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**U.S. Offshore Wind's
\$200Bn+ Supply Chain
Opportunity**

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Executive Summary

Most of the research to date on U.S. offshore wind power (US OW) addresses governmental action and the status of widely publicized East Coast wind farm projects. In this report, we tackle the missing link that doesn't exist yet and thus doesn't get the airtime it deserves – domestic supply chain.

- **Immature supply chain poses the biggest risk to US OW generation goals**
- **US OW supply chain capex could total \$200bn+ through 2035, higher than \$100-\$150 that most participants anticipate**
- **Lium's US OW boat database shows urgent vessel construction needs with only 1 of the 23 global WTIVs we track located in the US today (need as many as 8 through 2035)**
- **Public turbine providers (GE, SGRE, VWS) are the most obvious beneficiaries (30% of wind farm spend)...**
- **...But hundreds of companies - public (ie NETI, NOV, GFI, HLX) and private - are developing business in emerging US OW supply / service niches**
- **Lium MODELS shows enough progress CAN BE MADE towards supply chain maturation by 2030 to maintain confidence in the Biden administration's 30GW target**

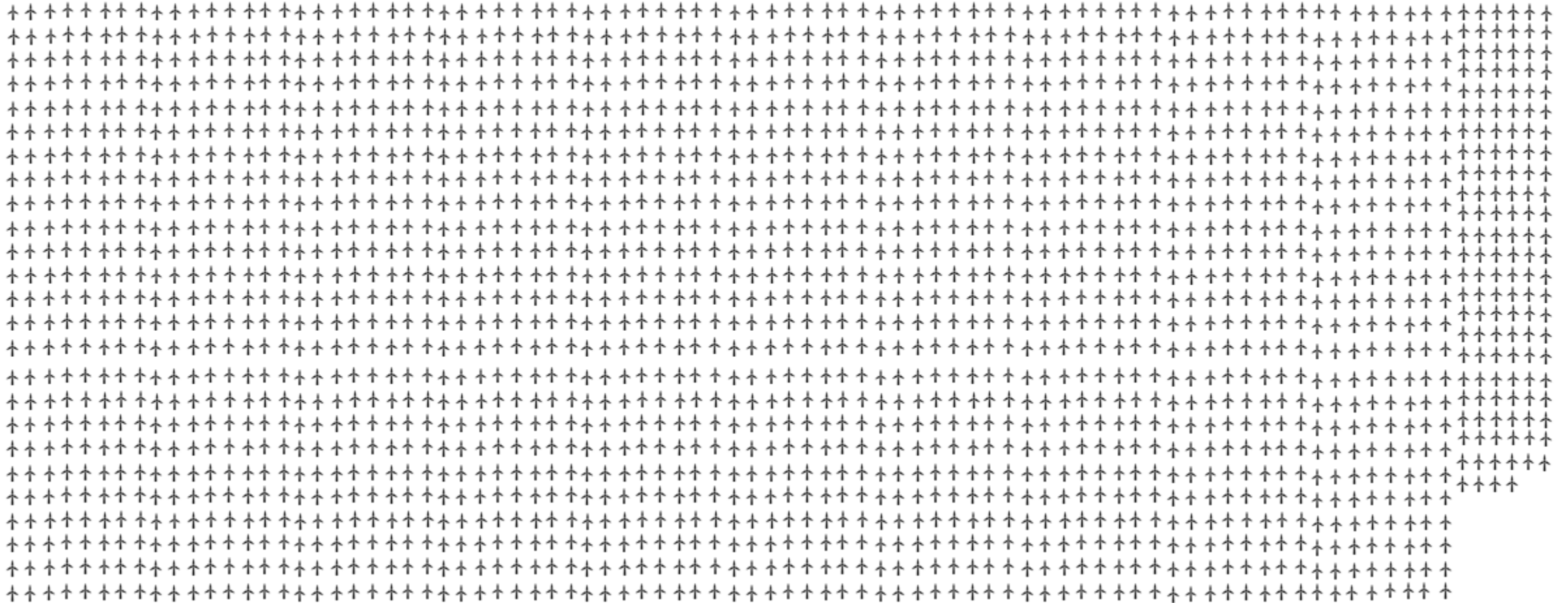
Section 1:

U.S. Offshore Wind Power Is A \$200bn+ Supply Chain Opportunity Through 2035

Turbines In U.S. Waters Today...

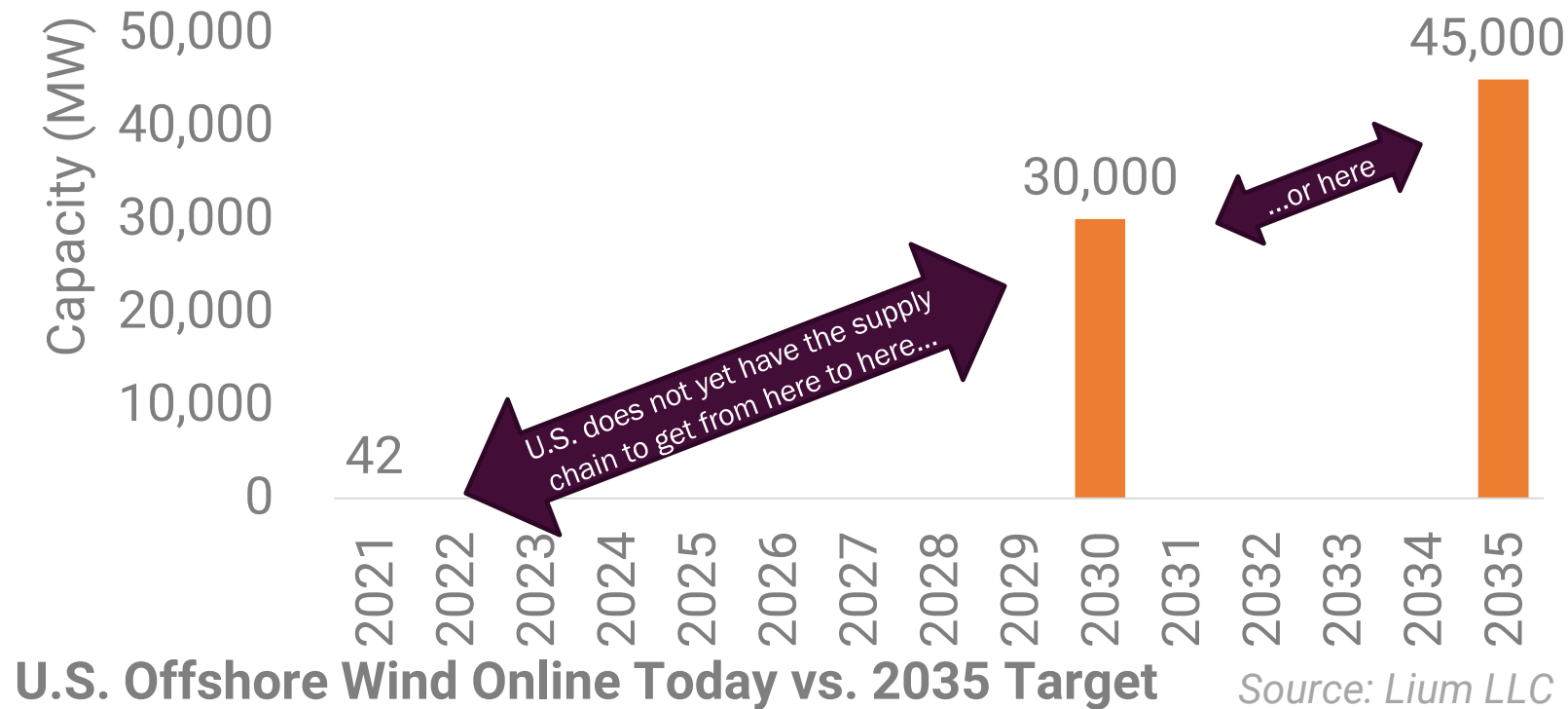
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...Turbines In U.S. Waters By 2030



