mid-Atlantic (Atlantic Shores Offshore Wind)

Why Offshore Wind?

- There is a growing demand for low-carbon electricity
  - More than 2/3 of the global economy committed to achieve Net Zero emissions, including the US by 2050
  - This drives the shift to electrification of commercial, industrial, and transportation sectors (plug-in electric vehicles, heat pumps, etc.)

Image Credit: DOE 2021 Offshore Wind Market Report



- Offshore wind is the best available technology to meet this demand
  - The cost of electricity from wind has decreased dramatically as the scale of the industry and supply chain has grown globally
  - Offshore wind can be deployed on the major commercial (GW+) scale:
    - Availability of substantial area for offshore development
    - Higher average wind speeds compared with onshore
    - Ability to transport and install much larger wind turbines
    - Siting offshore nearby major load centers (urban areas)

The Electric Grid Today

36.6 quadrillion BTUs of electricity generated in the US in 2021

- =10.7 million GWh/yr
- = 1,200 gigawatts generated on average all day every day all year

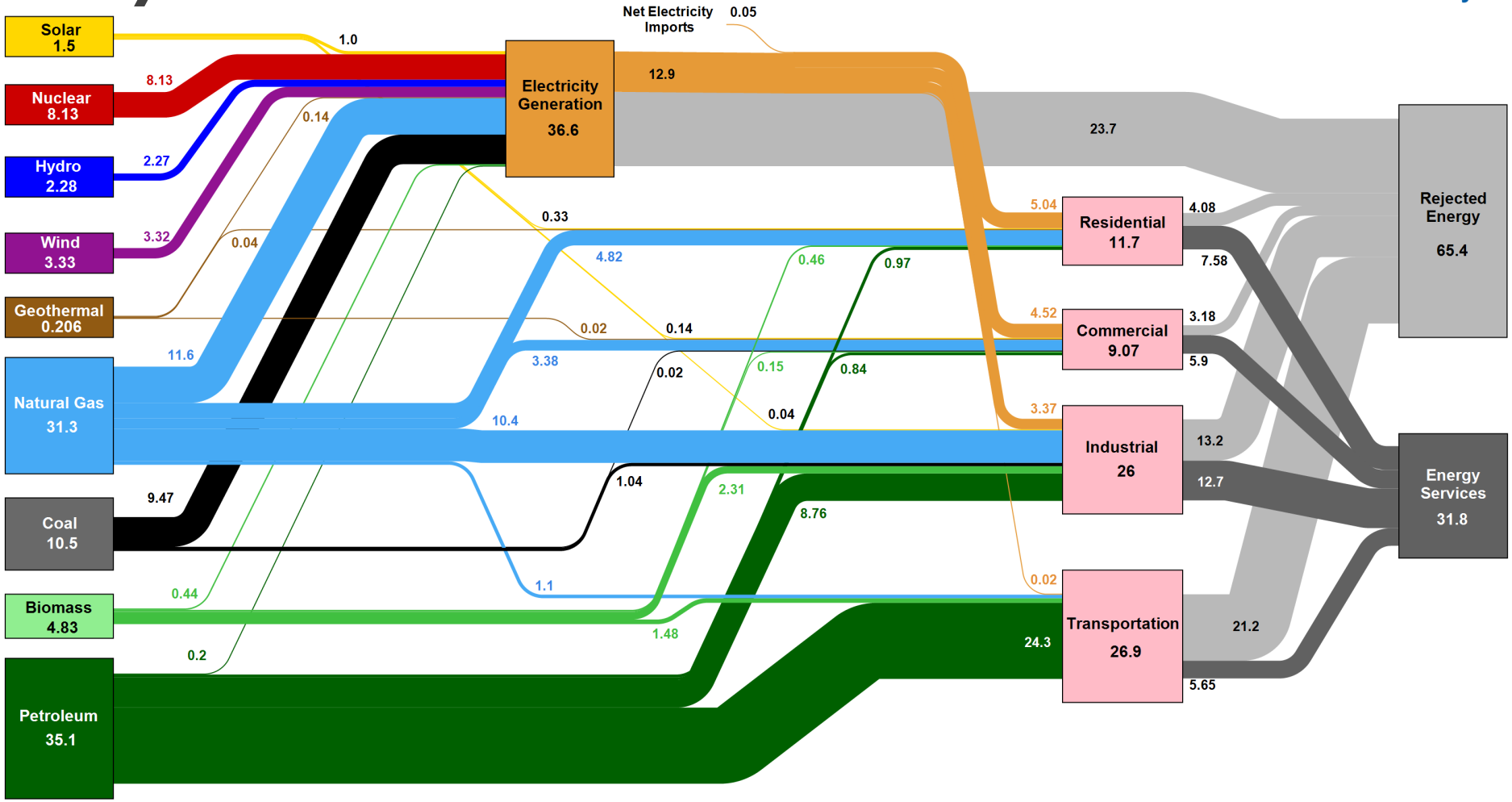
Of this, in 2021 about 9% of electricity came from wind generation (nearly all onshore wind)

A 1,500 MW (1.5 GW) capacity wind farm (~100 wind turbines) would generate ~6,000 GWh/yr or ~0.06% of 2021 US electricity demand

