Revitalizing U.S. Shipbuilding With U.S.-Built Offshore Wind Installation and Maintenance Vessels

LABOR ENERGY PARTNERSHIP

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FOREWORD

This paper was prepared by Will Foster and Riley Ohlson for the Labor Energy Partnership Offshore Wind Workshop and is not intended to reflect the views, opinions or research of the Labor Energy Partnership.

About the Labor Energy Partnership

The Labor Energy Partnership (LEP) is based on a shared commitment of the AFL-CIO and the Energy Futures Initiative (EFI) to promote federal, regional and state energy policies that address the climate crisis while recognizing the imperatives of economic, racial and gender justice through quality jobs and the preservation of workers' rights.

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INTRODUCTION

In March 2021, the Biden administration issued an executive order establishing a goal of deploying 30 gigawatts (GW) of offshore wind (OSW) in U.S. waters by 2030. Although combined state government commitments to OSW will already exceed 40 GW by 2040, this report will focus on deployment of 30 GW by 2030 as a central scenario. Each of the proposed projects that will make up the first 30 GW must be supported by vessels to transport crew and materials to the sites, install the turbines, service the installations during operations and, ultimately, decommission the facilities.

Stimulating commercial shipbuilding activity is critical to facilitating OSW deployment while demonstrating the potential for this deployment to support and grow good manufacturing jobs. Average labor income per job in the shipbuilding sector was more than $90,000 in 2019, 49% higher than the average for all private-sector jobs.[1] Many of the sector's key suppliers, such as the steel and aluminum industries, also pay wages above the private-sector median.

Arguably, the greatest challenge facing sustained OSW development is neither technical nor financial but political. Many American workers, particularly those in industries tied to fossil fuels, are deeply skeptical of the prospects of a just transition and the fundamental ability for renewable energy production to support middle-class jobs. The U.S. experience during the last big policy push toward clean energy—after passage of the American Recovery and Reinvestment Act (ARRA) in 2009—justifies this skepticism. Then, the expected boom in manufacturing related to the solar industry buildout failed to materialize in the face of a crush of heavily subsidized imports. Despite massive growth in solar installation, U.S. manufacturing jobs in solar declined in the initial years following the ARRA's passage. Instead of supporting jobs in clean domestic facilities, many of these installations were largely supplied by polluting and carbon-intensive factories in China's solar energy sector,[2] one allegedly "connected to a broad program of assigned labor in China, including methods that fit well-documented patterns of forced labor."[3]

Neither American workers, the United States nor the planet can afford a repeat of these mistakes as we seek to battle climate change and develop a robust domestic OSW industry. Building long-term support for OSW will require concrete measures to ensure that its development creates good jobs—and not just in construction and maintenance, but also in manufacture of the components and vessels necessary for deployment. Doing so will ensure that the positive economic impacts of OSW development are felt across the country, which will in turn build support among workers and, ultimately, our political leaders.

This support will be necessary to safeguard the industry against shifting political fortunes. By strengthening the domestic shipbuilding industry's role in OSW deployment, we will build support not only in the many districts where shipyards are located, but also in the districts across the country that will supply the steel and other materials and components to build these vessels. Instituting measures to maximize the OSW industry's impact on supporting family- and community-sustaining jobs in shipbuilding and its upstream supply chains is an essential step toward building the durable coalition necessary to prevail in the long-term fight to address climate change.

1 Maritime Administration. (March 30, 2021). *The Economic Importance of the U.S. Private Shipbuilding and Repairing Industry.* Retrieved from https://www.maritime.dot.gov/sites/marad.dot.gov/files/2021-06/Economic%20Contributions%20of%20U.S.%20Shipbuilding%20and%20Repairing%20Industry.pdf.

2 Dalton, M. (July 31, 2021). "Behind the Rise of U.S. Solar Power, a Mountain of Chinese Coal." Wall Street Journal. Retrieved from https://www.wsj.com/articles/behind-the-rise-of-u-s-solar-power-a-mountain-of-chinese-coal-11627734770.

3 Swanson, A., & Buckley, C. (Jan. 8, 2021). "Chinese Solar Companies Tied to Use of Forced Labor." New York Times. Retrieved from https://www.nytimes.com/2021/01/08/business/economy/china-solar-companies-forced-labor-xinjiang.html.

Jones Act and Applicability to Offshore Wind Vessels

With a large buildout planned in the United States and abroad, one of the challenges that the OSW industry must overcome is a global shortage of viable vessels to perform these duties. Additionally, U.S. OSW developers must also comply with the Jones Act. The Jones Act (officially titled the Merchant Marine Act of 1920) was enacted to support U.S. shipbuilders, mariners and operators and requires that any vessel transporting cargo between U.S. ports be United States–flagged, United States–crewed and built by Americans.

This report will consider six types of vessels, as detailed in **Table 1**.

TABLE 1. **OSW Working Vessel Types**

Vessel Type	Jones Act Applicability	Vessel Description
Wind turbine installation vessel (WTIV)	Varies[4]	Capable of installing OSW turbines and foundations at development site
Foundation installation vessel (FIV)	Applicable[2]	Capable of installing foundations but not the actual turbines at the development site
Service operation vessel (SOV)	Applicable	Transports large teams of technicians to work in wind farm for extended periods of time
Crew transfer vessel (CTV)	Applicable	Transports small teams of technicians to wind farm on daily basis
Feeder support vessel (FSV)	Applicable	Transport construction materials to the project site
Cable-laying vessel (CLV)	Not applicable[5]	Lays subsea cables connecting OSW farm to onshore interconnection point

Some of these vessels will need to be developed specifically for the U.S. OSW industry. For instance, any Jones Act–compliant WTIV would need to be newly built for the industry because these types of vessels are uniquely designed for their role of installing the turbines. There are no currently operational Jones Act–compliant WTIVs that are capable of installing OSW turbines with individual nameplate capacities of 12 megawatts (MW) and greater. Dominion Energy's *Charybdis*, which is currently under construction in Brownsville, Texas, will be the first such vessel. Others may be converted from Jones Act–compliant ships that are used currently for other operations. Candidates for conversion include offshore support vessels (OSV) and platform supply vessels presently used in the U.S. offshore oil and gas industry that may be converted to CTV,[6] as well as barges that may be converted to CLV or used as FSV, as in the case of the Block Island Wind Farm.

This paper focuses largely on WTIVs because their large size and unique capabilities make them capital-intensive to fabricate. Therefore, these vessels will remain a likely bottleneck as the U.S. OSW industry continues to accelerate. We also consider SOV and FSV fabrication, although we spend less time discussing FIV, CTVs and CLVs. Foundation installation may be performed by WTIVs, and it is unclear whether any new-build FIVs will be required in addition to the WTIV construction. As discussed above, CTVs are less specialized and may be pulled from existing fleets in the United States. According to a recent ruling by the U.S. Customs and Border Protection (CBP), CLVs need not be Jones Act–compliant[7] and may be adapted from existing barges.[8]

4 Akin Gump. (May 13, 2021). "As Offshore Wind Energy Projects Expand, So Too Does the Reach of the Jones Act." Retrieved from https://www.akingump.com/en/news-insights/as-offshore-wind-energy-projects-expand-so-too-does-the-reach-of-the-jones-act.html.

5 Winston & Strawn LLP. (n.d.). "U.S. Customs Issues Offshore Cable Lay Wind Farm Guidance." MaritimeFedWatch blog. Retrieved from https://www.lexology.com/library/detail.aspx?g=6e144e92-b0e4-426c-89d9-fe47a4124163.

6 Parker, B. (Feb. 7, 2020). "Are OSVs Fit for Refit for Offshore Wind?" MarineLink. Retrieved from https://www.marinelink.com/news/osvs-fit-refit-offshore-wind-475434

7 Winston & Strawn LLP, 2020.

8 Greenhalgh, K. (Jan. 8, 2021). "Jones Act Quandary Fails to Slow U.S. Offshore Wind Momentum." IHS Markit. Retrieved from https://ihsmarkit.com/research-analysis/jones-act-quandary-fails-to-slow-us-offshore-wind-momentum.html.

Feeder Vessels and Foundations

Two aspects of OSW farm construction are key to understanding the issues at play: FSVs and OSW turbine foundation designs.

The absence of Jones Act–compliant WTIVs has led U.S. OSW project developers to plan their projects using FSVs. These vessels are Jones Act–compliant and are used to bring construction materials from a port to the construction site, where they deliver the items to a WTIV that may not be Jones Act–compliant. The WTIV remains at the construction site throughout the build and does not transport any materials from a U.S. port to the OSW project construction site, thereby avoiding violation of the Jones Act. FSVs do not have the same specialized requirements of WTIVs because they do not themselves install foundations in the seabed or lift the turbine components during the installation process. The feeder vessel method provides flexibility by enabling the use of foreign-flagged WTIVs to install the foundations and turbines, while Jones Act–compliant FSVs transport the project components to the project site. It is unclear whether the feeder vessel method will remain a competitive strategy once multiple Jones Act–compliant WTIVs are operating, as many believe that leasing a single vessel will be more cost-effective than leasing the multiple needed for the feeder vessel method. Advocates for the latter process note its potential to save time and money, as the WTIVs can spend more time installing turbines and less time in transit. Although we do not include an analysis of the feeder vessel method's benefits in this paper, it is noteworthy that we were unable to find any examples of FSVs being used in markets not subject to the Jones Act requirements. This suggests that developers abroad likely opted to develop projects without FSVs for economic reasons.

Additionally, the type of OSW turbine foundation that is selected affects the project's vessel needs. OSW turbine foundation designs include gravity, monopile, tripod, jacket and floating foundations.[9] Monopile, tripod and jacket foundations generally require an FIV or a WTIV to drive the foundation into the seafloor. Globally, monopiles are currently the predominant foundation type and deployed in nearly 75% of installed OSW projects, although a shift toward jacket foundations is anticipated.[10] Monopiles are the leading foundation type in the U.S. OSW market as well, with a manufacturing facility currently under construction in Paulsboro, New Jersey,[11] and large projects such as the 2.6-GW Coastal Virginia Offshore Wind—Commercial (CVOW-C) project submitting orders for monopiles for their turbines.[12] Gravity foundations use a large prefabricated base that is moved to the project site via barge and then submerged without the need for an FIV or a WTIV. Equinor is considering using gravity-base foundations for its Empire Wind project, but its recently filed Construction and Operations Plan also reflects consideration of monopile foundations.[13]

Floating OSW turbine foundations similarly do not require a WTIV; the turbine is affixed to the floater before being towed out to the project site, where it is moored to the seafloor. Floating foundations will be necessary for deploying OSW in waters deeper than approximately 60 meters, such as those off the West Coast and in the Gulf of Maine. Although both floating and gravity foundations seem like reasonable candidates to install during a shortage of viable WTIVs, neither provides a perfect solution. Floating foundations are prohibitively expensive and have not yet been deployed at a large scale; we expect to see cost declines for this technology but not on the timeline necessary to make them viable for the projects that will constitute the first 30 GW in the United States. Gravity foundations require particular substrate conditions on the seafloor and may not be suitable for many of the lease areas that are currently under development in the United States.

9 Keene, M. (Jan. 4, 2021). "Comparing Offshore Wind Turbine Foundations." Windpower Engineering & Development. Retrieved from https://www.windpowerengineering.com/comparing-offshore-wind-turbine-foundations/#:~:text=1%20Monopile%20Foundations.%20Steel%20monopile%20foundations%20can%20be,and%20Portugal%2C%20with%20more%20European%20projects%20in%20development.