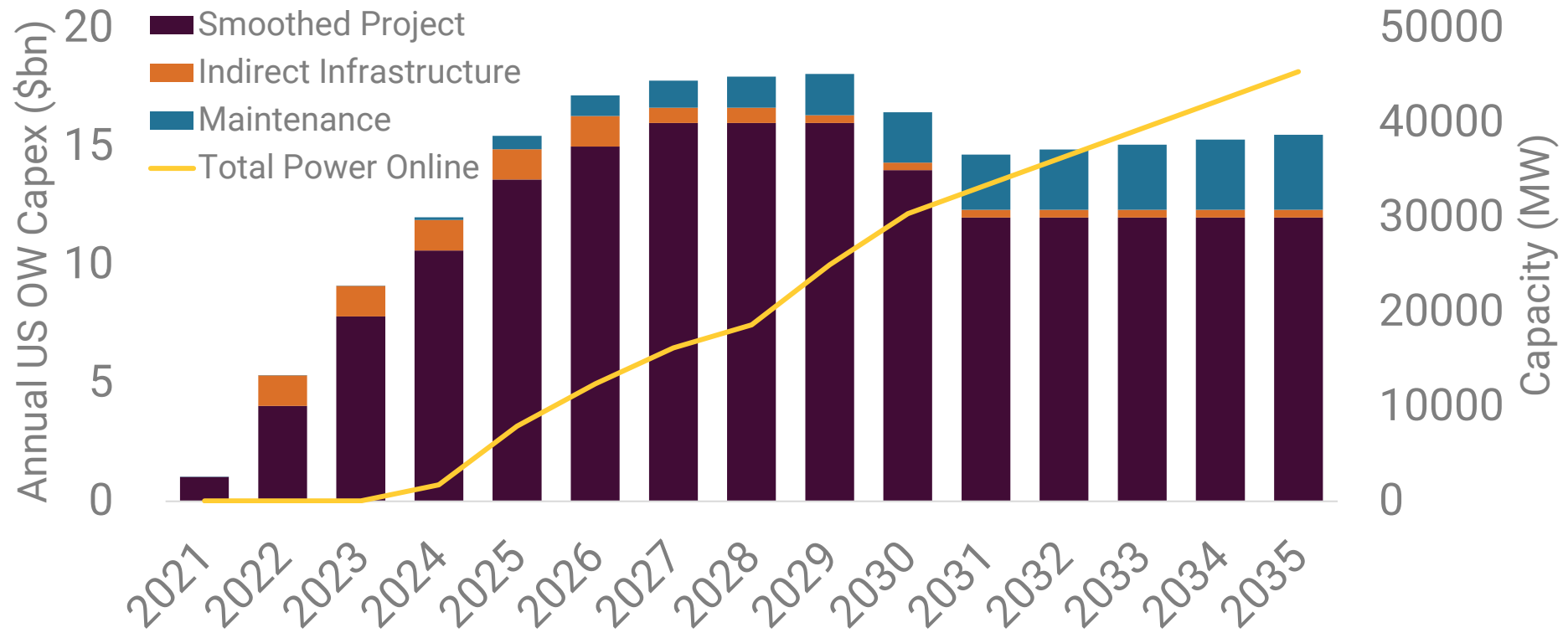
Lofty Goals, But No Supply Chain? That's A Problem...

Aggressive US OW State and Federal mandates have been widely publicized. One big problem is... there is no domestic supply chain in place. Onshore wind, European offshore wind, and diverse U.S. manufacturing / logistics infrastructure will be leveraged; however, supply chain is a hole in the US OW growth roadmap. Less than 10 wind turbines are installed in US waters now. By 2035, there will be thousands.



...And It's Also A \$200bn+ Investment Opportunity

Most participants are underestimating US OW supply chain capex over the next 1.5 decades because recent third-party estimates fall in the \$100-\$150bn range (shy of our \$200bn+ estimate through 2035). We believe consensus is too low for several reasons including i) development acceleration under Biden, ii) indirect infrastructure needs, iii) materials cost inflation, and iv) maintenance/service intensity.