30 GW of installed offshore wind capacity would be 120,000 GWh/yr or ~1% of 2021 US electricity demand

Estimated U.S. Energy Consumption in 2021: 97.3 Quads

Lawrence Livermore National Laboratory

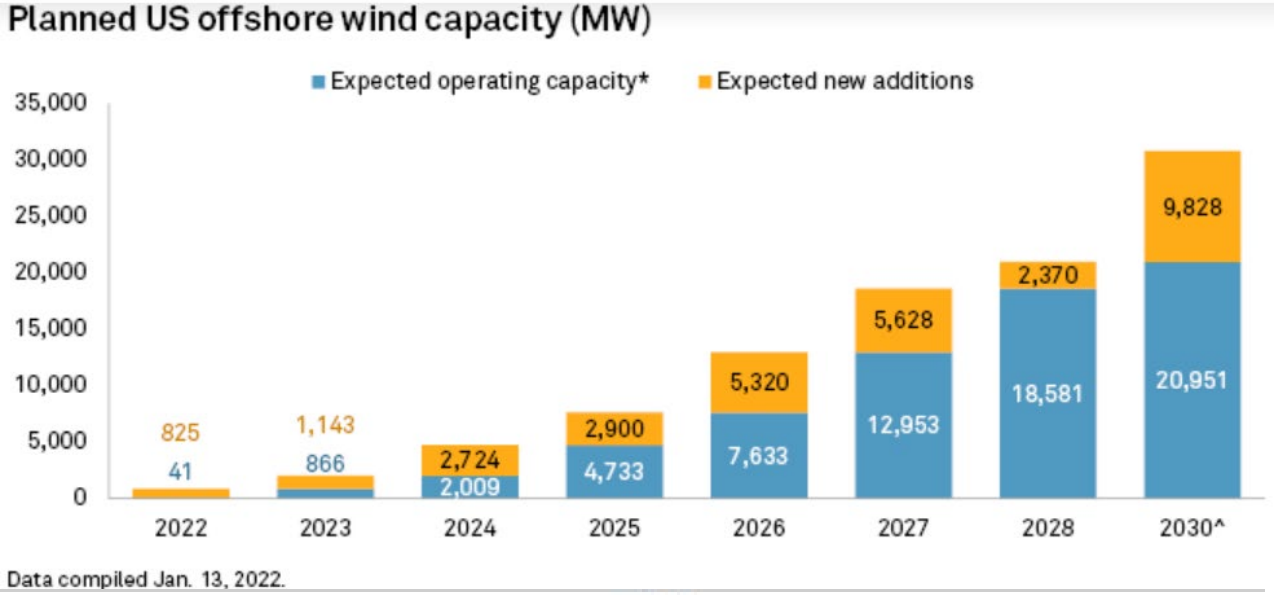


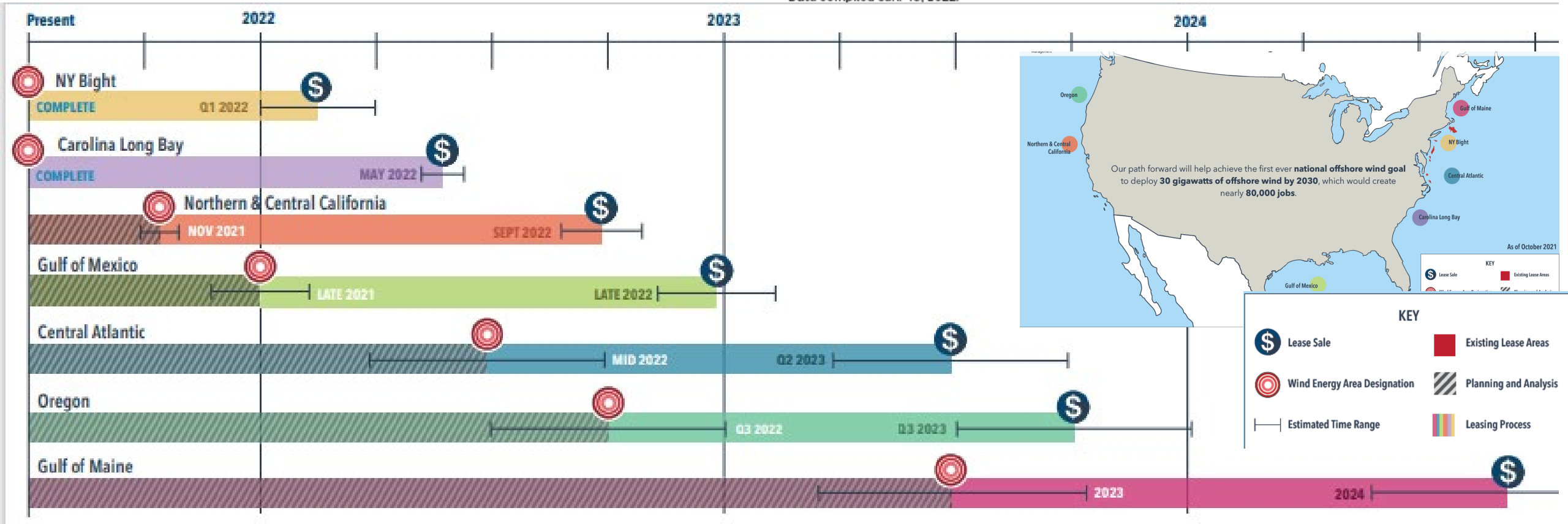
1 Quad = 1 quadrillion BTUs ≈ 185 million bbls of crude oil ≈ 293,000 GWh

US Offshore Wind Outlook "30GW by 2030"