10 U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. (August 2021). *Offshore Wind Market Report: 2021 Edition*. Retrieved from https://www.energy.gov/sites/default/files/2021-08/Offshore%20Wind%20Market%20Report%202021%20Edition_Final.pdf.

11 Gov. Phil Murphy (New Jersey; December 2021). "Governor Murphy Announces $250 Million Total Investment in State-of-the-Art Manufacturing Facility to Build Wind Turbine Components to Serve Entire U.S. Offshore Wind Industry." Retrieved from https://nj.gov/governor/news/news/562020/approved/20201222a.shtml.

12 Heavy Lift News. (Nov. 5, 2021). "EEW SPC Collects 176 Monopile Contract From Dominion Energy for Coastal Virginia Offshore Wind." Retrieved from https://www.heavyliftnews.com/eew-spc-collects-176-monopile-contract-from-dominion-energy-for-coastal-virginia-offshore-wind/.

13 Bureau of Ocean Energy Management. (July 2021). *Empire Wind Construction and Operations Plan*. Retrieved from https://www.boem.gov/renewable-energy/empire-wind-construction-and-operations-plan.

Erosion of U.S. Commercial Shipbuilding Capacity

To understand the environment in which government, the private sector and labor must work to support the domestic production of WTIVs and other necessary vessels, it is critical to examine the challenges facing U.S. commercial shipbuilding and persistent distortions in the global industry. Incentivizing U.S. vessel construction will require transformative policy measures and broad collaboration.

Once a global player in commercial shipbuilding, the United States has lost significant production capacity in this advanced industry. The massive scale-up associated with U.S. involvement in World War II (WWII) produced 5,300 commercial vessels. This increase relied upon a combination of privately owned, government-owned and privately operated, and government-owned and government-operated shipyards.[14] The industry shrank after the war, and thousands of these ships were sold off, but into the early 1980s U.S. shipyards continued to produce nearly 20 oceangoing commercial vessels per year.[15]

Competitiveness in the commercial shipbuilding industry relies heavily on economies of scale, and many countries aggressively support their industries to capture market share and achieve growth. For decades, the United States was no exception, engaging in active industrial policy to support its shipyards. A key pillar of this support was the Construction Differential Subsidy (CDS) program run through the Maritime Administration (MARAD). This program paid up to 50% of the price difference between building a ship in the United States and constructing a vessel in a foreign yard and could only be used for vessels engaged in international trade. This program, which was implemented prior to WWII, was eliminated in 1981. In the last five years of its existence, the CDS program provided more than $1 billion to domestic shipyards.[16]

As U.S. government support for shipbuilding dramatically declined, foreign competitors continued to subsidize their own shipyards, and the U.S. industry cratered. In 1975, that industry produced 77 vessels over 1,000 gross tons. Numerous factors affected U.S. shipbuilders before the elimination of the CDS program, including the collapse of tanker demand[17] as production slipped to 46 large vessels in 1980. But without the CDS program, production plummeted, with 11 vessels constructed in 1985 and only three in 1990.[18] A 1984 report by the Congressional Budget Office identified 27 major shipyards capable of producing naval or major commercial ships.[19] This figure has dropped precipitously, falling to only eight shipyards today.[20] An industry that employed more than 180,000 Americans in 1980 has shrunk to 107,000 workers despite the explosion of international shipping.[21] The Jones Act has preserved some domestic capacity, particularly for smaller commercial vessels, but the market has proven too small and the quantity of orders too erratic to sustain the economies of scale needed to compete with subsidized foreign yards in global markets.

Today, nearly 80% of the U.S. shipbuilding industry is related to military procurement and repair. The magnitude of demand to support defense production has maintained some U.S. shipyards, but state-supported international competitors consistently undercut U.S. shipbuilders for commercial fleets. This demonstrates the strength in which demand can shape the market, but it also has implications for what the domestic buildout of the necessary vessels for 30 GW of OSW in U.S. waters can mean for the relatively smaller commercial segment.[22]

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14 Wilson, M. (2017). *Destructive Creation*. University of Pennsylvania Press.

15 U.S. Congress, Office of Technology Assessment. (October 1983). Chapter 4: The U.S. Shipbuilding Industry: Status and Trends in Technology and Productivity. In *An Assessment of Maritime Trade and Technology*, OTA-O-220. Retrieved from https://www.princeton.edu/~ota/disk3/1983/8302/830206.PDF.

16 Meanwhile, other shipbuilding powers did not retreat from state support. A 1996 report by the National Research Council found that between 1988 and 1993, competitors continued to heavily subsidize their shipbuilders. South Korea provided $2.4 billion; Germany, $2.3 billion; Japan, $1.9 billion; Italy, $940 million; Spain, $897 million; and France, $634 million.

17 It should be noted this collapse in demand also affected foreign competitors.

18 Klein, A. (Sept. 1, 2015). "Decline in U.S. Shipbuilding Industry: A Cautionary Tale of Foreign Subsidies Destroying U.S. Jobs." Eno Transportation Weekly. Retrieved from https://www.enotrans.org/article/decline-u-s-shipbuilding-industry-cautionary-tale-foreign-subsidies-destroying-u-s-jobs/; Bureau of Transportation Statistics. (Sept. 10, 2012). "Figure 1: U.S. Commercial Shipbuilding Orderbook History: As of January 2002." Retrieved from https://www.bts.gov/archive/publications/transportation_statistics_annual_report/2001/chapter_05_figure_01_132_table.

19 Congressional Budget Office. (August 1984). *U.S. Shipping and Shipbuilding: Trends and Policy Choices*. Retrieved from https://www.cbo.gov/sites/default/files/98th-congress-1983-1984/reports/1984_09_shipping.pdf.

20 Navy League of the United States. (2021). *Legislative Path to a New Maritime Transportation Strategy*. Retrieved from https://www.navyleague.org/wp-content/uploads/2021/10/Sealift-Capacity-Report.pdf.

21 MARAD, 2021.

22 Cook, D. (Oct. 30, 2021). *Ship Building Industry in the U.S.* IBISWorld Report 33661A. IBISWorld.

GLOBAL CAPACITY OF OFFSHORE WIND FLEET

Before examining the construction of OSW vessels within the United States, it is important to understand the global context. The existing international shortage of vessels underscores the need for domestic shipbuilding to service the offshore wind industry. In this section, we outline the capacity of the OSW fleet in terms of WTIVs because other vessels are difficult to track and easier to fabricate or convert than WTIVs. Rystad Energy concluded that the heavy-lift vessel segment (WTIVs) was the primary bottleneck toward the middle of the decade.[23]

Number of WTIVs

WTIVs currently operate both in Europe and off the coast of China. Although it is possible that the European fleet may be used in the U.S. industry with the feeder vessel method, most analyses have excluded the Chinese fleet from consideration in the United States. This is because this particular fleet neither operates internationally nor is expected to do so.

A December 2020 report by the Government Accountability Office[24] concludes that there are about 50 WTIVs operating in the global fleet with the capability of installing turbines as large as 6 MW. However, few of these are likely to be able to install the next-generation turbines 12+ MW that will be used in projects in the United States.

IHS Markit's (IHS) analysis released in May 2021[25] identified a global fleet of about 50 WTIVs currently operating, with two-thirds located in China. It also noted that there are six vessels under construction that are expected to be deployed by 2023. IHS anticipates global demand surpassing global supply in 2026 or 2027.

Tufts University researchers performed a study[26] that provides perhaps the best insight into the global fleet of WTIVs capable of installing turbines 12+ MW. **Table 2** includes a summary of five vessels identified by the Tufts study that could install these turbines as well as five additional vessels under construction that are expected to be available for use outside of mainland China. These include Dominion Energy's *Charybdis*, two unnamed vessels under construction in Japan and South Korea and two WTIVs commissioned by a Norwegian firm to be built in China. While the Tufts paper identified vessels capable of handling turbines 12+ MW, many announcements indicate that the vessels are intended to handle turbines up to 20 MW. The shipbuilders understand that turbine sizes will continue to increase and largely have been able to design ships to accommodate turbines larger than those that exist on the current market.

23 Rystad Energy. (Nov. 25, 2020). "The World May Not Have Enough Heavy Lift Vessels to Service the Offshore Wind Industry Post 2025" [Press release]. Retrieved from https://www.rystadenergy.com/newsevents/news/press-releases/the-world-may-not-have-enough-heavy-lift-vessels-to-service-the-offshore-wind-industry-post-2025/.

24 U.S. Government Accountability Office. (Dec. 8, 2020). *Offshore Wind Energy: Planned Projects May Lead to Construction of New Vessels in the U.S., but Industry Has Made Few Decisions Amid Uncertainties*. GAO-21-153. Retrieved from https://www.gao.gov/products/gao-21-153.

25 IHS Markit. (May 5, 2021). "Global Offshore Wind Goals Threatened by Lack of Suitable Infrastructure, IHS Markit Report Warns" [Press release]. Retrieved from https://news.ihsmarkit.com/prviewer/release_only/id/4715004.

26 Bocklet, C., Herbosa, C., Loweth, G., et al. (June 28, 2021). *Wind Turbine Installation Vessels: Global Supply Chain Impacts on the U.S. Offshore Wind Market*. OSPRE-2021-02. Tufts University. Retrieved from https://dl.tufts.edu/concern/pdfs/rn301f830.

TABLE 2. **WTIVs Capable of Installing Turbines 12+ MW**

Vessel	Status	Country of Origin	Flag	Notes
Pacific Osprey	Built	South Korea[27]	Cyprus	Recently completed crane upgrades allowing vessel to carry three 14-MW turbines[28]
Scylla	Built	South Korea[29]	Panama	
Innovation	Built	Poland[30]	Germany	
Voltaire	Expected completion in 2022	People's Republic of China	To be determined (TBD)	Largest WTIV currently under construction[31]
Brave Tern	Awaiting crane upgrade; expected completion in February 2022[32]	Dubai[33]	Malta	
Charybdis	Expected completion in 2023	United States	United States	First Jones Act–compliant WTIV capable of handling larger turbine installations
Seaway Ventus	Under construction; delivery scheduled for mid-2023[34]	People's Republic of China	TBD	Commissioned by Norway's Offshore Heavy Transport AS (OHT) to be built at China Merchants Heavy Industry shipyard[35]
VIND 2	Construction is planned; delivery date TBD	People's Republic of China	TBD	Commissioned by Norway's OHT to be built at China Merchants Heavy Industry shipyard[36]
TBD	Expected completion in late 2022[37]	Japan	Japan	
TBD	Expected completion in third quarter of 2024[38]	South Korea	TBD	Anticipated capability of installing 20-MW turbines

Availability to Service the United States

Although the abovementioned analyses vary in their calculations, the takeaways are clear. The global fleet of WTIVs is split into two distinct groups: the European fleet and the Chinese fleet. The latter is not expected to be available for use by developers building OSW farms in the United States, and the European fleet will likely have more demand than supply by the mid-2020s. As a result, it is unlikely that the existing global fleet will be available to serve the U.S. industry by the mid-2020s, even if developers opt for a feeder vessel approach. Given the three-year timeline for constructing these vessels, the United States has a short runway of one or two years to commission more WTIVs to deploy 30 GW in U.S. waters by 2030.