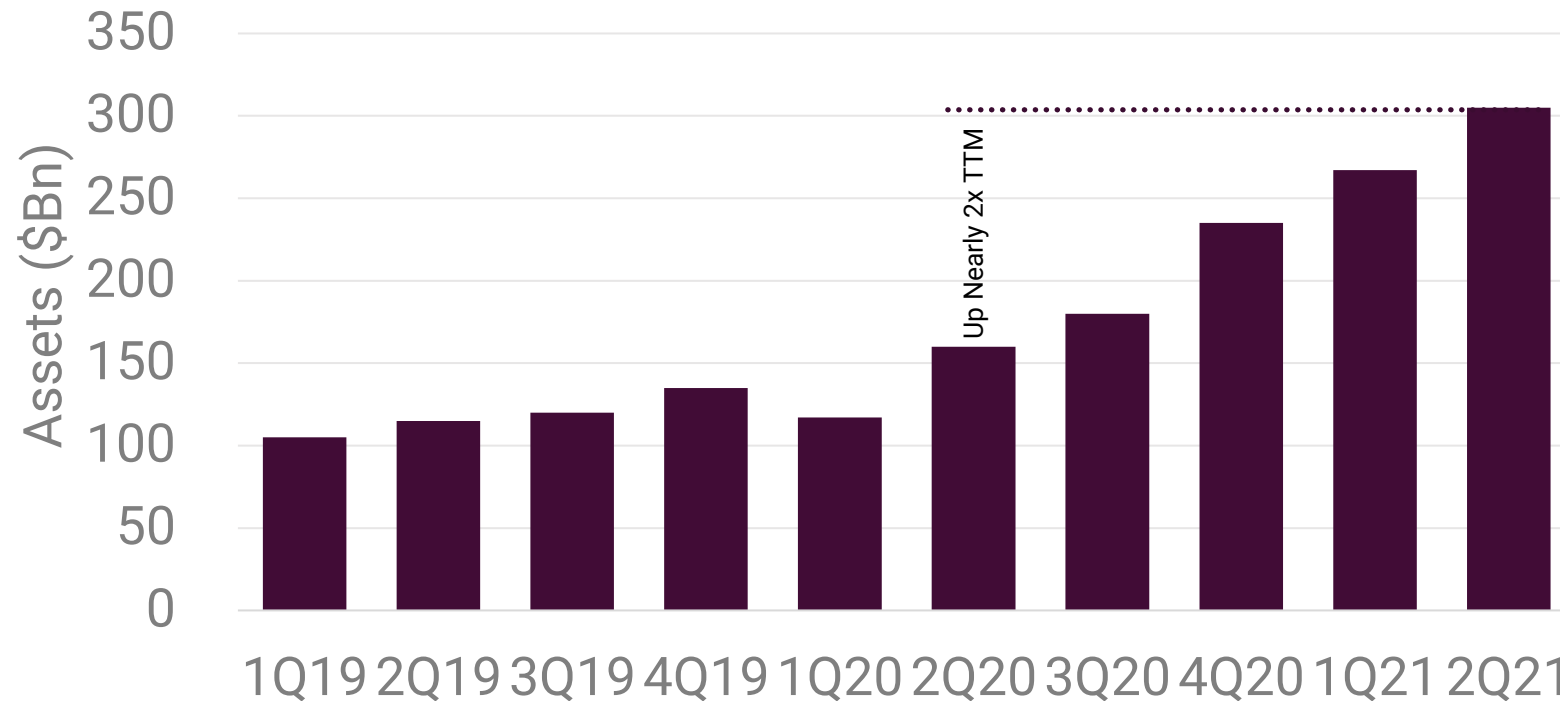


U.S. Offshore Wind Supply Chain Addressable Market

Source: Lium LLC

Easy Money Available For US OW Supply Chain Build-out

Between record-high renewable energy fund raising, green bonds, and government spending on renewables, capital is readily available for the US OW supply chain build-out. Each quarter, tens of billions of dollars are pouring into sustainable funds. We expect US OW-specific funds to emerge, following EU OW precedent. On the government side, DOE launched a \$3bn US OW loan program, Biden's \$1T infra bill has grid upgrade earmarks benefitting US OW, and East Coast states are sinking hundreds of millions into port upgrades.



US Sustainable Fund Trends

Source: Morningstar, Lium LLC

Robust, Multi-Faceted Addressable Market Emerging

Project RFPs and service / supply contracts will vary depending on the state and the developer's procurement strategy and project. However, each wind farm will require similar services and components from vendors and OEMs. With local content factoring into RFPs, regional markets are likely to develop around the US OW complex, starting on the northeast coast and spreading south and west.

Large Components Requiring Specialized OEM Manufacturing & Quayside Assembly

Turbines
(Nacelle,
Blades, Drive
Train, Tower)

Foundation &
Electrical
Balance

Multitude Of Smaller Components
(Fragmented, Diverse OEM Base)

Castings, Forgings, Cables,
Transmission, Substations,
Offtake

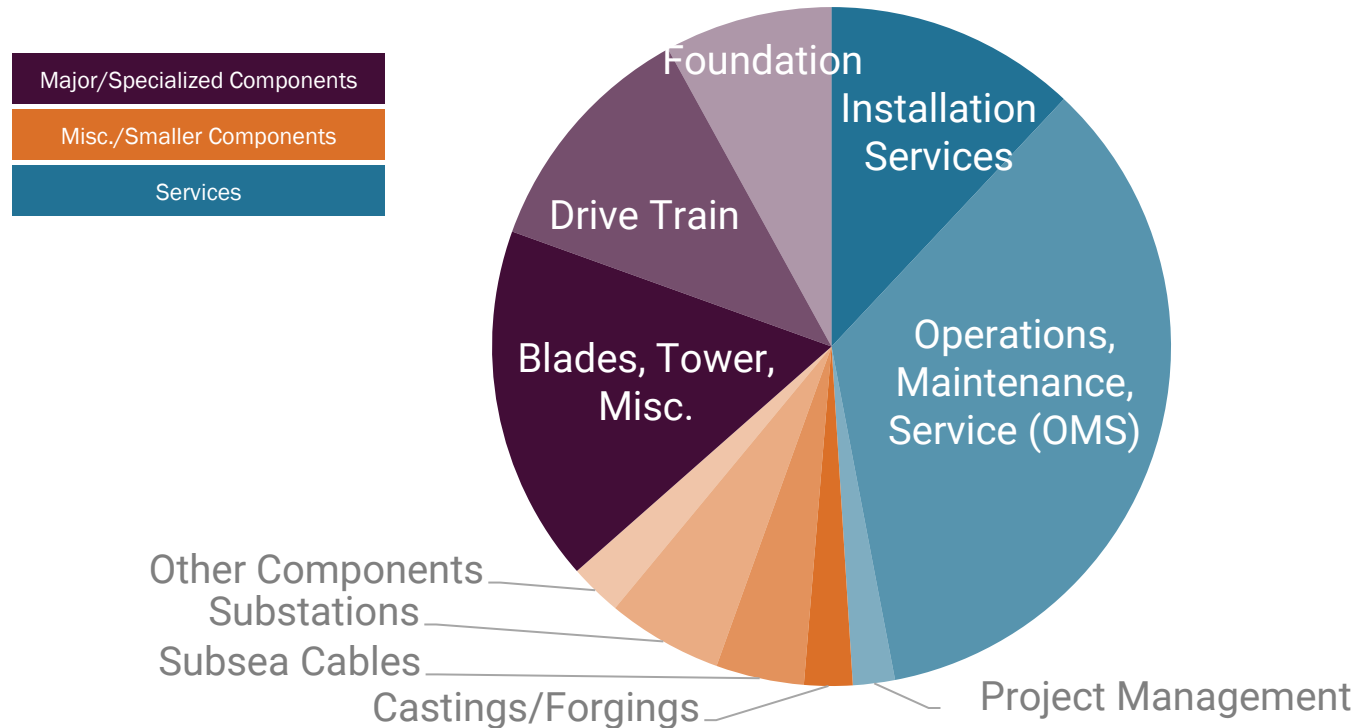
Service Sector

Ports / Staging, EPC,
Engineering, Marine Vessels
(Installation & Transport),
Cable Lay, Maintenance,
Onshore Logistics,
Operations

Source: Lium LLC

Cost Components In Wind Farm Capex

Although thousands of variables can impact project costs (and thus the addressable market for various supply chain verticals), we've constructed in broad strokes a "typical" wind farm AFE below. These estimates represent an average fixed foundation East Coast wind farm about 20 miles from shore built with 12MW turbines.