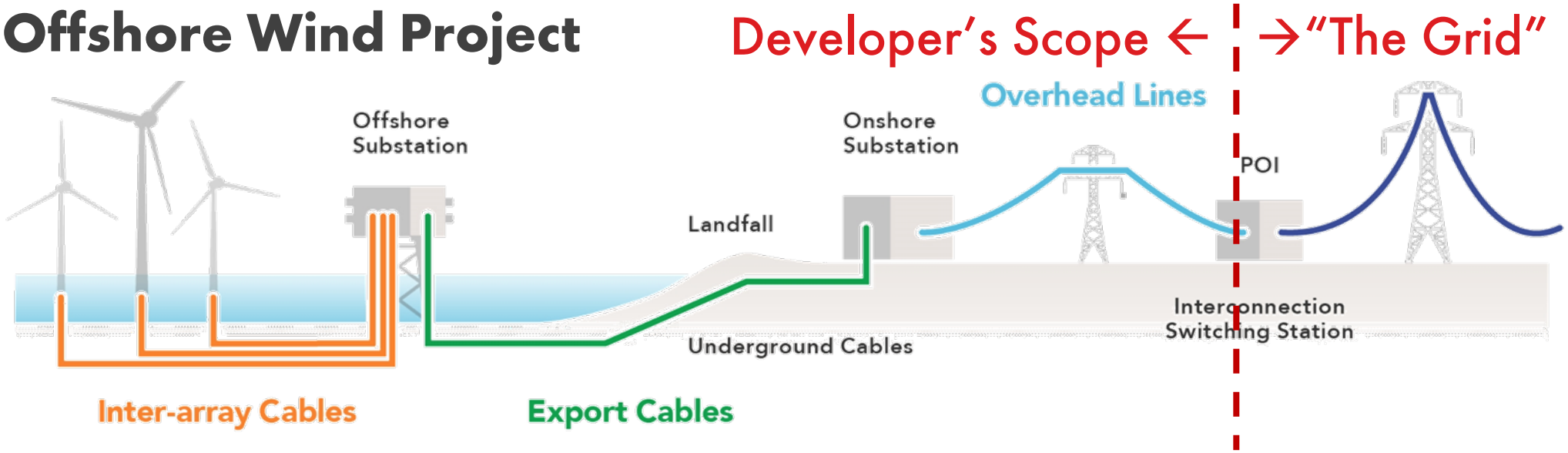
Recent and upcoming federal seabed lease auctions in the US

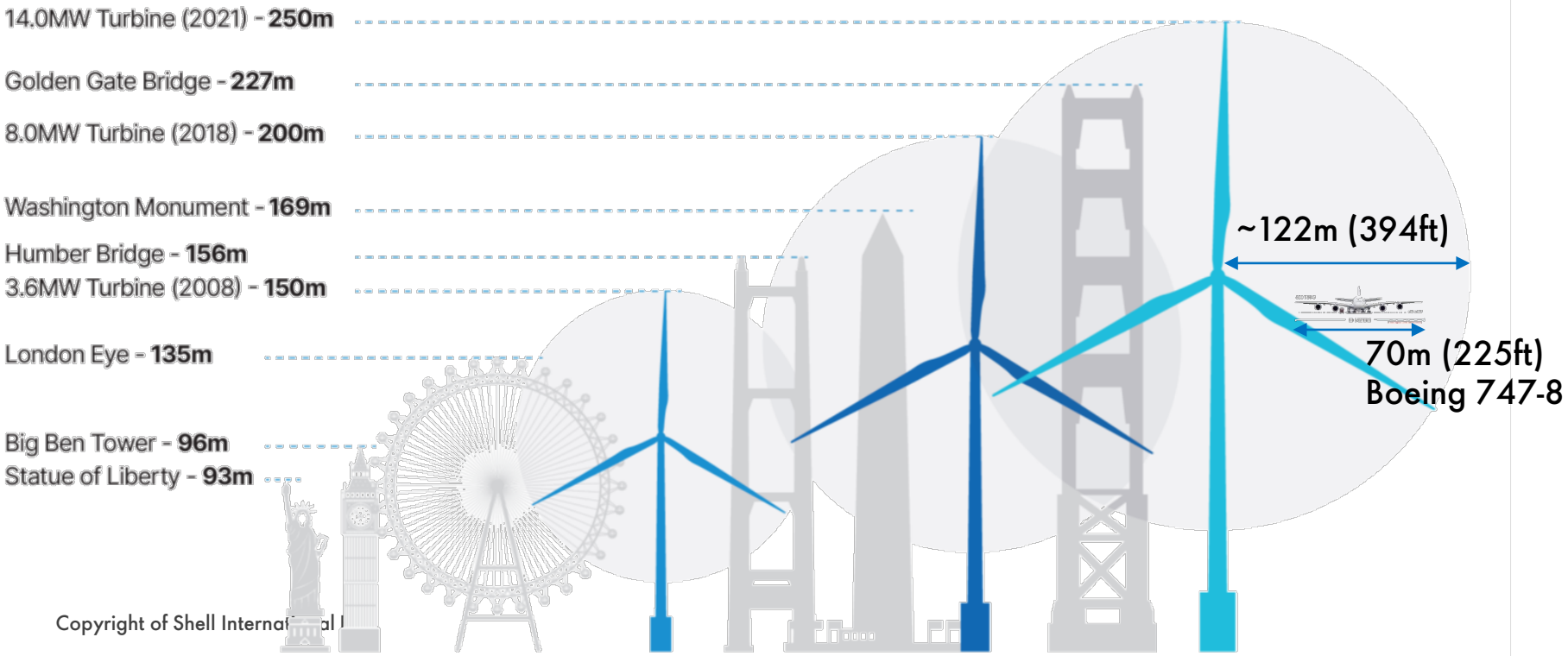
- NY Bight Leased 6 sites for ~$4.4bn
- Carolina auction last week - 2 sites, $315M
- GoM leasing expected in next 12 months