27 Offshore Energy. (April 5, 2031). "Installation Vessel Pacific Osprey Named in Denmark" [Press release]. Retrieved from https://www.offshore-energy.biz/south-korea-installation-vessel-pacific-osprey-named/.

28 4 C Offshore. (n.d.). "Wind Osprey: Heavy Maintenance and Construction." Retrieved from https://www.4coffshore.com/vessels/vessel-wind-osprey-vid257.html.

29 Seajacks. (June 5, 2015). "Update: Seajacks Scylla Nearing Completion." Retrieved from https://www.seajacks.com/news/update-seajacks-scylla-nearing-completion/.

30 Wärtsilä. (n.d.). "Wind Turbine Installation Vessel INNOVATION." Wärtsilä Encyclopedia of Marine and Energy Technology. Retrieved from https://www.wartsila.com/encyclopedia/term/wind-turbine-installation-vessel-innovation.

31 Moore, K. (June 6, 2019). "Next-Gen Offshore Wind Vessel Will Lift 3,000 Tons." WorkBoat. Retrieved from https://www.workboat.com/offshore/next-gen-offshore-wind-vessel-will-lift-3000-tons.

32 Heavy Lift News. (July 6, 2020). "Fred. Olsen Windcarrier Name Brave Tern for New 1600t Crane." Retrieved from https://www.heavyliftnews.com/fred-olsen-windcarrier-name-brave-tern-for-new-1600t-crane/.

33 Ship Technology. (Nov. 25, 2014). "Brave Tern Wind Farm Installation Vessel." Retrieved from https://www.ship-technology.com/projects/brave-tern-wind-farm-installation-vessel/.

34 Seaway7. (November 2021). *Seaway Ventus*. Retrieved from https://www.seaway7.com/wp-content/uploads/2022/03/Seaway_Ventus.pdf.

35 Blenkey, N. (July 29, 2021). "New WTIV to Feature Wärtsilä Propulsion System." Marine Log. Retrieved from https://www.marinelog.com/offshore/new-wtiv-to-feature-wartsila-propulsion-system/.

36 Ibid.

37 Energy Facts. (Dec. 9, 2020). "Steel-Cutting Ceremony for Shimizu Latest Wind Turbine Installation Vessel." Retrieved from https://www.energyfacts.eu/steel-cutting-ceremony-for-shimizu-latest-wind-turbine-installation-vessel/.

38 Durakovic, A. (May 12, 2021). "Eneti Orders Mega Jack-Up for 20 MW Wind Turbines." Offshore WIND. Retrieved from https://www.offshorewind.biz/2021/05/12/eneti-orders-mega-jack-up-for-20-mw-wind-turbines/.

THE FIRST 30 GW: VESSEL NEEDS OF THE U.S. OFFSHORE WIND INDUSTRY

Below, we discuss potential vessel buildout projects, considering both the feeder vessel and Jones Act–compliant WTIV installation methods. We estimate upper bounds on installation vessels required in each scenario, although the reality is that the variability of project conditions and vessel availability will likely lead to a combination of WTIVs and feeder vessels to meet the demands of the first 30 GW. We find that the first 30 GW would likely not require more than five WTIVs or 18 feeder vessels, although momentum in the sector could lead to the fabrication of additional WTIVs and feeders during the time frame beyond 2030.

WTIVs as the Dominant Pathway

A 2013 Douglas-Westwood assessment[39] identified a need for four to five WTIVs to reach a 30-GW buildout. An IHS report asserts that four new WTIVs must be built to meet global demand outside of mainland China by mid-decade. Ultimately, the number of Jones Act–compliant WTIVs required for the U.S. buildout will depend on how many projects elect to use the feeder vessel method; each project that uses feeder vessels will theoretically be able to use a foreign-flagged WTIV. This has the potential to reduce the demand for U.S.-flagged WTIVs. However, global WTIV supply constraints make it less likely that users of the feeder method will find affordable foreign WTIVs by mid-decade.

While there is still uncertainty about whether the feeder vessel method will be used after Jones Act–compliant WTIVs have been fabricated, we perform a rough calculation to approximately reproduce the numbers from the Douglas-Westwood and IHS reports. Assuming that no projects use the feeder vessel method beyond 2023 and that 28 GW of OSW projects will be installed from 2024 to 2030, we can perform some rough calculations. Each WTIV can install 70 to 100 turbines per year, with 85 as an average. The total of 28 GW will require about 2,300 12-MW turbines. This number spread over six years suggests approximately 390 turbines per year, which would require about 4.5 WTIVs. In a 2021 Tufts University analysis, authors performed similar calculations with additional consideration for a shortened installation season due to environmental impacts, to reach an expected requirement of 4.8 to 5.4 WTIVs.[40] However, due to lengthy development timelines and complex regulatory processes, this demand may not be spread smoothly across this period. For instance, while the Tufts analysis projects that as few as two WTIVs may be necessary between 2026 and 2028, the industry is expected to need five WTIVs to service all scheduled projects.[41]

A detailed analysis is beyond the scope of this paper, but a preliminary calculation using industry multipliers calculated by the Economic Policy Institute[42] indicates that investments of the scale included in our assumptions—five WTIVs at an average cost of $500 million—could support as many as 9,825 direct jobs, 11,175 indirect jobs and another 11,275 jobs as a result of induced economic activity. This does not include estimates for the thousands of jobs that will be supported by demand for scour, feeder and other related vessels. It also may underestimate the supply chain and induced effects, as MARAD estimates that each direct shipbuilding job supports an additional 3.67 jobs. This figure would translate to as many as 36,000 jobs in supply chains and induced activity supported by these investments.

39 Wind Energy Technologies Office. (Oct. 1, 2013). “Study Reveals Challenges and Opportunities Related to Vessels for U.S. Offshore Wind.” Retrieved from https://www.energy.gov/eere/wind/articles/study-reveals-challenges-and-opportunities-related-vessels-us-offshore-wind.

40 These findings are similar to work conducted by the National Renewable Energy Laboratory, which anticipates that four to six WTIVs will be needed. Lantz, E., Barter, G., Gilman, P., et al. (August 2021). *Power Sector, Supply Chain, Jobs and Emissions Implications of 30 Gigawatts of Offshore Wind Power by 2030*. NREL/TP-5000-80031. National Renewable Energy Laboratory. Retrieved from https://www.nrel.gov/docs/fy21osti/80031.pdf.

41 Bocklet et al., 2021.

42 Bivens, J. (Jan. 23, 2019). “Updated Employment Multipliers for the U.S. Economy” [Press release]. Economic Policy Institute. Retrieved from https://www.epi.org/publication/updated-employment-multipliers-for-the-u-s-economy/.

Feeder Vessels as the Dominant Pathway

It is possible that some wind farms will continue to use the feeder vessel method even once we have multiple Jones Act–compliant WTIVs, due to excess demand for WTIVs in the United States. In fact, the feeder vessel method is already the planned pathway for some of the projects that will begin construction before the *Charybdis* or any other Jones Act–compliant WTIVs become available. There are also industry members who believe that the feeder vessel method will remain competitive and are planning to fabricate Jones Act–compliant feeder vessels.[43,44]

While it is unclear how many feeder vessels may be fabricated, we can estimate the potential upper bound for the buildout, assuming that the *Charybdis* remains the only Jones Act–compliant WTIV. If the *Charybdis* is delivered in 2023 and operates through 2030, it may install about 600 turbines, or 7.2 GW. This leaves 23 GW of work for feeder vessels until 2030. If we assume that each wind farm will require two feeder vessels, the average wind farm size is 700 MW, there is a construction timeline of two years per farm and we assume the feeder vessels are moving immediately to the next farm between jobs, it is possible that we would see a buildout of 16 to 18 Jones Act–compliant feeder vessels.

Service Operation Vessels and Crew Transfer Vessels

SOVs and CTVs will need to be Jones Act–compliant. Unlike WTIVs, there is no option in which foreign-flagged versions may perform this scope of work. IHS research has determined that there are 29 SOVs serving the OSW industry globally outside of mainland China, all located in Europe.[45] IHS also indicates that there are 14 SOVs in construction with delivery dates planned through 2024. Although we have generally limited the scope of our analysis to the 30-GW-by-2030 framework, it is noteworthy that some estimates anticipate a global need for up to 600 SOVs by 2050.[46]

Based on lessons from Europe, which reflect that a single SOV can service about 800 to 1,200 MW,[47,48] we may estimate that one SOV is required for each GW of OSW. Europe currently has approximately 25 GW of installed OSW capacity, which roughly matches the 29 SOVs. If our estimate of one SOV per GW holds, this sets the required number of SOVs for the first 30 GW at 30 SOVs. This should be considered an upper limit for the first 30 GW, because not all the wind farms on the U.S. East Coast will require SOVs, and some may elect to use CTVs for their daily transfer of crew back and forth. Although some CTVs are likely to be fabricated for the industry, some projects could elect to convert vessels from oil and gas operations.

The first Jones Act–compliant SOV was commissioned by Ørsted and Eversource, to be constructed by Edison Chouest Offshore. The fabrication of the vessel will create more than 300 new production jobs as the ship is built at shipyards in Florida, Mississippi and Louisiana.[49] If we considered 300 production jobs per vessel and a potential buildout of 30 vessels, we would expect an upper limit near 9,000 construction jobs for SOV fabrication alone. In addition, in January 2022, Ørsted and Eversource contracted for five new CTVs to support their operations that will be built by Rhode Island shipyards.[50]

43 Offshore. (April 21, 2021). "Dutch Firms Unveil U.S. Offshore Wind Feeder Vessel Design." Retrieved from https://www.offshore-mag.com/rigs-vessels/article/14201858/cjob-naval-architects-ampelmann-unveil-us-offshore-wind-feeder-vessel-design.

44 Buljan, A. (June 17, 2020). "U.S. Companies Plan Construction of Two SuperFeeder Offshore Wind Vessels." Offshore WIND. Retrieved from https://www.offshorewind.biz/2020/06/17/us-companies-plan-construction-of-two-superfeeder-offshore-wind-vessels/.

45 MacFarlane, C. (Aug. 1, 2021). "Offshore Wind Installation Vessel Market Booming." Offshore. Retrieved from https://www.offshore-mag.com/renewable-energy/article/14206400/ihs-markit-offshore-wind-installation-vessel-market-booming.

46 Foxwell, D. (Nov. 16, 2021). "600 Service Operation Vessels Could Be Required by 2050." Riviera Maritime Media. Retrieved from https://www.rivieramm.com/news-content-hub/600-service-operation-vessels-could-be-required-by-2050-68484.

47 MarineLink. (Sept. 17, 2016). "ESVAGT Orders Two SOVs From Havyard." Retrieved from https://www.marinelink.com/news/esvagt-orders-two-sovs-havyard-441615.

48 Maritime Executive. (April 6, 2021). "North Star Orders Three SOVs From VARD for Scottish Wind Farm Ops." Retrieved from https://www.maritime-executive.com/article/north-star-orders-three-sovs-from-vard-for-scottish-wind-farm-ops.

49 World Oil. (Oct. 1, 2020). "First U.S. Built, Jones Act–Compliant Windfarm Service Operations Vessel Chartered." Retrieved from https://www.worldoil.com/news/2020/10/1/first-u-s-built-jones-act-compliant-windfarm-service-operations-vessel-chartered/.