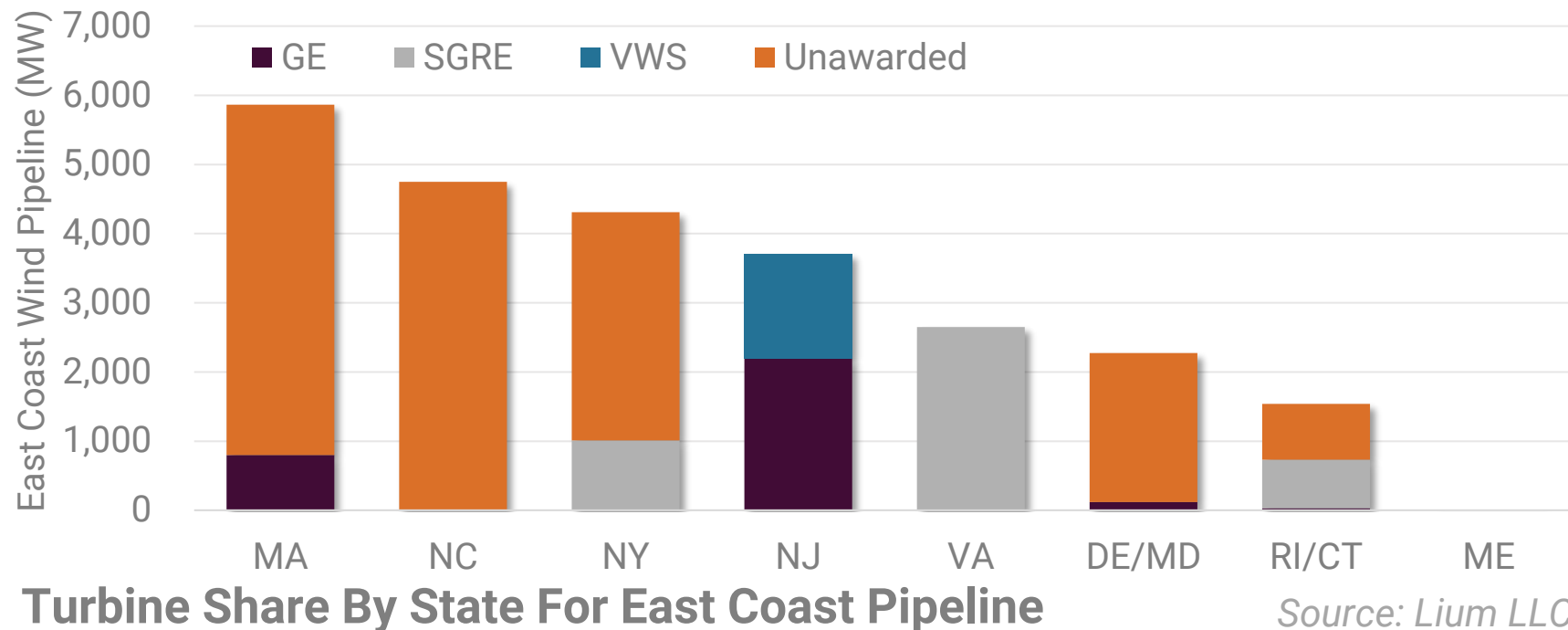


"Typical" US East Coast Wind Farm Investment Detail

Source: Lium LLC

Local Footprint Will Factor Into Contract Awards

Localized roofline, as well as component standardization for multi-project developers, are both likely to underpin some competitive advantage for vendors when it comes to winning supply / service contract awards. In turbine packages, SGRE has had good wins in VA, NY, and RI/CT while GE's wins have come in NJ and MA. Vestas just won a project in NJ as well. NC is one state to watch with no clear frontrunner yet as projects there are earlier stage than in the states higher on the coast.



US OW Will Fuel Domestic Manufacturing Resurgence

Rapid US OW growth will include a focus by developers on local content. Domestic component sourcing is expected to translate into material new demand for domestic manufacturing. Two new US factories are likely to be built for each major windfarm component (i.e. wind turbine nacelles, blades, towers, foundations, and subsea cables). Foundries, assembly, mills, etc. will also benefit – case in point is the recently announced US Wind plan to revitalize a historic but closed Baltimore steel facility, Sparrows Point.

\$6bn+ to be invested in factories, ports, vessels, and grid connections



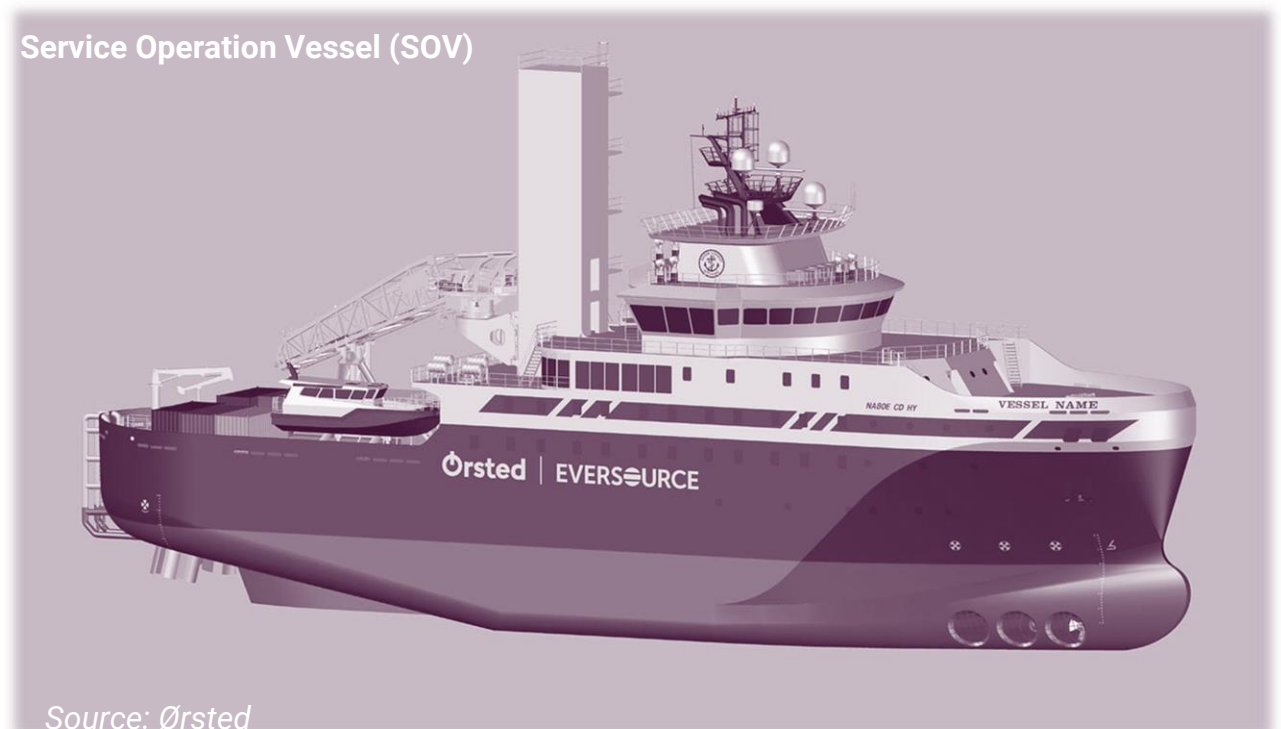
Source: Lium LLC

11mm tons of steel to be consumed through 2035
(6yrs of an avg steel mill's output)