Scope of an Offshore Wind Project





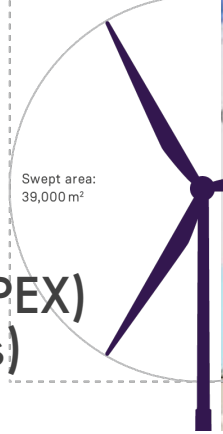
Offshore Wind Turbine Generators (WTGs)

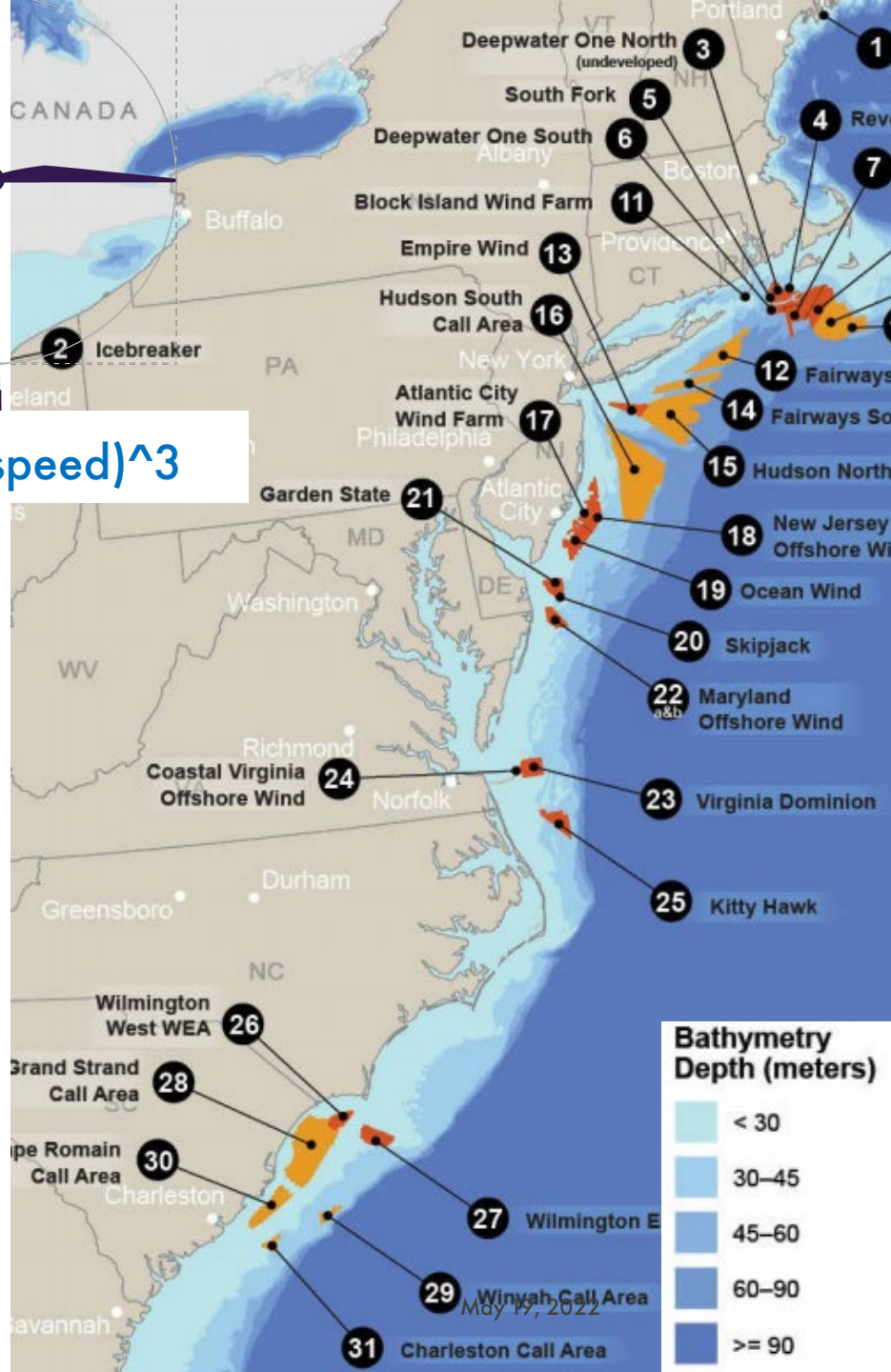
- CVOW (Virginia) installed 6MW WTGs in 2020
- Current Projects in development with 2023-24 startup have 12-13 MW WTGs
- ~15MW by 2025
- ~20MW by 2030