50 Revolution Wind. (Jan. 27, 2022). "Rhode Island Shipyards to Build Five New Offshore Wind Crew Vessels to Service Ørsted and Eversource's Northeast Wind Farms." Retrieved from https://revolution-wind.com/news/2022/01/rhode-island-shipyards-to-build-five-new-offshore-wind-crew-vessels.

Supply Chain and Broader Economic Impacts

In addition to the jobs created directly at shipyards, the buildout of WTIVs, SOVs and other vessels will also stimulate activity throughout domestic supply chains as shipbuilders source steel and other metals, electrical and mechanical components and various services. The activity could support thousands of additional jobs in these industries.[51] These investments will have further ripple effects, as workers who are employed in building these vessels and supplying needed components and services spend more at businesses in their communities.

According to the MARAD, shipyards directly employ 107,180 workers and support another 286,210 jobs in their lengthy supply chains and through induced economic activity.[52] Materials and supplies constitute 34.1% of total industry costs, spending that stimulates good jobs in the production of key materials, such as steel, aluminum and copper as well as components including engines, valves and hoists.[53] Taken together, the shipbuilding industry, its supply chain and related economic activity contribute more than $42 billion to the United States' gross domestic product and $8.5 billion to federal, state and local government coffers.[54] The Jones Act, however, requires domestic sourcing only for the hull and superstructure as well as final assembly in the United States. To further boost supply chain effects, members of Congress have in recent years passed legislation[55] and introduced bills to require more domestic sourcing.[56] Studies examining infrastructure policy have found that increasing the use of domestic content can increase U.S. manufacturing job creation by as much as 33%.[57]

51 A detailed study is beyond the scope of this paper, but an estimate made using industry multipliers, as calculated by the Economic Policy Institute, provides useful insight into the potential impacts of domestic WTIV production. Investments of the scale included in our assumptions—five WTIVs at an average cost of $500 million—could support approximately 9,825 direct jobs, 11,175 indirect jobs and another 11,275 jobs as a result of induced economic activity. This does not include estimates for the thousands of jobs that will be supported by demand for supply and other related vessels. It also may underestimate the supply chain and induced effects, as MARAD estimates that each direct shipbuilding job supports another 3.67 jobs. This figure would translate to as many as 36,000 additional jobs in supply chains and induced activity supported by these investments.

52 MARAD, 2021.

53 Gordon, K., & Steidl, C. (2019). *Global Value Chains and the Shipbuilding Industry.* Organisation for Economic Co-operation and Development. Retrieved from https://read.oecd-ilibrary.org/science-and-technology/global-value-chains-and-the-shipbuilding-industry_7e94709a-en#page19.

54 MARAD, 2021.

55 Office of U.S. Congressman John Garamendi. (July 22, 2020). "Readiness Chairman Garamendi Votes to Pass National Defense Authorization Act in the House" [Press release]. Retrieved from https://garamendi.house.gov/media/press-releases/readiness-chairman-garamendi-votes-pass-national-defense-authorization-act.

56 Office of U.S. Senator Tammy Baldwin. (Oct. 10, 2020). "U.S. Senator Tammy Baldwin Reintroduces Legislation to Support American Manufacturers and Shipbuilders" [Press release]. Retrieved from https://www.baldwin.senate.gov/news/press-releases/made-in-america-shipbuilding-act-2020.

57 Heintz, J., Pollin, R., & Garrett-Peltier, H. (January 2009). *How Infrastructure Investments Support the U.S. Economy: Employment, Productivity and Growth*. Political Economy Research Institute. Retrieved from https://infrastructureusa.org/wp-content/uploads/2009/07/aam_investments.pdf.

DOMESTIC SHIPBUILDING CAPABILITY

The challenges in vessel supply that the United States' and global OSW industries face could represent a pathway to strengthen U.S. commercial shipbuilders. The United States currently builds fewer than 10 commercial oceanic vessels each year, whereas China builds upward of 1,000.[58]

Although a government report in 2015 identified 124 shipyards capable of fabricating vessels and 200 capable of repairing them,[59] the *Charybdis* designers state that there may be as few as two or three shipyards in the United States with the capability of building WTIVs, due to their large size and unique specifications.[60] Because we are so early in the development of these larger WTIVs, an exact count of yards with existing capacity is difficult to pin down. A review of facility size would indicate as many as six to seven yards could be WTIV-capable, but this number could be whittled down based on specifications of a particular vessel order—or, alternately, increased with new investments. The possibility has also been raised that shipyards that construct military vessels could enter the market, thereby providing operators and developers with more options. But sources indicate that these yards are unlikely to have interest in this work without changes to the pipeline of government orders or volume of commercial demand.

Industry participants indicated that clear, long-term demand signals could induce more existing yards to make necessary investments to enter this market; however, near-term challenges remain. If there are in reality only a handful of American shipyards that are currently capable of fabricating modern WTIVs, one is already being used for the *Charybdis* until the end of 2023, each fabrication takes three years and the United States needs four WTIVs by 2025, then the United States may need to upgrade one or more yards. It is also expected that construction of the remaining three WTIVs would need to start in early 2022 to have them ready for delivery in 2025.

58 Thompson, L. (July 23, 2021). "U.S. Shipbuilding Is at Its Lowest Ebb Ever. How Did America Fall So Far?" Forbes. Retrieved from https://www.forbes.com/sites/lorenthompson/2021/07/23/us-shipbuilding-is-at-its-lowest-ebb-ever-how-did-america-fall-so-far/?sh=f1376af6c87a.

59 MARAD, 2021.

60 Ford, N. (Feb. 10, 2021). "U.S. Vessel Builders Seek Urgent Orders to Catch Offshore Wind Wave." Reuters. Retrieved from https://www.reutersevents.com/renewables/wind/us-vessel-builders-seek-urgent-orders-catch-offshore-wind-wave.

COMMISSIONING OF THE *CHARYBDIS*

Dominion Energy has commissioned the first Jones Act–compliant WTIV with expected completion in 2023 and an anticipated price tag of $500 million. WTIVs are larger and more specialized than the other types of vessels used to develop wind farms, and Dominion Energy's decision to invest has received significant media attention.

Development and Planned Use

The *Charybdis* is being constructed at the Keppel AmFELS shipyard in Brownsville, Texas, and will provide approximately 700 construction jobs during fabrication, with completion scheduled for late 2023.[61] The fabrication will require 14,000 tons of steel, approximately 10,000 tons of which is expected to be American-made, and the ship will have a 472-foot-long hull.[62] The *Charybdis* is planned to be larger than comparable vessels that have already been constructed and is anticipated to be able to handle turbines larger than 12 MW, which is important for the U.S. buildout, which will likely involve turbines 12 MW to 15 MW.

The vessel already has commitments for the first several years of its life. It is scheduled to be used on the construction of two wind farms, Revolution Wind and Sunrise Wind, which are being built by Ørsted and Eversource. After the building of these wind farms is complete, the vessel is scheduled to sail south to begin construction on Dominion Energy's CVOW-C project, with expected permitting on the project slated to allow construction beginning in 2026. After the CVOW-C project, the company plans to contract out the vessel to other developers that are building projects in the United States. With no other WTIVs under construction and high demand related to the 30-GW buildout, the company does not anticipate problems finding additional customers.

Dominion Energy's Thought Process

Dominion Energy commissioned the vessel as a nonregulated asset to be owned by a subsidiary company, Blue Ocean Energy Marine. The vessel has not been added to Dominion Energy's rate base, and the utility's ratepayers will not see their rates increase to pay for it. Although it may seem unexpected for a utility to commission a vessel, there are several reasons why Dominion Energy was positioned to make this investment, as detailed below.[63]

1. **Risk mitigation.** Dominion Energy is mandated to develop more than 2.6 GW of OSW capacity in the CVOW-C project and a total of 5.2 GW by 2034 by the Virginia Clean Economy Act (VCEA).[64] The VCEA both gave Dominion Energy the certainty it would need to invest in the OSW industry and exposed the company to industry risks, such as exposure to high charter rates for OSW vessels. Dominion Energy wanted to reduce the possibility that it would not be able to develop the project due to a lack of vessels or that a vessel shortage would lead to exorbitant charter pricing. This led the company to its desire to commission vessels to develop its projects.

61 Dominion Energy. (June 1, 2021). "Dominion Energy, Ørsted and Eversource Reach Deal on Contract to Charter Offshore Wind Turbine Installation Vessel" [Press release]. Retrieved from https://news.dominionenergy.com/2021-06-01-Dominion-Energy,-rsted-and-Eversource-Reach-Deal-on-Contract-to-Charter-Offshore-Wind-Turbine-Installation-Vessel.

62 Wall, S. (June 1, 2021). "Dominion Vessel to Assist in Building Northeastern Offshore Wind Farms." Virginia Business. Retrieved from https://www.virginiabusiness.com/article/dominion-vessel-to-assist-in-building-northeastern-offshore-wind-farms/.

63 Insights into Dominion Energy's thought process come from interviews with members of the Dominion Energy team working on the *Charybdis'* commissioning.

64 Virginia's Legislative Information System (LIS). (n.d.). "H.B. 1526 Electric Utility Regulation; Environmental Goals." Retrieved from https://Lis.Virginia.Gov/Cgi-Bin/Legp604.Exe?201+Sum+HB1526.

2. **Concerns with the feeder vessel method.** Dominion Energy expects there to be a shortage of barges capable of serving as feeder vessels for large next-generation turbines 14+ GW. It also anticipates that barges commissioned to fill the shortfall, coupled with the cost of leasing a foreign-flagged WTIV, would result in a total expense similar to commissioning Jones Act–compliant WTIVs. Furthermore, Dominion Energy's experience in the CVOW-C pilot project and discussions with industry consultants from Europe convinced the company that using FSVs presented many unknowns and risks related to FSV performance on windy days. Dominion Energy also saw uncertainty in the political environment and regulatory enforcement of the Jones Act and indicated that it valued the long-term certainty of a Jones Act–compliant vessel. Ultimately, the company decided either the FSV or the Jones Act–compliant WTIV method would come with similar price tags, but the WTIV-only method used elsewhere in the world carried fewer risks.

3. **Profitable chartering.** The same vessel shortage that caused Dominion Energy to believe that the company needed its own vessel has led to its belief that owning a WTIV will also require higher charter pricing. The Dominion Energy subsidiary that owns the *Charybdis* should in theory be required to charge higher rates to recoup the initial investment and costs of operating under U.S. flag requirements. Charter rates for WTIVs in Europe are as high as $220,000 per day,[65] but charges may be higher in the United States due to the lack of available ships.

4. **Comfort with large capital deployments.** As a utility, Dominion Energy has the comfort of deploying large amounts of capital to build physical assets. The company saw parallels between the vessel's construction and Dominion's experience with managing large power plant construction projects, including mechanical, electrical and labor similarities.

Other Vessels

As of the time of writing, two firms other than Dominion Energy had announced their intention to build Jones Act–compliant WTIVs, although neither has begun construction or made public concrete commitments. Lloyd's Register has announced a partnership with the Northeast Technical Services Co. (NETSCo) to build a ship and may be planning to convert an existing vessel to a WTIV.[66] Eneti had also indicated plans to build a WTIV in the United States but has since contracted for two WTIVs to be built in South Korea and announced that it was halting its plans for a U.S.-built vessel.[67]

The Norwegian firm Havfram recently announced its intent to develop a WTIV that can serve the U.S. market.[68] In the past, the company noted that it believed the feeder vessel method was feasible for the U.S. buildout,[69] and reporting indicates that the vessel is likely to be built overseas. Havfram claims the ship will be capable of running on zero-emissions fuel and handling turbines up to 20-MW capacity.