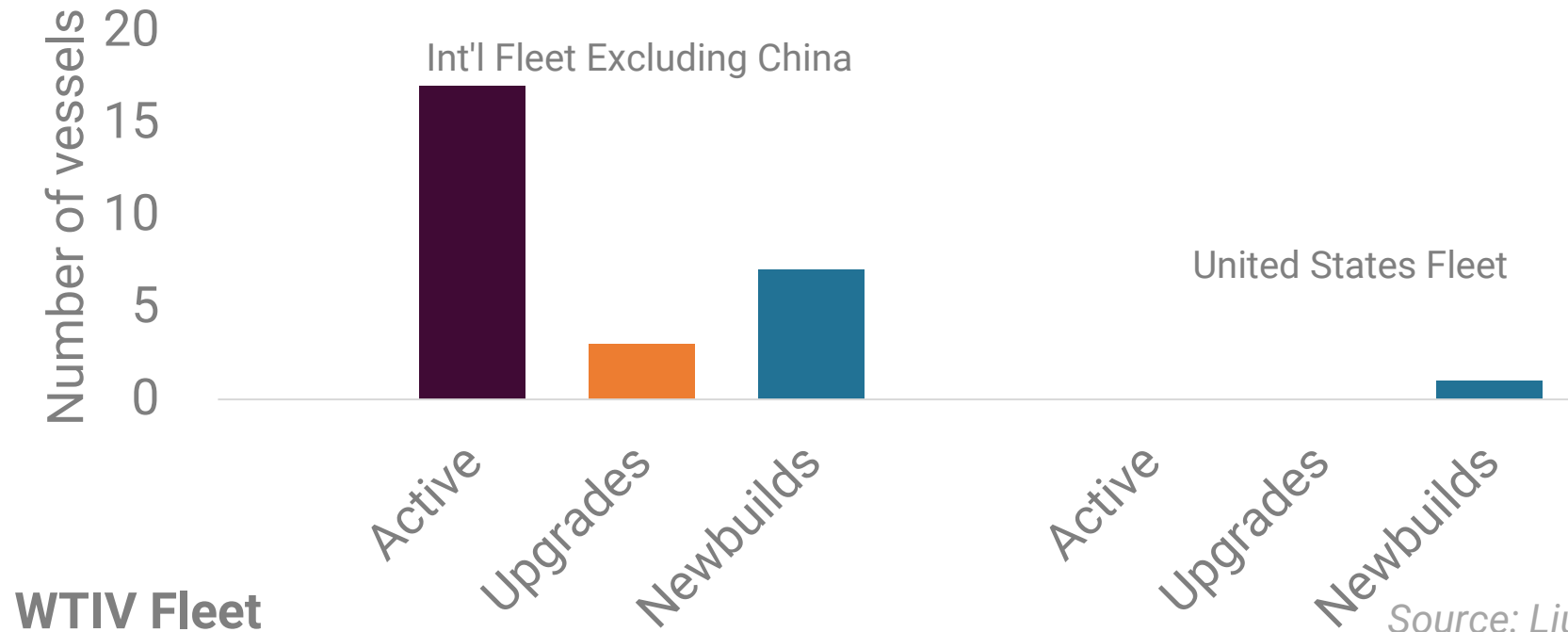
Boat Boom Looms

A large fleet of marine vessels must be built (or exiting vessels retrofitted) in order to install and service US OW farms. We estimate 5-10 WTIVs will be needed (build cost of \$500mm per vessel with a lead time of 24-36 mos). The first U.S.-flagged WTIV is under construction for 2023 delivery, and a handful of foreign-flagged WTIVs may enter US waters as well. The industry will also need 10-12 SOVs initially at \$100mm build cost per unit (the SOV fleet will scale up with turbines in water). The first U.S. SOV is under construction now. Dozens of CTVs are also needed.



Marine Market Wrinkles From Jones Act & Big Turbines

The Jones Act requires goods shipped between U.S. ports use ships built, owned, and operated by U.S. citizens. Thus, US OW cannot utilize foreign-flagged SOVs and CTVs due to the coastwise nature of those vessels' operations. Larger, more costly WTIVs are a gray area – a hybrid solution is legal where U.S.-flagged feeder vessels ferry components to foreign-flagged WTIVs for turbine installation. However, we expect global utilization of “super-spec” WTIVs to tighten through 2030 because installing larger new-gen turbines exceeds the capabilities of older gen WTIVs. Leveraging Lium’s WTIV database, there are currently 23 WTIVs (outside of China) capable of working in the US market by 2024/2025 (most will be kept busy overseas) with only one U.S. flagged - Dominion’s newbuild. More new construction is needed.