Project Siting

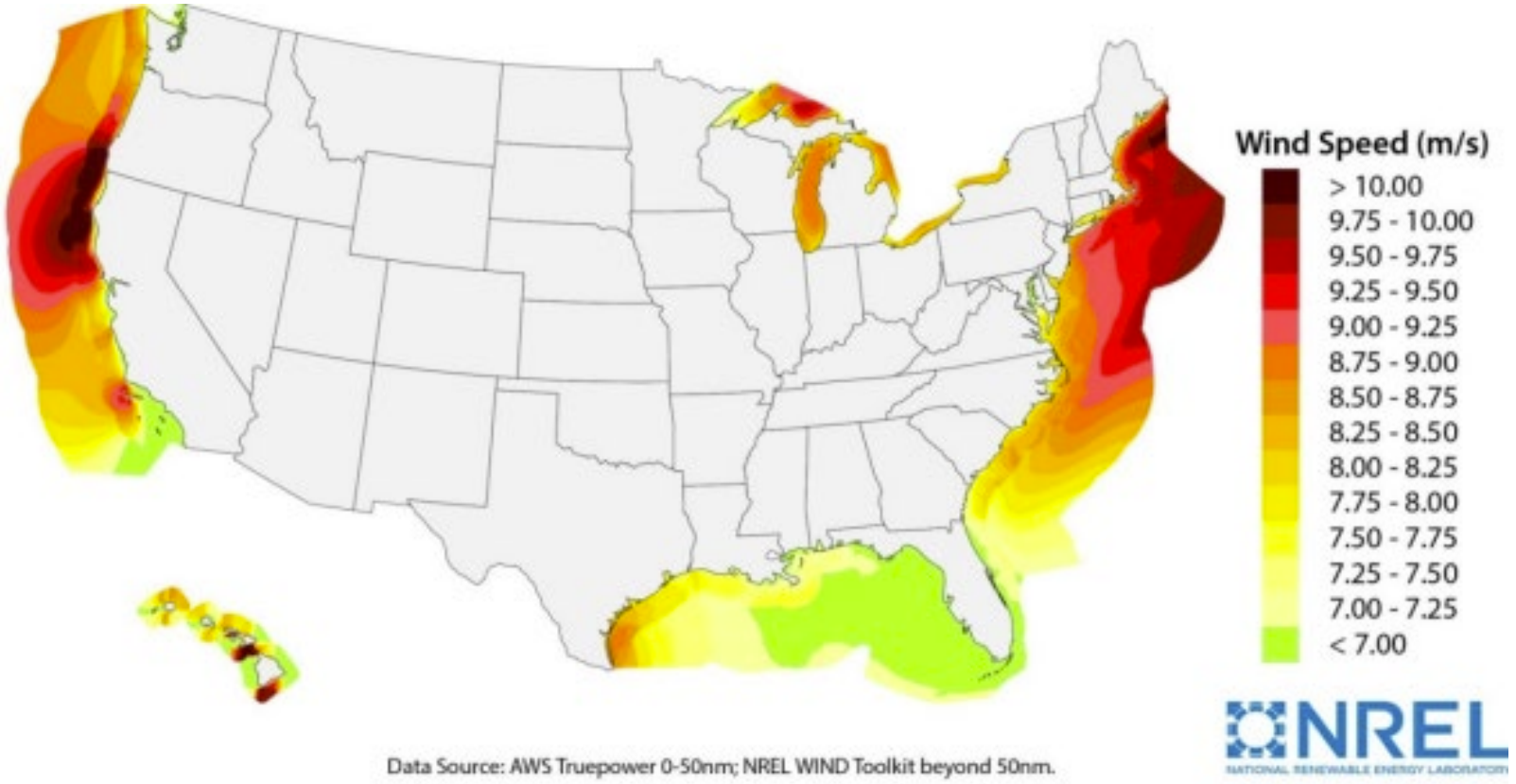
Ideal project locations are:

- Areas of high average wind speed
- Shallower water (less expensive foundations / lower CAPEX)
- Near large energy markets (power purchase agreements)