65 Hellenic Shipping News. (Oct. 10, 2021). "Wind Turbine Installation Vessel Business—Reprieve or a Debt Trap for Scorpio Bulkers?" Retrieved from https://www.hellenicshippingnews.com/wind-turbine-installation-vessel-business-reprieve-or-a-debt-trap-for-scorpio-bulkers/.

66 Lloyd's Register. (Dec. 16, 2020). "LR and NETSCo to Develop Jones Act Compliant Wind Turbine Installation Vessel." Retrieved from https://www.lr.org/en/latest-news/lr-netsco-jones-act-compliant-wind-turbine-installation-vessel/.

67 Eneti Inc. (May 11, 2021). "Eneti Inc. Announces a Contract for the Construction of One Next-Generation Offshore Wind Turbine Installation Vessel and Provides an Update on Its Jones Act Initiative" [Press release]. Retrieved from https://www.eneti-inc.com/eneti-inc-announces-a-contract-for-the-construction-of-one-next-generation-offshore-wind-turbine-installation-vessel-and-provides-an-update-on-its-jones-act-initiative/; Maritime Executive. (Feb. 1, 2022). "Eneti Halts Plan to Build the Second U.S. Jones Act WTIV." Retrieved from https://www.maritime-executive.com/article/eneti-stops-plan-to-build-the-second-u-s-jones-act-wtiv.

68 Buljan, A. (Sept. 27, 2021). "Havfram Set to Order Installation Vessel for 20+ MW Offshore Wind Turbines." Offshore WIND. Retrieved from https://www.offshorewind.biz/2021/09/27/havfram-set-to-order-installation-vessel-for-20-mw-offshore-wind-turbines/.

69 Foxwell, D. (Feb. 12, 2021). "Semi-Sub and Feeder Ships Put Havfram in the Frame for Jones Act Market." Riviera Maritime Media. Retrieved from https://www.rivieramm.com/news-content-hub/news-content-hub/semi-sub-and-feeder-ships-put-havfram-in-the-frame-for-jones-act-market-63506.

GLOBAL MARKET CHALLENGES

The global shipbuilding industry is rife with market distortions and has regularly battled overcapacity. To address the persistent market distortions, overcapacity and other issues in the global shipbuilding industry, the Organisation for Economic Co-operation and Development (OECD) established the Working Party on Shipbuilding specifically to increase transparency and further normal competitive conditions within the industry.[70] Despite these efforts, subsidies and other forms of state support remain prevalent.[71]

China, South Korea and Japan

China has aggressively entered the market in recent decades and heavily subsidizes its industry through various mechanisms, including low-interest financing, production subsidies and streamlined permitting and licensing processes.[72] One study estimated that between 2006 and 2012, subsidies lowered shipyard costs between 13% and 20%, a massive competitive advantage.[73] Separately, researchers found that between 2010 and 2018, the Chinese government provided as much as $132 billion in support of its shipping and shipbuilding industries.[74] This amount included direct subsidies but also increasingly sophisticated forms of support, such as private equity infusions, and an explosion in lending and leasing by Chinese state-owned banks. These figures likely underestimate the impact of state policies, as China's government heavily subsidizes its steel industry, a major supplier for shipbuilders.[75] Further, the review did not include other likely sources of support, such as subsidies to unlisted firms and state-supported fundraising. These industrial policies have not only spurred rapid growth in market share, currently 33%, but have also led to overcapacity in China's shipbuilding industry.[76]

This problem is not limited to state-owned enterprises. Yangzijiang Shipbuilding Holdings, which was ostensibly converted to a private enterprise, "received direct subsidies that amounted to 1.8% of its revenue, a ratio that was even higher than the state-owned shipbuilders." This broad level of support is no accident: The Chinese government has identified its intent to support domestic industry for years and recently included high-technology shipping in its China 2025 plans, a clear signal that intense state support should be expected to continue.[77]

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70 The Working Party includes multiple European nations as well as South Korea and Japan. OECD. (n.d.). "The OECD Council Working Party on Shipbuilding." Retrieved from https://www.oecd.org/sti/ind/shipbuilding-working-party.htm.

71 Bachri, S., Bartenfeld, C., Blackwell, R., et al. (2015). *Spring 2015 Industry Study. Final Report: Shipbuilding*. Dwight D. Eisenhower School for National Security and Research Strategy. Retrieved from https://es.ndu.edu/Portals/75/Documents/industry-study/reports/2015/es-is-report-shipbuilding-2015.pdf.

72 Kalouptsidi, M. (April 15, 2019). "China's Shipbuilding Industry: Measuring the Effect of Industrial Policy." London School of Economics and Political Science blog. Retrieved from https://blogs.lse.ac.uk/businessreview/2019/04/15/chinas-shipbuilding-industry-measuring-the-effect-of-industrial-policy/.

73 Kalouptsidi, M. (June 2015). *Detection and Impact of Industrial Subsidies: The Case of World Shipbuilding*. Retrieved from https://www8.gsb.columbia.edu/faculty-research/sites/faculty-research/files/finance/Website%20Materials/myrtosubsidies.pdf.

74 Blanchette, J., Hillman, J. E., McCalpin, M., and Qiu, M. (July 2020). *Hidden Harbors: China's State-Backed Shipping Industry*. Retrieved from https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/207008_Blanchette_Hidden%20Harbors_Brief_WEB%20FINAL.pdf.

75 Bachri et al., 2015.

76 European Union Chamber of Commerce in China. (2016). *Overcapacity in China: An Impediment to the Party's Reform Agenda*. Retrieved from https://www.europeanchamber.com.cn/en/publications-overcapacity-in-china#:~:text=China's%20industrial%20economy.-,Overcapacity%20in%20China%3A%20An%20Impediment%20to%20the%20Party's%20Reform%20Agenda,on%20this%20topic%20in%202009.

77 Rubio, M. (Dec. 2, 2019). *Made in China: 2025 and the Future of American Industry*. U.S. Senate Committee on Small Business & Entrepreneurship, Project for Strong Labor Markets and National Development. Retrieved from https://www.rubio.senate.gov/public/_cache/files/d1c6db46-1a68-481a-b96e-356c8100f1b7/3EDECA923DB439A8E884C6229A4C6003.02.12.19-final-sbc-project-mic2025-report.pdf.

South Korea also plays a significant role in global shipbuilding, retaining about 28% of the market as of 2019.[78] It also has a long history of state intervention: Most recently, a World Trade Organization complaint filed by Japan alleged that South Korea subsidized its industry by $10.5 billion between 2015 and 2018[79] (Japan itself has recently increased its shipbuilding subsidies[80]). The South Korean shipbuilding industry has a global lead in premium ships and eco-friendly ships, which may offer lessons for low-emission shipping in OSW. The South Korean government has recently mapped out several initiatives to increase the nation's shipbuilding industry, including the development of liquefied natural gas (LNG) bunkering ships and bunkering infrastructure.[81] South Korea also has committed hundreds of millions of government dollars to eco-friendly shipbuilding research and development (R&D) and supports the industry with payroll subsidies and training programs.

While current U.S. policies do not put the nation's industry in a position to compete with China or South Korea in the global shipbuilding market, understanding the role their industrial policies have played in establishing their dominant market positions is critical as we seek to leverage the U.S. OSW buildout to strengthen our own shipbuilding sector.

Implications for Industry

The high levels of state support globally for shipbuilding create market distortions that render typical market-based approaches to improving competitiveness less effective and necessitate a more aggressive government role to level the playing field. There is not likely to be one solution to incentivize expanded domestic production, so we have instead laid out several approaches that could be used in concert to achieve the desired ends. Due to the scale of the challenge, a successful outcome will require regular engagement by industry and labor, as well as support and coordination from government, to maximize the use of these available levers and contemplate developing new tools.

78 OECD. (April 2021). *Report on China's Shipbuilding Industry and Policies Affecting It*. OECD Publishing. Retrieved from https://www.oecd-ilibrary.org/science-and-technology/report-on-china-s-shipbuilding-industry-and-policies-affecting-it_bb222c73-en.

79 World Trade Organization. (Feb. 10, 2020). "Japan Initiates Second WTO Dispute Complaint Regarding Korean Support for Shipbuilders." Retrieved from https://www.wto.org/english/news_e/news20_e/ds594rfc_06feb20_e.htm.

80 Chambers, S. (May 14, 2021). "Japan's Parliament Passes Package of Shipbuilding Measures." Splash 247. Retrieved from https://splash247.com/japans-parliament-passes-package-of-shipbuilding-measures/.

81 Maritime Executive. (Sept. 9, 2021). "South Korean Government Pledges Premium Ship Construction Leadership." Retrieved from https://www.maritime-executive.com/article/south-korean-government-pledges-premium-ship-construction-leadership.

POLICY LEVERS TO ACCELERATE OFFSHORE WIND SHIPBUILDING

Guaranteed Demand

Multiple reports and industry sources point to the need for certainty for shipbuilders and operators to make the significant investments necessary to produce large-scale WTIVs and, to a lesser extent, large feeder vessels. It is clear there is a chicken-or-egg problem hampering the buildout of WTIVs. The continued ambiguity around the feeder vessel versus WTIV method; questions about global availability and OSW project timeliness; prospect of heavily subsidized foreign yards expanding production and saturating the market; and fractured, state- or region-based nature of these projects create risk for shipbuilders and operators that might be interested in filling this market gap.

Clear market signals are essential for shipbuilders and operators to maintain confidence that there will be a market that warrants these investments. There are multiple recent examples of the government's ability to help create markets that stimulate private production and capacity. For instance, in 2014, Buy America preferences for domestically produced iron and steel products were expanded to cover water infrastructure projects. In response, the Environmental Protection Agency found that "[m]anufacturers have constructed new foundries and continue to invest in their domestic manufacturing capabilities."[82] The clear market signals sent by the expansion of Buy America incentivized domestic investments to meet demand. More recently, as the COVID-19 pandemic spread, it became strikingly clear that vaccines would be needed on an accelerated timeline. The United States' traditional approach to economic policy has often focused on investments in basic R&D, leaving commercialization and production activity to the markets. Although several factors contributed to Operation Warp Speed's[83] success, the guarantee of sustained demand was central to the operation's effectiveness.[84]

Similarly, clear demand signals for WTIVs will incentivize both operators to execute contracts for these vessels and existing shipyards to make any investments necessary to produce them. Thus far, government action has been critical to enhancing market certainty, with notable landmarks that include President Biden's 30-GW-by-2030 target, the Bureau of Ocean Energy Management's (BOEM) announcement of Wind Energy Area leasing through 2025 and steady progress toward state government OSW procurement targets. Already, domestic shipyards are receiving orders for OSW-related vessels, including CTVs, the aforementioned Charybdis and a recent announcement for a $197 million fallpipe vessel to be built at the Philly Shipyard for the Great Lakes Dredge & Dock corporation.