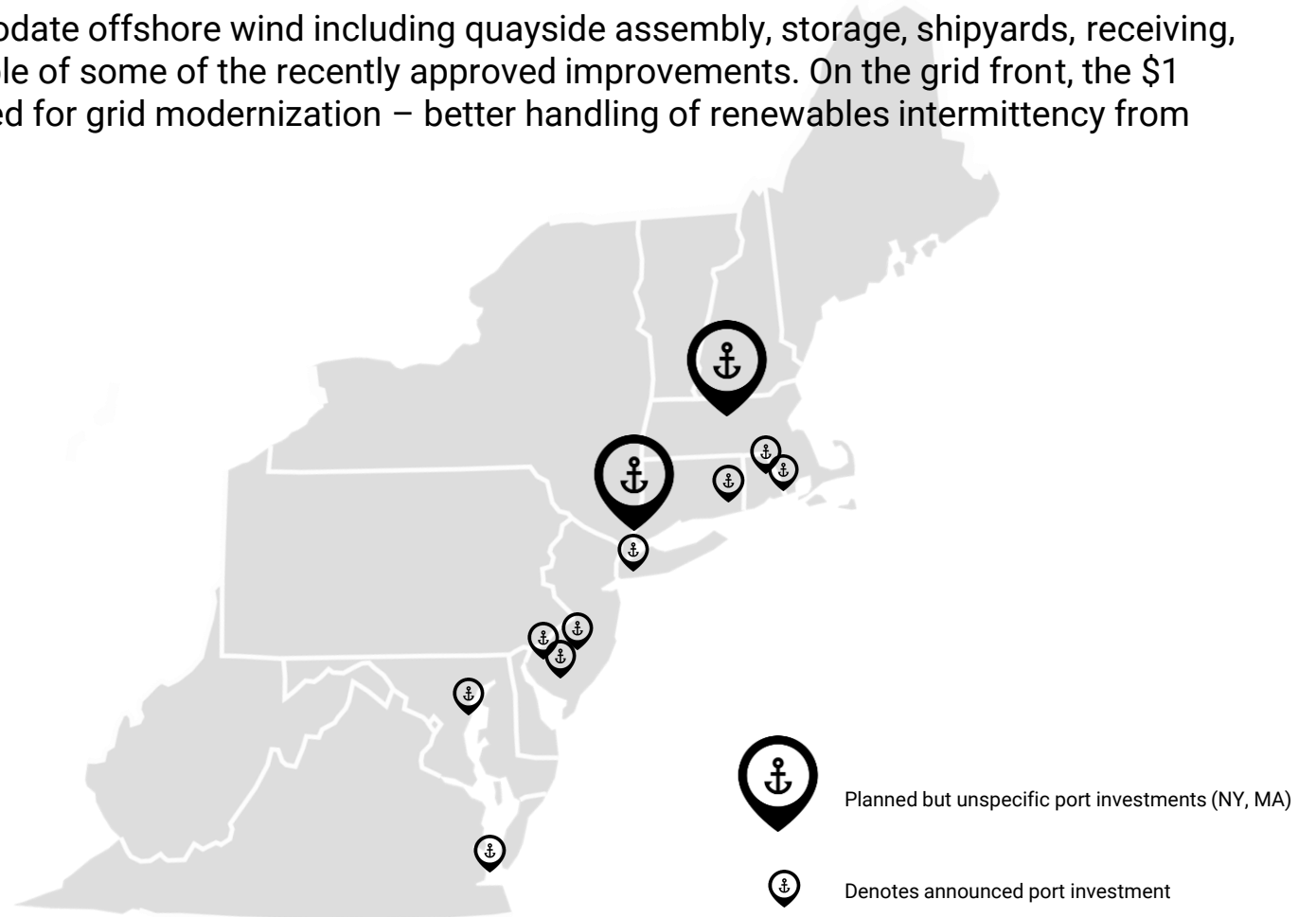


Source: Lium LLC

Needful Port & Grid Upgrades Are Moving Ahead

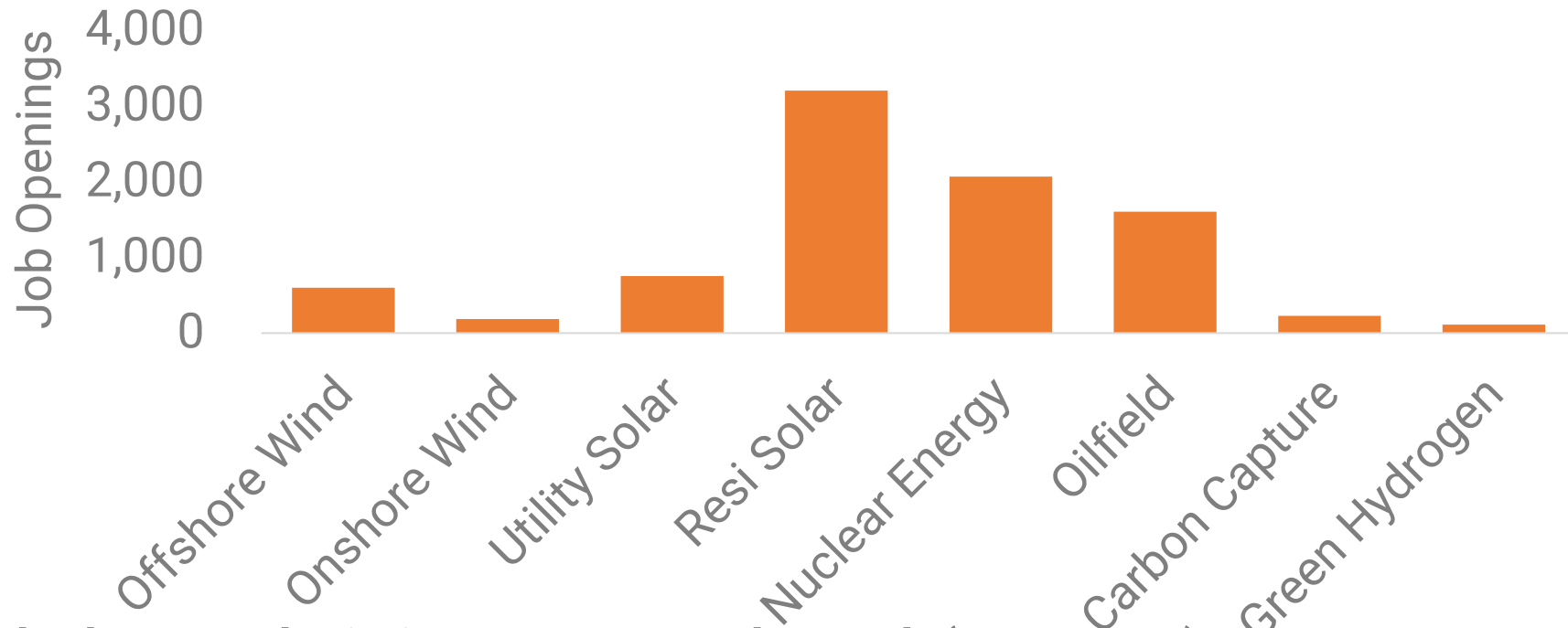
Multiple states are investing in port upgrades to accommodate offshore wind including quayside assembly, storage, shipyards, receiving, shipping, docking, fabrication, etc. Below is a map and table of some of the recently approved improvements. On the grid front, the \$1 trillion bipartisan infrastructure bill has \$73 billion allocated for grid modernization – better handling of renewables intermittency from this spend will be good for US OW.

State	Port Investments	State OW Target
RI	Orsted and Eversource to invest \$40 million into RI port and fabrication facilities	N/A
MA	Plans to invest \$100 million into port infrastructure and training programs	4.0 GW by 2027
CT	\$235 million re-development of the State Pier into an OW staging area	2.0 GW by 2030
NJ	Pledged \$250 million for OW manufacturing facility; plans for a \$400 million port	7.5 GW by 2035
VA	Investing \$40 million to upgrade the Portsmouth Marine Terminal into an OW staging area	5.2 GW by 2034
MD	US Wind investing \$77 million for port infrastructure, plans on investing an additional \$150 million into an OW foundation fabrication plant	1.2 GW by 2030
NY	Committed to investing \$200 million for port infrastructure upgrades... and applied to USDOT for a grant to upgrade Arthur Kill into an OW staging and assembly port	9.0 GW by 2035



Jobs Juggernaut

Meeting the 30GW by 2030 US OW goal will create 45,000+ jobs with 30,000+ additional indirect jobs created. US OW workforce will have a heavy weighting towards transferrable skills that can be hired from other industries – such as manufacturing, construction, electricians, engineering, marine, and logistics. This reduces the risk of growth bottlenecks from workforce creation. Notably, LinkedIn already shows US OW with more openings than onshore wind and about the same as utility solar.



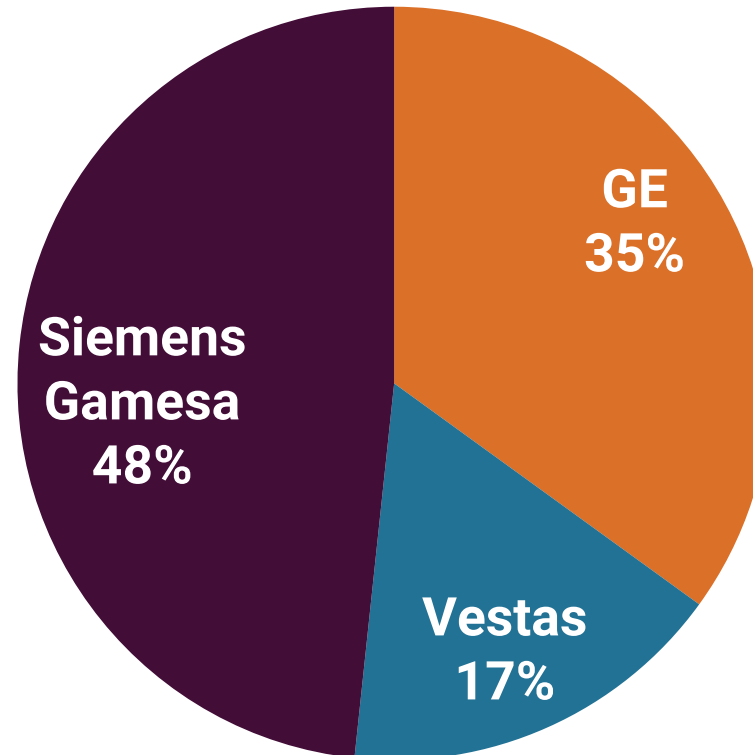
LinkedIn US Job Listings By Keyword Search (Aug. 2021)

Source: Lium LLC

Section 2: Company Detail

Turbine Providers Are Most Recognizable Participant...