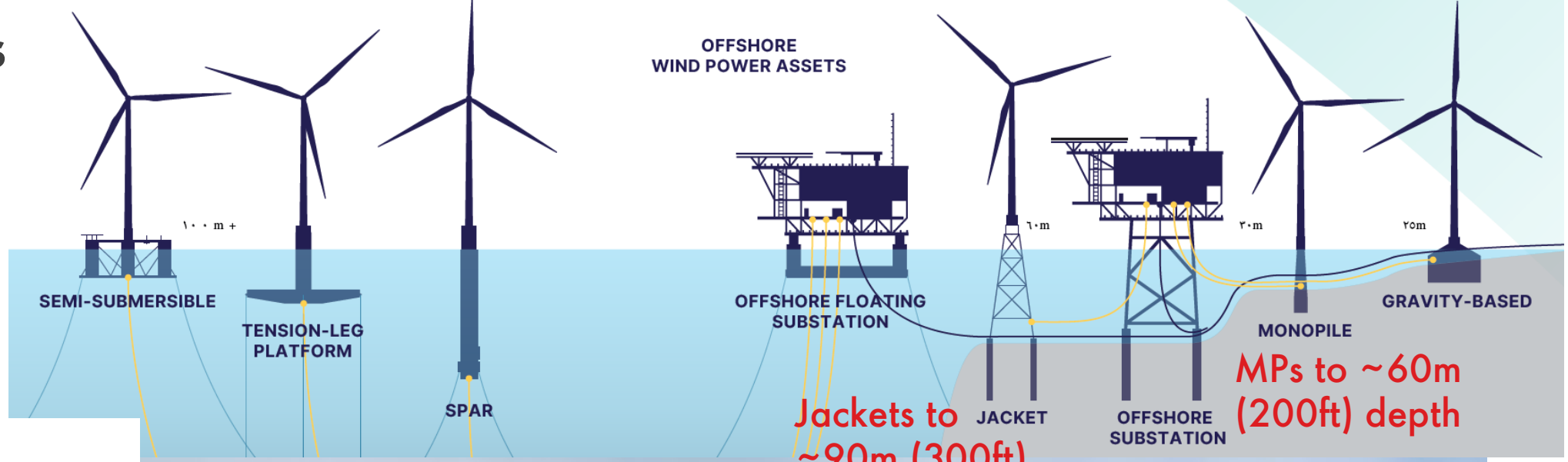


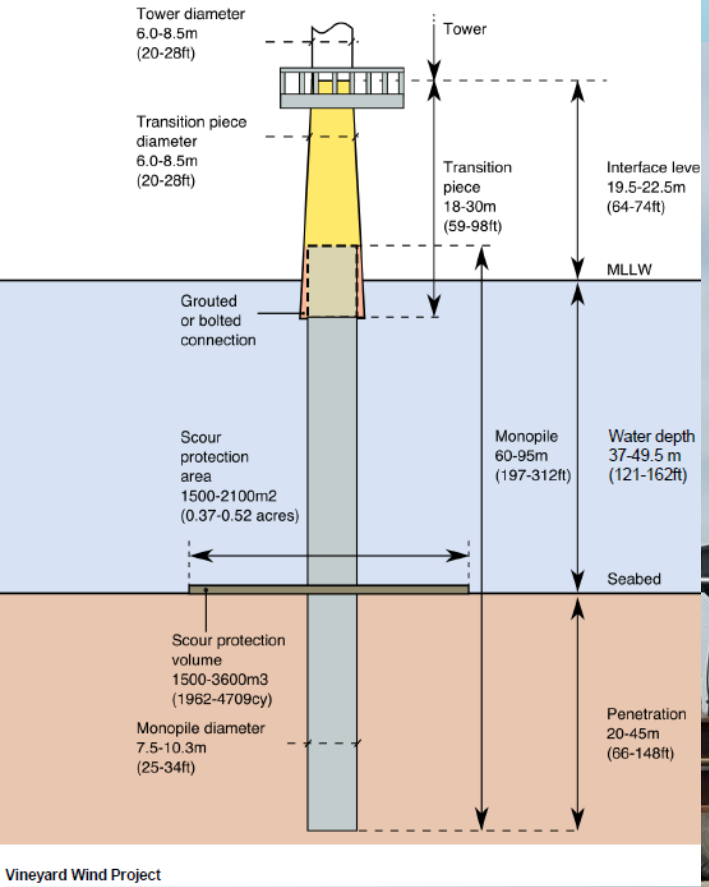
WTG Power Generated = ½ (air density)x(swept area)x(wind speed)^3



Foundations

Water Depth and Soil Conditions are primary drivers for selecting a foundation type





1/3rd of the length an 8m diameter Monopile (MP) at an EEW fabrication site in Paulsboro, NJ (2022)

Manufacturing capability up to ~12m is being developed to accommodate larger WTGs