However, as discussed earlier, most sources believe that Dominion Energy is an outlier among firms developing OSW projects due to its ability to take on a build of this scale because of the company's vertical integration with its offshore project and the certainty of demand for the vessel. It is our understanding that within the financial structure of individual projects under development, it would be difficult to justify direct procurement for a single project. A 2017 study found that a WTIV owner would need reasonable assurances that it could find customers for its vessels for 10 years, or about 3.5 to 4 GW of OSW capacity, to justify financing a new build. This study looked at smaller and less expensive WTIVs, so the challenge of justifying the initial investment is now likely even more daunting.[85]

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82 Environmental Protection Agency. (July 2019). *Drinking Water State Revolving Fund American Iron and Steel Requirement: 2018 Annual Report Addendum*. EPA 816-R-19-009. Retrieved from https://www.epa.gov/sites/default/files/2019-07/documents/dwsrf_ais_annual_report_add.pdf.

83 Operation Warp Speed was a federal effort that supported multiple COVID-19 vaccine candidates to speed up development.

84 Adler, D. (Summer 2021). "Inside Operation Warp Speed: A New Model for Industrial Policy." *American Affairs*, *V*(2). Retrieved from https://americanaffairsjournal.org/2021/05/inside-operation-warp-speed-a-new-model-for-industrial-policy/.

85 Cheater, B. (October 2017). *U.S. Jones Act Compliant Offshore Wind Turbine Installation Vessel Study: A Report for the Roadmap Project for Multi-State Cooperation on Offshore Wind*. NYSERDA Report 17-13. Retrieved from https://www.cleanegroup.org/wp-content/uploads/US-Jones-Act-Compliant-Offshore-Wind-Study.pdf.

To provide more certainty for ship operators and builders, Congress included an amendment in the fiscal year (FY) 2021 National Defense Authorization Act (NDAA) that clarified that the Jones Act applied to OSW development projects on the Outer Continental Shelf.[86] While proponents of the amendment were seeking blanket application, until the CBP issued a subsequent letter ruling, it was unclear how the Jones Act would be applied to the OSW industry.[87]

The first CBP letter rulings after passage of the FY 2021 NDAA appear to extend certain Jones Act loopholes created in earlier rulings to OSW development. Although a ruling on January 27, 2021, held that the pristine seabed would be treated as a coastwise point,[88] meaning that Jones Act–compliant vessels would be needed for all activity between U.S. ports and the proposed installation site, including the initial installation of scour protection, this was reversed in a March 25, 2021, ruling.[89] Separately, a Feb. 4, 2021, ruling held that the feeder method working in concert with a non-Jones Act–compliant WTIV would not be a Jones Act violation, citing rulings from the early 2000s as precedent.[90]

Previous experience with CBP exceptions indicates that these rulings will reduce the likelihood that OSW deployment will translate to a significant buildout of WTIVs in U.S. shipyards. For instance, in 2017, the CBP issued a notice that it intended to revoke 25 previous letter rulings that had created loopholes in Jones Act application,[91] but it withdrew this notice shortly thereafter. The Shipbuilding Council of America (SCA) asserted that the withdrawal of the 2017 notice "resulted in the cancellation of numerous construction contracts… because of the uncertainty introduced by executive-fiat and in contravention of Congressional intent."[92] The SCA also pointed out how these cancellations hampered shipyards' ability to make investments in facility modernization and workforce development.

Although there is currently a global shortage of WTIVs capable of handling the largest wind turbines, the possibility of heavily subsidized foreign yards increasing production, coupled with the CBP's exemption for stationary WTIVs, is likely to deter investments in domestically built WTIVs. The prospect of subsidized operators entering the U.S. market for WTIVs after investments in domestically built ships are underway put these investments at risk. Although the Jones Act will still require many vessels, such as feeder vessels, to be Jones Act–compliant despite these rulings, offshore production of WTIVs ultimately translates to less value created domestically.[93] Further, although the rate at which turbine size increases is forecasted to slow, there may eventually be demand for WTIVs capable of handling installation of even larger equipment. By missing out on the investment and expertise in developing WTIVs for the buildout to 2030, the United States loses an opportunity to benefit from potential changes in the industry's future vessel needs.

86 Office of U.S. Congressman John Garamendi. (Dec. 11, 2020). "Congress Passes Garamendi Amendment Requiring Jones Act Enforcement in Offshore Wind" [Press release]. Retrieved from https://garamendi.house.gov/media/press-releases/congress-passes-garamendi-amendment-requiring-jones-act-enforcement-offshore.

87 Morrissey III, G. A., Cavanaugh, J. M., & Pribyl, S. T. (Feb. 2, 2021). "CBP Expressly Applies Jones Act to Offshore Wind Projects on Outer Continental Shelf." Holland & Knight. Retrieved from https://www.hklaw.com/en/insights/publications/2021/02/cbp-expressly-applies-jones-act-to-offshore-wind-projects-on-outer.

88 Burley, L. L., of the Office of International Trade, Regulations and Rulings, CBP. (Jan. 27, 2021). Letter to Michael H. Wray and Courtney Campion. "Coastwise Transportation; Coastwise Towing; Scour Protection; 46 U.S.C. 55102; 46 U.S.C. 55111; 19 CFR 4.80(b)." Retrieved from https://www.customsmobile.com/rulings/docview?doc_id=HQ%20H317289&highlight=HQ%2020H309186.

89 Burley, L. L., of the Office of International Trade, Regulations and Rulings, CBP. (March 25, 2021). Letter to Michael H. Wray and Courtney Campion. "Coastwise Transportation; Coastwise Towing; Scour Protection; 46 U.S.C. 55102; 46 U.S.C. 55111; 19 CFR 4.80(b); 19 U.S.C. 1625; 19 CFR 177.12(b); Modification of H309186 (Jan. 27, 2021)." Retrieved from https://www.customsmobile.com/rulings/docview?doc_id=HQ%20H317289&highlight=HQ%20H317289.

90 Burley, L. L., of the Office of International Trade, Regulations and Rulings, CBP. (Feb. 4, 2021). Letter to John Giffin, Esq. "Coastwise Transportation; Outer Continental Shelf; Wind Turbines; 46 U.S.C. 55102 and 55103; 19 CFR 4.80a and 4.80b; 43 U.S.C. 1333." Retrieved from https://www.customsmobile.com/rulings/docview?doc_id=HQ%20H316313&highlight=category%3ACARRIERS.

91 CBP. (Jan. 18, 2017). "General Notice 19 CFR Part 177: Proposed Modification and Revocation of Ruling Letters Relating to Customs Application of the Jones Act to the Transportation of Certain Merchandise and Equipment Between Coastwise Points." *Customs Bulletin and Decisions*, *51*(3). Retrieved from https://www.cbp.gov/sites/default/files/assets/documents/2017-Jan/Vol_51_No_3_Title.pdf.

92 Hearings before the U.S. House of Representatives Committee on Transportation and Infrastructure Subcommittee on Coast Guard and Maritime Transportation (Jan. 17, 2018). Testimony of Matthew Paxton. Retrieved from https://republicans-transportation.house.gov/uploadedfiles/2018-01-17_-_paxton_testimony.pdf; Hearings before the U.S. House of Representatives Committee on Transportation and Infrastructure Subcommittee on Coast Guard and Maritime Transportation. (Feb. 9, 2019). Testimony of Ben Bordon. Retrieved from https://docs.house.gov/meetings/PW/PW07/20210209/111177/HHRG-117-PW07-Wstate-BordelonB-20210209.pdf.

93 Up-to-date pricing data have been difficult to obtain, but a 2017 report determined that the indicative price for a feeder vessel at the time was $87 million, compared with $222 million for a WTIV. Even if a project uses two Jones Act–compliant feeder vessels in conjunction with a WTIV that is non-Jones Act–compliant, there is still less domestic value creation in the shipbuilding sector.

To maximize the impact of OSW deployment on the shipbuilding sector, the Jones Act should apply to all vessels engaged in OSW activity.[94] This would reverse the chilling effect that the CBP's rulings are likely to have on WTIV construction. This may also have positive impacts elsewhere: For instance, the March 25, 2021, ruling could stymie fallpipe vessel construction if the prospect of utilizing ships coming from Canada limits demand for Jones Act–compliant fallpipe vessels for projects in the Northeast.

This approach is not without controversy but would be a key step to ensuring that OSW development's impact on domestic shipyards, their workers and supply chains is maximized.[95] Further, the political environment would appear to be favorable to action in this space to strengthen domestic industrial capabilities and foster resilient supply chains that support good jobs. The Biden-Harris administration has already taken steps to strengthen domestic procurement rules, issuing the January 25, 2021, Executive Order titled *Ensuring the Future Is Made in All of America by All of America's Workers*.[96] The fact sheet explaining the order specifically references support for the Jones Act and the implications of the 2021 NDAA's OSW language:

> With the signing of the 2021 National Defense Authorization Act, the Jones Act has also been affirmed as an opportunity to invest in America's workers as we build offshore renewable energy, in line with the President's goals to build our clean energy future here in America.

It should be noted that the authors heard a diverse set of viewpoints on this issue, including concern from some in the development industry about the potential adverse impacts that closing loopholes in Jones Act application might have on investors and the level of profitability—or even viability—of these projects. The nascent U.S. OSW industry is confronting a number of challenges: the extended OSW permitting process, locked-in structures of cash flows secured by developers despite uncertainty around technical challenges that may arise and uncertainty around the likelihood—and size—of tax expenditures and other forms of support for the industry. The implications of these challenges could also generate friction with utilities concerned about cost. Meanwhile, estimates about the overall impact of using Jones Act–compliant vessels are limited (one recent attempt estimated a 1.4% total cost increase).[97] This is further complicated by the relative lack of information on the difference in day rates between Jones Act–compliant and foreign-built WTIVs. Most news reports simply include the total cost of the build, a metric not well suited to evaluating the impact on the actual project costs where day rates are more relevant.

94 It is the authors' understanding that the CBP can issue waivers for nonavailability. This is a critical distinction from the current CBP determinations that the Jones Act simply does not apply. A waiver for nonavailability will help address any short-term domestic supply and demand mismatches while maintaining the demand signal needed to incentivize these builds. A nonavailability waiver could be granted to allow a project to proceed should no Jones Act–compliant WTIVs be available—and assuming the developer can secure a foreign-built WTIV, which, as discussed earlier, could also be a challenge. However, a ship operator purchasing a domestically built WTIV would have the confidence that upon completion, it would have the customers necessary to justify the investment.

95 Two recent notices of revocation by the CBP, in 2009 and 2017, prompted a flurry of advocacy from supporters and opponents of the Jones Act.

96 White House. (Jan. 25, 2021). *Executive Order on Ensuring the Future Is Made in All of America by All of America's Workers*. Retrieved from https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/25/executive-order-on-ensuring-the-future-is-made-in-all-of-america-by-all-of-americas-workers/.

97 McCown, J. D. (July 5, 2021). "Unfairly Characterising the Impact of the Jones Act on Offshore Wind." Riviera Maritime Media. Retrieved from https://www.rivieramm.com/opinion/unfairly-characterising-the-impact-of-the-jones-act-on-offshore-wind-66412.

The potential impact of cost increases, however, should also be weighed against the economic repercussions of increased domestic shipbuilding activity. If the goal is to maximize the economic impact of these projects, closing Jones Act loopholes is likely the most direct means of spurring the desired investments and resulting employment outcomes. Concerns about cost should be considered in the context of the many factors affecting the economics of OSW development, and continued dialogue with the shipbuilding, ship operating and project development industries will be needed to ensure the policies that Congress and the presidential administration pursue do not create a false choice between domestic production and OSW development.