Turbine providers are often recognized by investors as the “face” of the offshore wind supply chain. This is because they are large and publicly traded with onshore wind and international offshore wind success under their belts and turbine awards are visible. They will collect a large chunk of US OW capex spend, potentially up to 30% of direct project spend, or \$40-\$50bn, through 2035.



Known East Coast Awards (9GW)

Source: Lium LLC

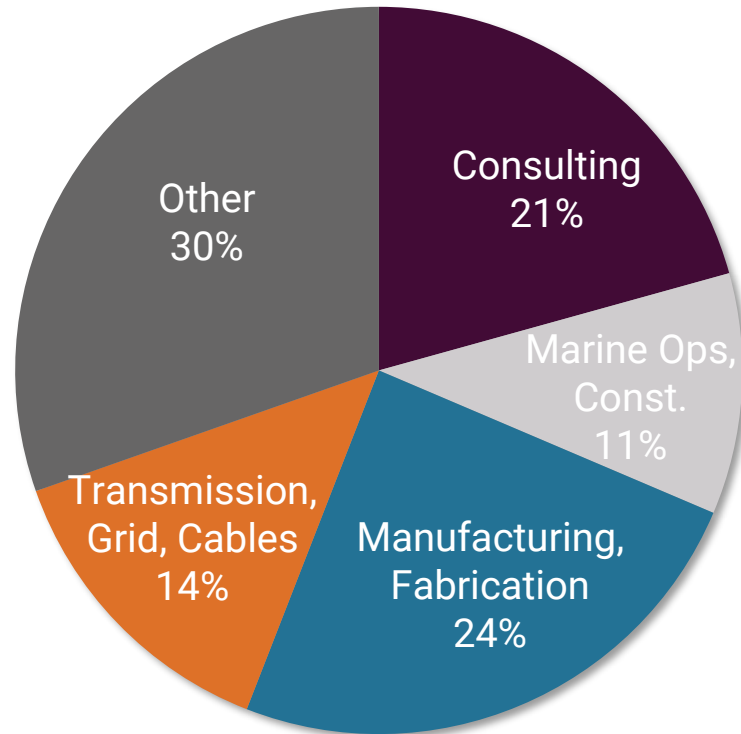
...But Other Publics Have Exposure To US OW Supply Chain Too...

In this slide, we have listed some of the public companies OTHER THAN turbine suppliers and developers that have exposure to US OW supply chain. Many of these are names that energy specialists will recognize from the O&G industry who are pivoting towards US OW and energy transition verticals, leveraging their installed base of manufacturing or logistics assets to serve the renewable energy sector.

Company (Ticker)	HQ	Service/Product	Comment
Eneti (NYSE: NETI)	Monaco	Offshore Wind Vessels and Operations	Formerly known as Scorpio Bulkers; planning to enter US WTIV market
NOV (NYSE: NOV)	TX	OEM, design, supply for mobile offshore units	NOV acquired GustoMSC in 2018; helping develop 1st Jones Act compliant WTIV
Gulf Island Fabrication (NYSE: GFI)	LA	Fabrication services	Engineered turbine jackets for Block Island Wind
Helix Energy Solutions Group (NYSE: HLX)	TX	Subsea engineering services	Experienced in intl. offshore wind projects
Amphenol Corporation (NYSE: APH)	CT	Interconnection systems	Has a facility in Sidney, NY... close proximity to East Coast projects
Bristow Group (NYSE: VTOL)	TX	Helicopter transportation and support	Experienced in O&G transportation
Enerpac (NYSE: ATU)	WI	Offshore construction services and equipment	Experienced in intl. offshore wind projects
Seacor Marine (NYSE: SMHI)	TX	OSV provider	Experienced in O&G transportation
Tetra Tech (NYSE: TTI)	CA	Siting, permitting, environmental analysis, agency outreach, etc	Provided services for the CVOW Pilot Project
Sprague Resources (NYSE: SRLP)	NH	Materials and components handling	Anticipate closing on a staging facility with Eversource (NYSE: ES) in 3Q21
Oil States International (NYSE: OIS)	TX	Design and provide equipment for offshore development	Supplied key equipment (specialized cranes, platform products, etc) for Block Island
Nucor (NYSE: NUE)	NC	Produces steel and steel products	Has PPA signed with Orsted in TX and has a history of supplying onshore wind projects
TPI Composites (NASDAQ: TPIC)	AZ	Wind blade manufacturer	Currently has a large share of US onshore turbine market
Aecom (NYSE: ACM)	CA	Consulting Services	Experienced in intl. offshore wind projects
US Silica (NYSE: SLCA)	TX	Silica material	Supplies majority of composite fiberglass used in domestic turbine blade fabrication
Tidewater (NYSE: TDW)	TX	OSV provider	Experienced in O&G transportation

...And Hundreds Of Privates Are Vying For Share

We reviewed supplier registries compiled by 3 different organizations, including state energy agencies, identifying more than 770 unique companies that have registered hoping to secure new business as the US OW supply chain market takes off. While there is some overlap in services provided by many of these firms, this chart aggregates the databases to show participant concentration across product / service lines for this universe of potential suppliers.



Emerging Competitive Landscape (Number Of Firms) *Source: Lium LLC*

Section 3:

U.S. Offshore Wind Power Outlook

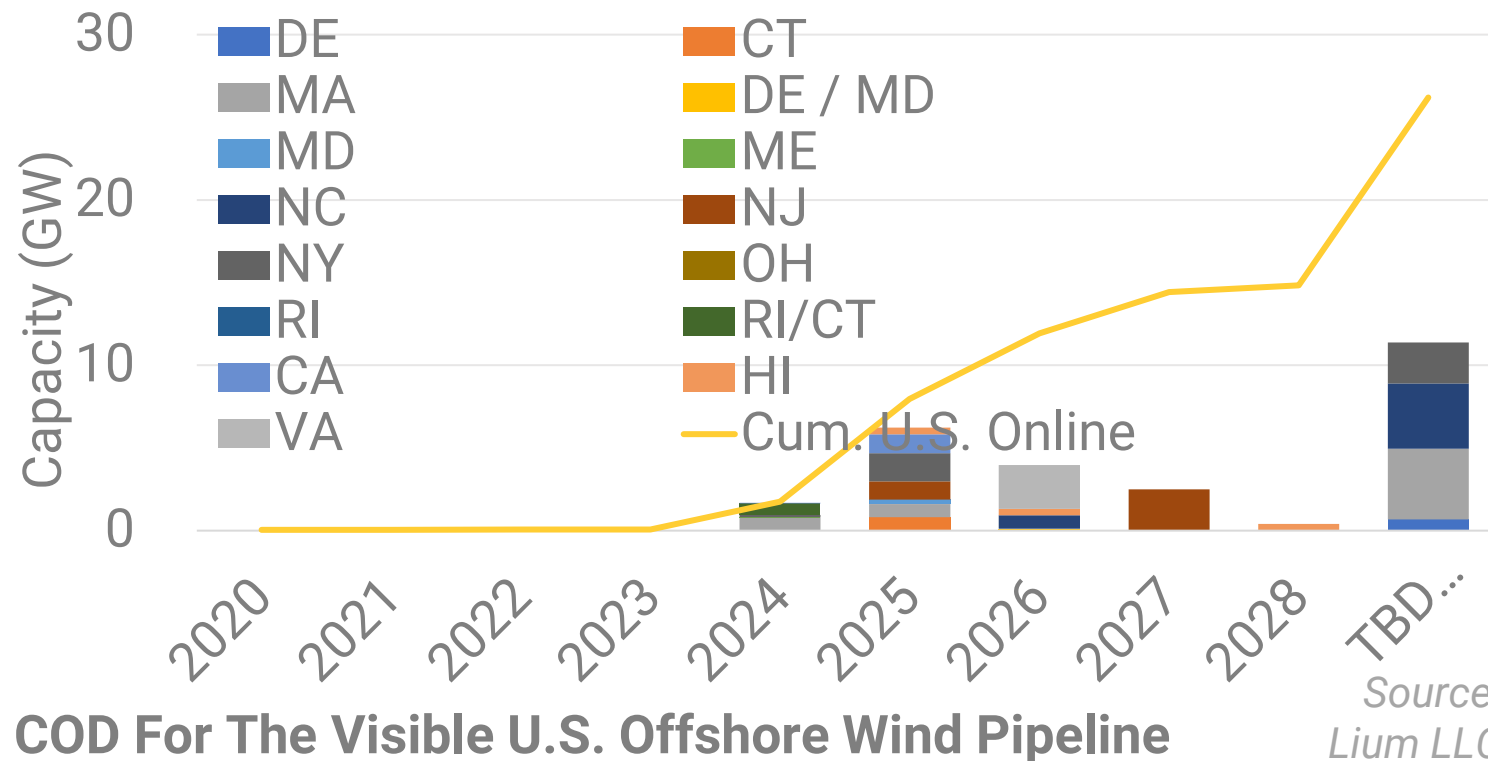
30GW By 2030 Attainable...

Biden's 30 GW of offshore wind power by 2030 power was met with skepticism by some; however, we believed this would be attainable from the day it was announced (in fact, we called the target light in an April 2021 - [link](#)). On the East Coast alone, we have eyes on 30 projects / project phases that amount to 25GW of power slated for COD by 2030. To get to the 30 GW by 2030 target, we expect to add a) more East Coast power as new leasing rounds and projects are announced over the next couple years and b) US OW power on the West Coast (which could easily see 5+GW in the water by 2030 between CA, HI, and OR). The supply chain analysis in this report shows enough progress in different directions to increase our conviction in the industry's ability to meet the Federal 2030 goal.

See US OW Project-By-
Project Status Here

...But Beware Near-term Timeline Slippage

We have already moved our estimated start date for several projects in the orderbook back a year later than guidance due to our expectation that near-term dates will slip until supply chain catches up to demand. Vineyard Wind is an example of a project with recent slippage disclosed, and we believe other dates will slip between 2021-2025. This is to be expected as the supply chain buildout needs to catch up with development timelines - something we expect to happen by the middle of the decade, in plenty of time to hit the 30GW by 2030 target.



COD For The Visible U.S. Offshore Wind Pipeline

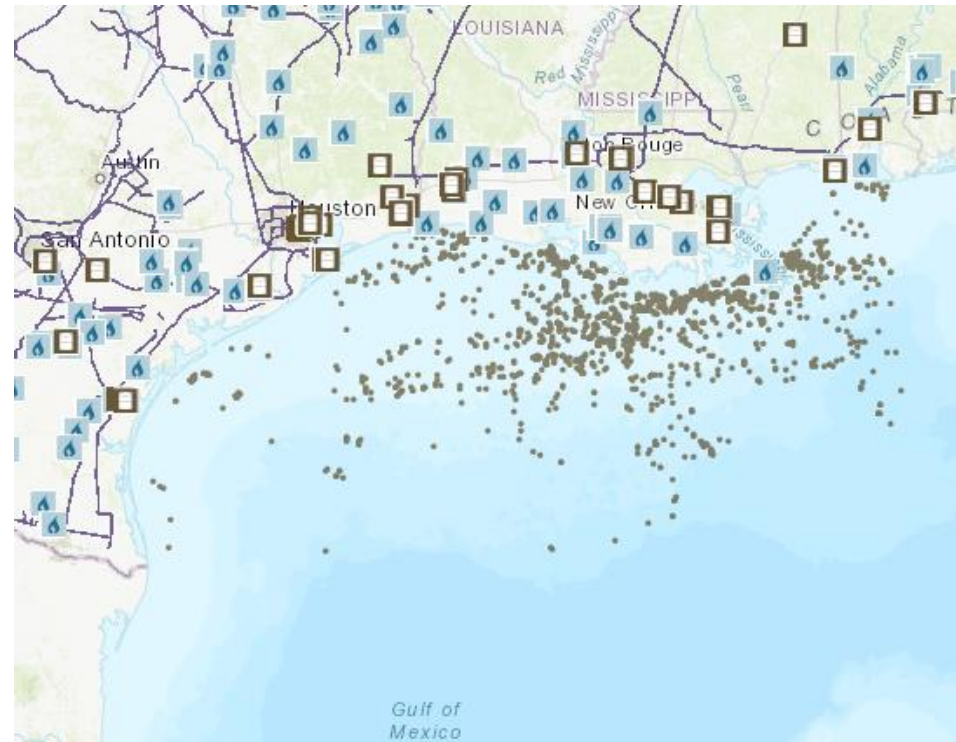
Growth Catalysts Multiplying

In addition to well documented progress on the East Coast, US OW is also gaining traction on the West Coast. Catalysts to watch in the near term include more lease auctions, progress in big call areas like NY Bight, turbine awards and supply chain progress, and BOEM environmental assessments. Click the button for a coast-to-coast catalyst summary...

Coast-to-Coast
Catalyst Summary

US GOM Emerging As A Wildcard Region For US OW

This summer, BOEM began to assess interest in potential offshore wind development in the US Gulf of Mexico (GOM) and formed a task force to coordinate a renewable energy push here. We are less optimistic about US OW prospects in the GOM than the coasts due to resource patterns and offtake economics, but this is an emerging wildcard region to watch especially given the heavy installed base of O&G assets / infrastructure here, some of which can be repurposed for US OW activity.





Related Predictive Data

US Offshore Wind Project Database

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