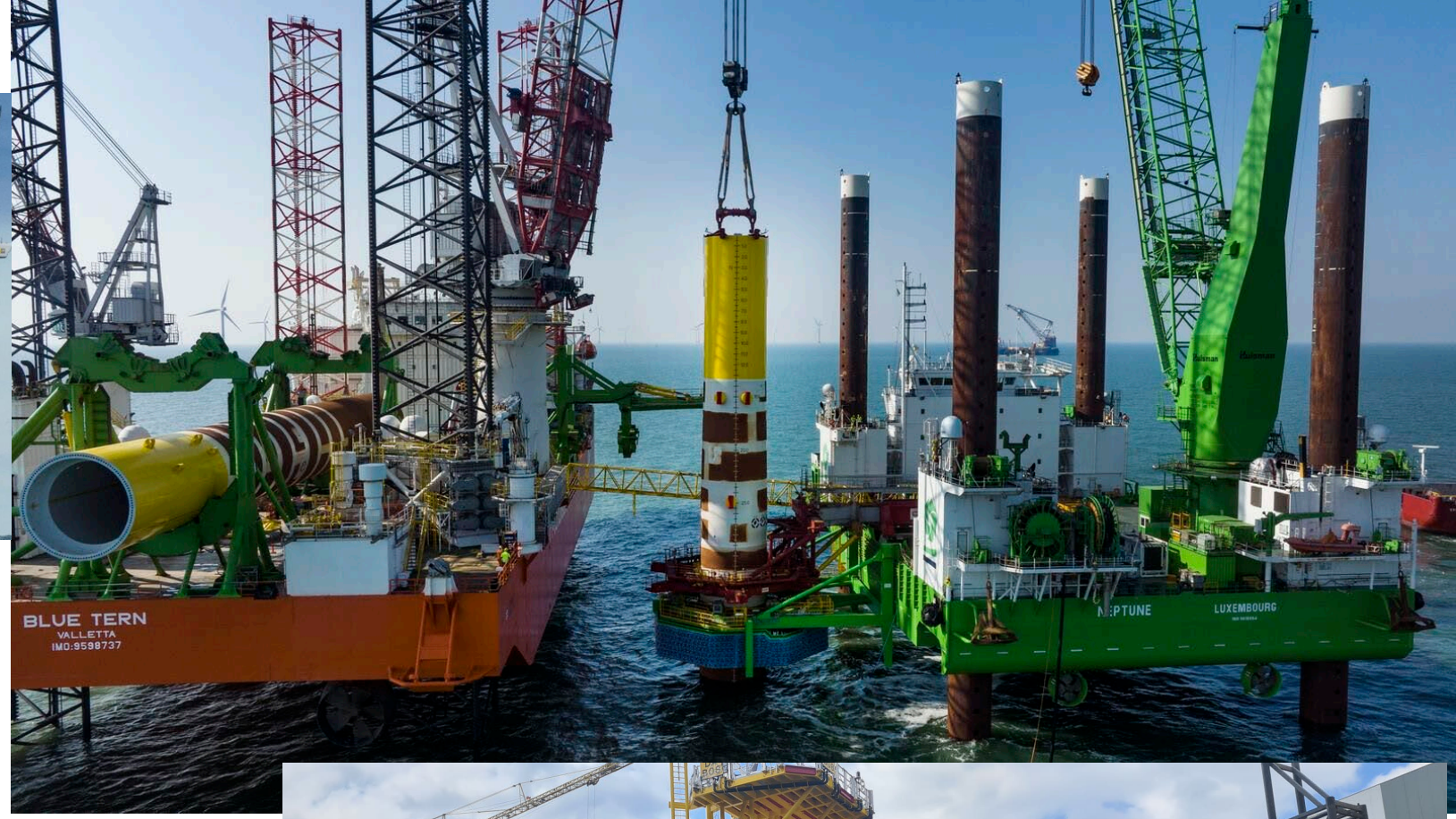
Wind Turbine Generators

Technician beside the hub of the Vestas 15MW-236m prototype (2022)

12MW – 220m Rotor Diameter
GE Haliade-X test turbine installed in the Port of Rotterdam (2019)
Sif fabricating Monopile foundations

WTG Foundations

Hydraulic impact hammer preparing to install a monopile foundation offshore



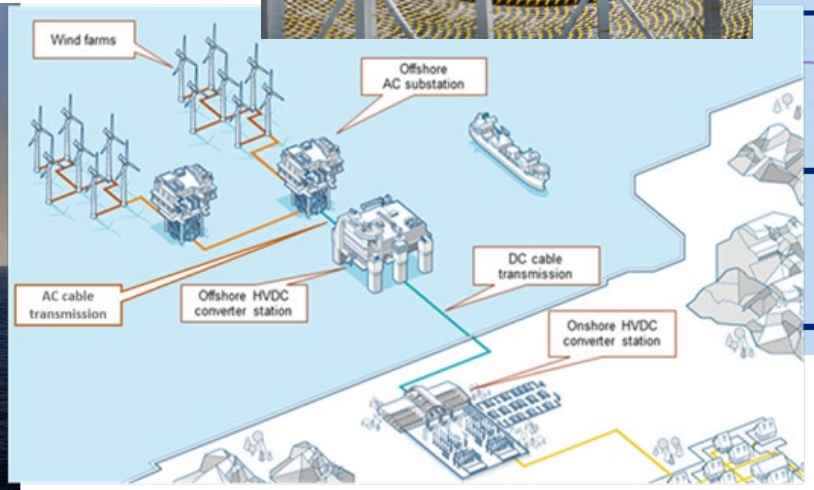
Installation of a monopile with integrated Transition Piece

Transition pieces at a marshalling yard waiting to load out for installation

Offshore Electrical

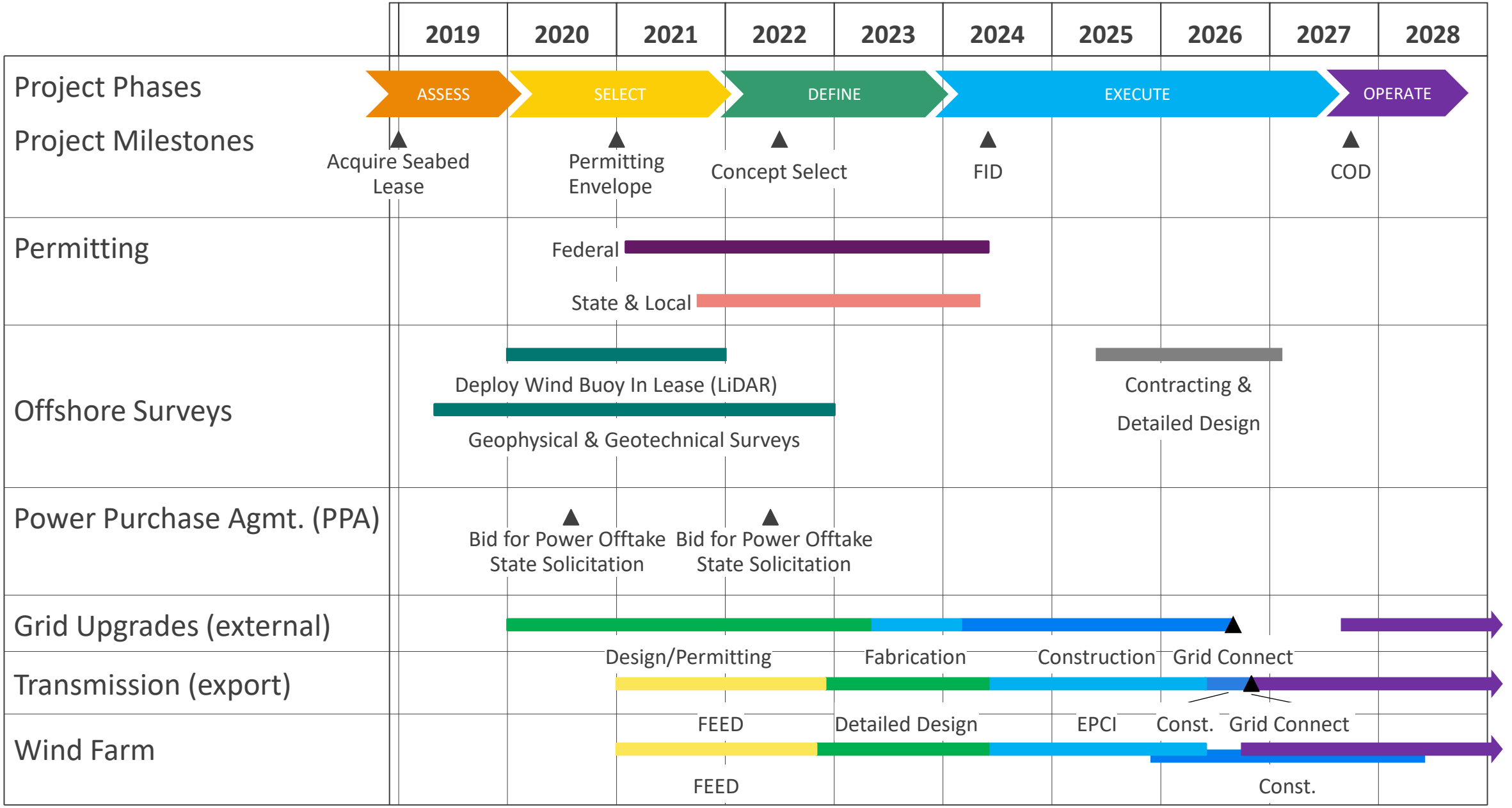
Offshore WTGs are connected together onto strings of inter-array cables (IACs), which are all route back to one or more offshore substations.