Ultimately, the benefits to domestic shipyards, American workers and critical U.S. supply chains warrant working with the administration and Congress to ascertain the best path forward to stronger Jones Act application. Although doing so may not eliminate all lingering questions in the debate around the relative economic merits of the feeder vessel method versus an all-WTIV approach, it would remove these questions from the calculus for WTIV production as a Jones Act–compliant WTIV would be required in both scenarios. Further, an expedient execution of these changes would both provide the certainty necessary for ship operators and developers to accurately assess the size of the domestic WTIV market—and any implications on project costs—and give domestic shipyards the running room necessary to meet demand. In addition, should foreign WTIV supply not materialize, it would remove the prospect of projects being delayed while South Korean or Chinese vessels become available.[98]

Absent this clarification, options to create more certainty are limited but are worth further exploration. Another approach to send strong demand signals that calls for further investigation is the BOEM process for granting competitive leases. The BOEM has broad discretion afforded it by the Outer Continental Shelf Lands Act (OCSLA) to determine the terms and conditions of OSW leases. OCSLA language directs the Secretary of the Interior Department, among other requirements, to ensure "a fair return to the United States for any lease, easement, or right-of-way under this subsection" and gives wide latitude in determining the appropriate balance between this goal and others included in the statute.[99] In the recent final sale notice for the New York Bight, the BOEM expressed its commitment "to a clean energy future, workforce development and safety, and establishment of a durable domestic supply chain that can sustain the U.S. OSW energy industry" and included multiple related lease stipulations.[100] One stipulation requires lessees to describe "plans for contributing to the creation of a robust and resilient U.S.-based OSW industry supply chain." Another seeks to incentivize domestic production by offering a reduction in the operating fee rate should the lessee be "meaningfully and substantially assembling or manufacturing major components in the United States." A commitment to the consistent inclusion in sale notices of stipulations related to the use of Jones Act–compliant WTIVs is another possible means of creating demand signals.

An additional avenue to de-risk WTIV builds is to assist operators with potential fluctuations in domestic demand. We discuss a few financing possibilities below to make U.S.-built vessels more competitive for overseas projects, but an additional avenue worth further study is to examine the viability of extending its capacity to finance overseas sales to vessel leases, something the Export–Import Bank of the United States could be charge with. An alternative—or supplemental—approach that to address demand fluctuations involves programmatic changes that allow for loan deferrals during gaps between OSW projects.

98 For years, the U.S. government has lamented the United States' lack of energy independence. It makes little sense to exchange a dependence on imported fossil fuels for one on specialized foreign-built vessels. It should be noted that not only is market availability difficult to predict, but geopolitical considerations also pose risk. If this point seems far-fetched, one need only to look back at 2010, when China used its dominance of rare earths as leverage in a diplomatic dispute with Japan.

99 Anderson, R. T. (April 9, 2021). Letter to U.S. Department of the Interior Secretary. "Secretary's Duties Under Subsection 8(p)(4) of the Outer Continental Shelf Lands Act When Authorizing Activities on the Outer Continental Shelf." Retrieved from https://www.doi.gov/sites/doi.gov/files/m-37067.pdf.

100 BOEM. (Jan. 14, 2022). "Atlantic Wind Lease Sale 8 (ATLW-8) for Commercial Leasing for Wind Power on the Outer Continental Shelf (OCS) in the New York (NY) Bight—Final Sale Notice (FSN)." Docket No. BOEM-2022-0001. Retrieved from https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/ATLW%208%20%20NYB%20Final%20Sale%20Notice.pdf.

Finally, while the military side of the shipbuilding industry is the clearest example of how to achieve ship production goals with guaranteed demand, its application to WTIVs is difficult. Sources largely indicated that dual-use possibilities, in which the U.S. Department of Defense steps in to facilitate commercial production in exchange for access for training and emergencies, is limited for WTIVs. Although Congress appropriated $300 million annually from FY 2018 to FY 2020 to build new training vessels for maritime academies, these are procurements destined for public institutions with clear dual-use capabilities. Although some sources indicated that this option should not be ruled out, there is little recent precedent for the direct purchase of strictly commercial vessels by the U.S. government.[101] While a government contract would prompt a new build, it may also raise questions about timeline implications and possible additional requirements imposed on developers that lease a federally owned vessel.

Decreasing Financing Costs

Recent OSW lease auctions have received historic bids, as increasingly strong market signals have increased competition for development opportunities. A 2013 lease area was secured for $1.6 million, while a similar sized lease area went for $135 million in 2018 and another went for $1.1 billion in 2022. However, despite developers' increasing confidence in the ultimate profitability of these projects, shipyards, operators and developers would all benefit from concerted efforts to bring down costs. This would boost profitability for developers and improve the competitiveness of Jones Act–compliant WTIVs in global markets. The government has a number of tools at its disposal to speed development and lower costs for the dual goals of rapid OSW deployment and domestically produced WTIVs.

Loan Program Office Loan Guarantee

The U.S. Department of Energy's (DOE) Loan Program Office (LPO) has more than $40 billion worth of loan and loan guarantee authority at its disposal to facilitate energy infrastructure projects and procurements, $4.5 billion of which is eligible for renewable energy.[102] Successful application of an LPO guarantee to a vessel would increase the likelihood of others following suit and provide a pathway to de-risk future vessel investments. The most realistic avenue for applying LPO programs to an OSW vessel appears to be through Title XVII, which provides loan guarantees for innovative technology energy projects. Within Title XVII, there are two pathways that may be feasible:

1. **Applying to obtain a loan guarantee for an innovative vessel untethered to a project.** The specific technical criteria for a Title XVII vessel would be determined by the LPO, and a key component would be significant emissions reduction in the vessel as compared to similar vessels. It is realistic that a low-emission WTIV design such as the Ulstein or **Samsung Heavy Industries** ~~SHI~~ vessels mentioned in the section of this paper titled "Low-Emission Shipping Opportunities" could be eligible for this type of loan guarantee.[103]

2. **Applying to obtain a loan guarantee for a vessel as part of an OSW project.** This route has less stringent innovation and emissions reduction criteria than those for a standalone vessel application because it is tethered to a renewable energy project. The loan guarantee would need to cover other capital costs in the project in addition to the vessel itself.

101 While the authors would not suggest removing this option from discussion, the political and practical challenges it poses must be soberly considered during a discussion of viable short- and medium-term solutions.

102 LPO. (n.d.). *About Us Home*. Retrieved from https://www.energy.gov/lpo/about-us-home.

103 It should be noted that this pathway is limited to the first three demonstrations of an innovative project or build. Further use of this avenue would likely necessitate material additional innovations.

Capital Construction Fund (CCF)

The CCF, a MARAD program, allows ship owners to set up a sinking fund that shields investments, the profits of which will be used to pay off from taxes the debt incurred to purchase a U.S.-built vessel. The utility of this program has been limited by MARAD regulations that inhibit the resale of vessels for which CCF financing was used by limiting its use by the new owner to CCF-qualified services. A change to this approach would allow for wider adoption of the CCF program to make U.S.-built vessels more cost-competitive. An analysis conducted for the National Shipbuilding Research Program found that pairing CCF with a long-term loan guarantee, such as that which the DOE LPO has the authority to provide, could significantly lower the fully financed cost of vessel ownership.[104]

Title XI Federal Ship Financing Program

This program provides long-term debt repayment guarantees to incentivize U.S. shipowners to purchase new vessels from U.S. yards and can be used by shipyards for modernization investments.[105] This program has been heavily utilized in the past,[106] but sources indicate that it is now less attractive than other options. It also currently has only $35.4 million available, which MARAD estimates would support approximately $487 million in loan guarantees. This program would likely need enhancements and additional lending authority to effectively facilitate the WTIV buildout.

Direct Support

As laid out in this report, many global competitors receive a variety of government support, including direct subsidies. Many would argue the potential dual benefits of OSW development—taking concrete steps to address climate change while boosting the domestic industrial base and creating good jobs—warrant direct government support. Notwithstanding political challenges, domestic shipyards, their supply chains and OSW deployment could all potentially benefit from support to facilitate investment and domestic production of WTIVs and other vessels.

One program that currently disburses grants to improve shipyard productivity and expand shipbuilding employment is the Small Shipyard Grant Program. The program was authorized in 2006 to provide matching grants to shipyards with fewer than 1,200 production employees. Over the life of the program, $262 million has been distributed to shipyards.[107] Based on past application periods, it is expected expanded resources would be readily used by shipyards. According to a recent U.S. Senate letter, the MARAD received 100 applications requesting more than $80 million, a total far exceeding the $20 million available.[108] Recent bicameral efforts have pushed for $300 million in funding, and some of this financing may ultimately be included in the Build Back Better bill (BBB), should it become law.[109]

Additionally, there are dollars in various infrastructure programs that can be used for shipyard investments. Sources have indicated competition for these funds is often intense with other transport modes, but the influx of additional dollars as a result of the recently enacted Infrastructure Investment and Jobs Act merits further consideration.

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104 Cook Jr., H. C., & Love Thomas, T. (2015). *Financing Jones Act Vessels*. Presentation before the International Offshore Wind Partnering Forum.

105 MARAD. (Sept. 20, 2021). *Federal Ship Financing Program (Title XI)*. Retrieved from https://www.maritime.dot.gov/grants/title-xi/federal-ship-financing-program-title-xi.

106 The year 1998 was the high watermark for loan guarantees, the total of which reached $1.4 billion. In the past 10 years, a total of $1.9 billion has been guaranteed. Goldman, B. (Jan. 8, 2021). *U.S. Maritime Administration (MARAD) Shipping and Shipbuilding Support Programs*. Congressional Research Service Report R46654. Retrieved from https://crsreports.congress.gov/product/pdf/R/R46654.

107 MARAD. (April 26, 2021). "Maritime Administration Awards Nearly $20 Million in Funding to Strengthen U.S. Shipyard Economic Competitiveness" [Press release]. Retrieved from https://www.maritime.dot.gov/newsroom/press-releases/maritime-administration-awards-nearly-20-million-funding-strengthen-us.

108 Baldwin, T., Cassidy, B., Blumenthal, R., et al. (March 27, 2020). Letter to Susan Collins and Jack Reed. "FY2021 Small Shipyard Grants." Retrieved from https://www.baldwin.senate.gov/imo/media/doc/FY21%20Small%20Shipyard%20Grants.pdf.

109 WorkBoat. (Sept. 21, 2021). "Congress Pushes for $300 Million for Small Shipyard Grant Program." Retrieved from https://www.workboat.com/shipbuilding/house-and-senate-push-for-300-million-for-small-shipyard-grant-program.

Applicability of Tax Expenditures

President Biden's proposed 2022 budget outlined an expansion of Internal Revenue Code Section 48C Advanced Energy Manufacturing Tax Credit (MTC) that was initially passed in 2009. The expansion outlines specific technologies that would qualify for the tax credit and leaves some ambiguity about projects that are not listed. The proposal would increase the amount of available MTC credits to $10 billion. Clear language that identifies OSW vessels as qualifying investments for the MTC would open a pathway to the 30% tax credit for vessel manufacturers. Unfortunately, recent indications from BBB negotiations suggest ~~are~~ that tax credits in the clean energy production space may not be applicable to shipbuilding. The House of Representatives–passed legislation did not include tax expenditures that would support WTIV production at domestic shipyards. The U.S. Senate Finance Committee's most recent iteration of its portion of BBB did, however, include a 10% tax expenditure that could be put toward vessel construction. Inclusion of the Senate language and ultimate passage of the legislation would have a large impact on the financial feasibility of constructing these vessels and significantly narrow the difference for all-in costs between manufacturing these vessels in the United States and in overseas shipyards.