These substations step-up the voltage (and maybe convert from AC to DC) to transmit to the onshore grid



Source: http://new.abb.com/systems/offshore-wind-connections/dc-solutions

Example Offshore Wind Farm Development Roadmap



Offshore Wind Learning Curve

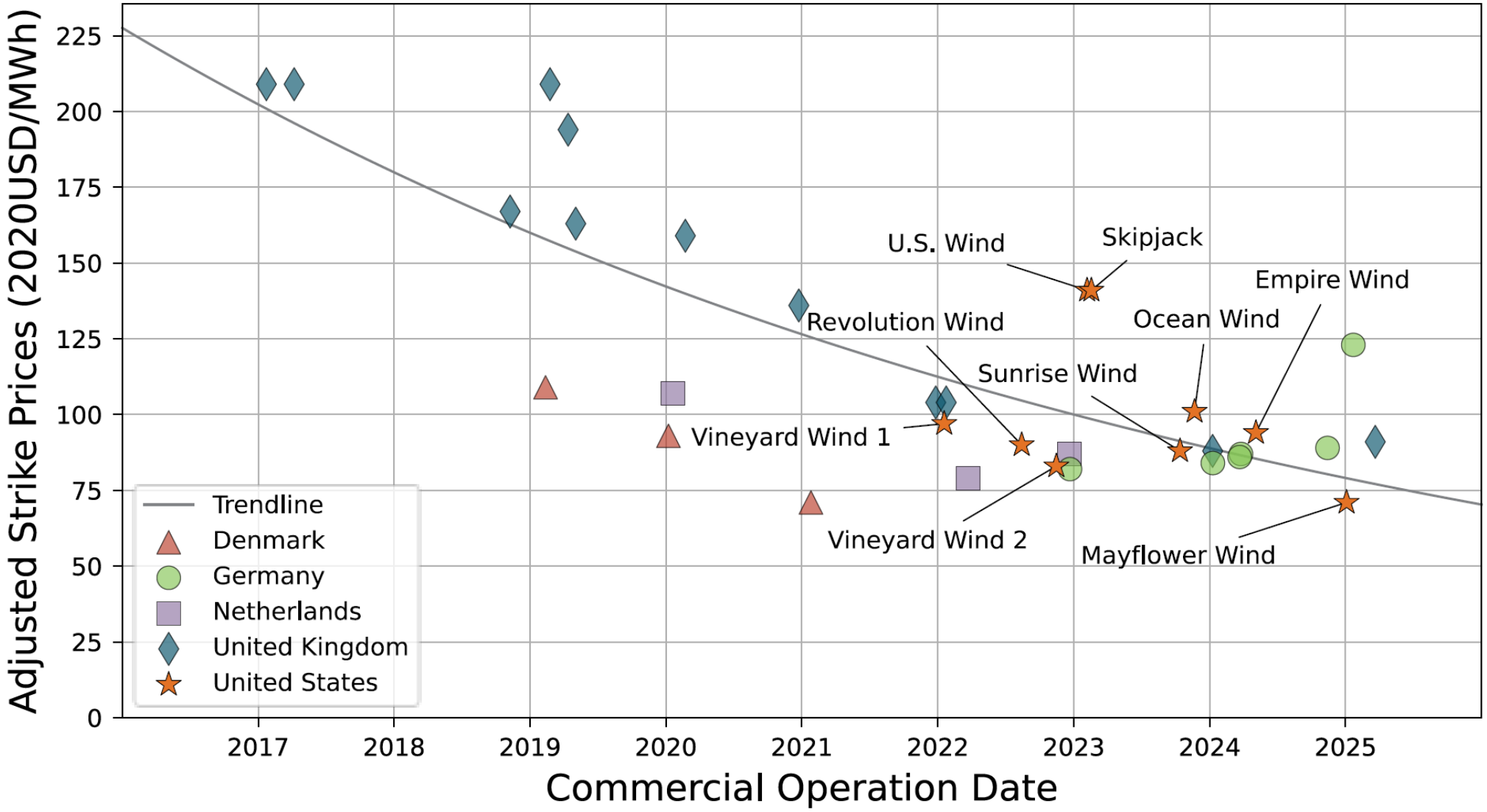


Figure 38. Adjusted strike prices from U.S. and European offshore wind procurements. *From Beiter et al. (2021a) for U.S. projects*

Questions?