Promoting the Wider Commercial Shipbuilding Ecosystem

A common refrain from industry is the need for greater and more stable demand. With the challenges posed in the international market by subsidized competitors, absent direct government support, more opportunities in the domestic market are critical to maintaining and expanding a competitive and resilient commercial sector. For instance, recent bipartisan legislation, the Energizing American Shipbuilding Act, called for mandating that a certain percentage of LNG and oil exports be shipped using domestically built, crewed and flagged vessels.[110] There have also been efforts to expand the use of short sea shipping, which is seen by many in the maritime community as a way to ease congestion on highways, stimulate the domestic production of mid-sized container vessels and increase the nation's reserve of mariners.[111] Further, multiple interviewees indicated that this method could ease the transport of OSW components between production facilities and various development sites.

The OSW buildout could be an important piece of this puzzle. Although a more comprehensive program to revitalize commercial shipbuilding is outside the scope of this paper, it is important to note the benefits that more regular demand would have on the industry, including its ability to supply OSW vessels. Shipbuilding requires economies of scale and large, skilled workforces. The healthier the commercial shipbuilding base is, the more prepared it will be to meet the dynamic needs of the OSW industry.

110 Office of U.S. Congressman John Garamendi. (June 7, 2018). "The Energizing American Shipbuilding Act of 2018." Retrieved from https://garamendi.house.gov/media/in-the-news/energizing-american-shipbuilding-act-2018.

111 Hearings before the Subcommittee on Coast Guard and Maritime Transportation on Short Sea Shipping. (June 19, 2019). Testimony of Larry I. Willis. Retrieved from https://ttd.org/policy/testimony-by-ttd-president-larry-i-willis-unlocking-the-benefits-of-short-sea-shipping/; Navy League, 2019.

OPPORTUNITIES TO PROMOTE EQUITY IN OFFSHORE WIND SHIPBUILDING

It will take deliberate, sustained engagement and coordination by industry, government and labor to ensure that women and BIPOC workers benefit from both the increase in opportunities for well-paying manufacturing jobs as well as how supply chain sourcing decisions are conducted. The following are a few existing resources that should be utilized to address the ownership question in the supply chain:

- The Manufacturing Extension Partnership (MEP) program supports small- and medium-sized manufacturers, with locations in all 50 states. Although there is no explicit program targeting minority-owned businesses, the MEP program has recently taken steps to collect better data on how to reach underserved segments.[112] It found that in the past three years, it had completed 2,400 projects with more than 1,200 minority-owned manufacturers—projects that spurred $485 million in new investments while supporting $2 billion in sales and nearly 21,000 jobs. Due to the MEP program's extensive network and experience in supplier scouting,[113] it could be a critical resource in identifying potential suppliers that are minority-owned businesses for the OSW vessel buildout.
- The Small Business Administration works to improve access to contracting opportunities through programs such as HUBZone and the Women-Owned Small Business Federal Contracting Program.[114]
- The Minority Business Development Agency provides an array of services to foster the development and growth of minority-owned businesses, including operating four advanced manufacturing centers to support Minority Business Enterprise (MBE) manufacturers and a federal procurement center to facilitate greater opportunities for MBEs in federal procurement markets.[115]

In addition, there are opportunities to promote greater access to good jobs in shipyards and their supply chains. Studies have found that ineffectual policy responses to unfair trade practices and deindustrialization have had outsized impacts on communities of color.[116] But as developers and government look to ensure an equitable transition, it is worth noting government statistics indicate that Black and Hispanic workers remain relatively well represented in ship and boat building—constituting 16.1% and 19.2% of the workforce, respectively—slightly higher than their share of the overall workforce (12.1% and 17.6%, respectively).[117] More should be done to provide opportunities to women and Asian American and Pacific Islander workers, but there is a promising foundation on which to build in the industry.

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112 Thomas, N. (Nov. 9, 2019). "The MEP National Network™ Connects With Minority Owned Manufacturers." National Institute of Standards and Technology (NIST) blog. Retrieved from https://www.nist.gov/blogs/manufacturing-innovation-blog/mep-national-networktm-connects-minority-owned-manufacturers.

113 NIST. (March 17, 2022). *Supplier Scouting*. Retrieved from https://www.nist.gov/mep/supplier-scouting.

114 Dilger, R. J., Ciluffo, A. A., & Blackford, R. C. (March 21, 2022). *Small Business Administration: A Primer on Programs and Funding*. Congressional Research Service Report RL33243. Retrieved from https://crsreports.congress.gov/product/pdf/RL/RL33243.

115 Lawhorn, J. M. (June 8, 2021). *The Minority Business Development Agency: An Overview of Its History and Programs*. Congressional Research Service Report R46816. Retrieved from https://www.everycrsreport.com/files/2021-06-08_R46816_a563b96809699a27b0fe99883bb52dd13f55190f.pdf.

116 Western, G., Zessoules, D., Brown, N., Cole-Smith, B., & Spriggs, W. (June 2021). *The Impact of Trade on Black Workers. Groundwork Collaborative.* Retrieved from https://groundworkcollaborative.org/wp-content/uploads/2021/06/The-Impact-of-Trade-on-Black-Workers.pdf; Scott, R. E. (Sept. 30, 2013). *Trading Away the Manufacturing Advantage.* Economic Policy Institute Briefing Paper 367. Retrieved from https://www.epi.org/publication/trading-manufacturing-advantage-china-trade/; Scott, R. E., Wilson, V., Kandra, J., & Perez, D. (Jan. 31, 2022). *Botched Policy Responses to Globalization Have Decimated Manufacturing Employment With Often Overlooked Costs for Black, Brown and Other Workers of Color.* Economic Policy Institute. Retrieved from https://www.epi.org/publication/botched-policy-responses-to-globalization/.

117 U.S. Bureau of Labor Statistics. "Table 18. Employed Persons by Detailed Industry, Sex, Race and Hispanic or Latino Ethnicity." Labor Force Statistics from the Current Population Survey. Retrieved from https://www.bls.gov/cps/aa2019/cpsaat18.htm.

One of the most effective ways to promote greater equity as workers are recruited to the industry is to partner directly with the labor movement. Many trades and industrial unions have extensive experience as partners standing up and executing workforce development programs for new and existing employees.[118] Specific to questions of equity and diversity, there is some evidence that apprenticeships with unions enroll higher percentages of women and workers of color, have better completion rates for these populations and, ultimately, pay significantly better wages.[119] The Department of Labor also regularly funds skills training and apprenticeship programs, opportunities that labor unions have years of experience leveraging to improve outcomes for workers and their employers. An example of one such apprenticeship program is the Apprentice School at the Newport News shipyard, which recently began a four-year campaign to increase equity and diversity in its apprenticeship programs beginning in 2021.[120] Working to create OSW workforce development programs with established institutions that have taken concrete steps toward promoting underrepresented groups in training programs will help accelerate the growth of a diverse workforce in OSW.

118 Johansson, E. (October 2017). *Advancing Equity Through Workforce Intermediary Partnerships: Best Practices in Manufacturing, Service and Transportation Industries*. AFL-CIO Working for America Institute. Retrieved from https://aflcio.org/sites/default/files/2017-11/WFAI_Equity-report_final.pdf.

119 Woods, E. (Feb. 5, 2019). *Washington Apprenticeship Growth and Expansion Study*. Washington State Labor Council, AFL-CIO. Retrieved from http://www.wslc.org/wp-content/uploads/2019/02/WAGES-apprenticeship-study-19Feb05_full.pdf.

120 Newport News Shipbuilding. (July 30, 2021). "The Apprentice School at Newport News Shipbuilding to Help Increase Equity, Diversity and Inclusion in Apprenticeship Programs" [Press release]. Retrieved from https://newsroom.huntingtoningalls.com/releases/the-apprentice-school-at-newport-news-shipbuilding-to-help-increase-equity-diversity-and-inclusion-in-apprenticeship-programs.

LOW-EMISSION SHIPPING OPPORTUNITIES

Existing Offshore Wind Low-Emission Shipping Manufacturers

Companies that hold global leadership in low-emission shipping may be the best place to begin the search for clean shipping opportunities in the United States. These manufacturers use a variety of technologies to reduce emissions, including using electrification, ammonia or green hydrogen as fuel and utilizing battery storage to reduce the need to run generators, and improve efficiency.

1. **Wärtsilä.** Wärtsilä has designed an OSW SOV meant to be fabricated in compliance with the Jones Act, which it is marketing to the U.S. OSW industry. The vessel is a hybrid and advertised as highly efficient.[121]

2. **Samsung Heavy Industries.** Perhaps the most interesting development in low-emissions OSW vessels is Samsung's work on the ECO-WTIV.[122] The ECO-WTIV design uses LNG engines, solid-oxide fuel cells and energy storage systems. Samsung asserts that the vessel can reduce carbon dioxide emissions by 50% compared to existing ships and save money through increased efficiency. Although the ECO-WTIVs are expected to be fabricated in South Korea, American shipbuilders may consider partnerships, joint ventures or other mechanisms to work with Samsung to bring the design to U.S. shipyards.

3. **Ned Project Inc.** Ned Project has recently received an Approval in Principle from the American Bureau of Shipping for its hydrogen-ready Jones Act–compliant WTIV.[123] The company is now working with GPZ Energy to develop WTIV projects using this design.

4. **Havfram.** Havfram has announced plans to build a WTIV capable of running on zero-emission fuel, but there have been few details provided.

5. **Ulstein.** Norwegian ship manufacturer Ulstein has designed a hydrogen hybrid WTIV that the company asserts can operate in zero-emission mode 75% of the time.[124] The company has also designed a hydrogen construction support vessel for use in the OSW industry.[125]

Ammonia

Several manufacturers are moving toward ammonia shipping for purposes outside of the OSW industry. Green ammonia is seen as a truly green fuel, as opposed to LNG, which is somewhat of a half-step away from the carbon-intense diesel and bunker fuels that most ships burn.

It seems unlikely that an ammonia fuel industry will lift off the ground in the United States by 2030 due to the massive infrastructure investments required; however, cost reductions in global ammonia shipping may cause the emergence of a domestic ammonia fueling industry further in the future. The European Union (EU) has been struggling to pass tighter emissions regulations related to shipping,[126] but despite the challenges, it seems to be ahead of the United States in developing shipping emissions policies.

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121 Wärtsilä. (Feb. 12, 2021). "Wärtsilä's New Multi-Purpose SOV for Offshore Wind—Future-Proof, Flexible and Jones Act Compliant." Retrieved from https://www.wartsila.com/insights/article/wartsila-s-new-multi-purpose-sov-for-offshore-wind-future-proof-flexible-and-jones-act-compliant.

122 Durakovic, A. (April 8, 2021). "Approval Galore for South Korean Wind Turbine Installation Vessel." Offshore WIND. Retrieved from https://www.offshorewind.biz/2021/04/08/approval-galore-for-south-korean-wind-turbine-installation-vessel/.

123 Maritime Executive. (Sept. 27, 2021). "ABS Awards AIP to Ned Project's Hydrogen Ready WTIV Design." Retrieved from https://www.maritime-executive.com/corporate/abs-awards-aip-to-ned-project-s-hydrogen-ready-wtiv-design.

124 Durakovic, A. (Oct. 2, 2020). "Ulstein Designs Hydrogen Hybrid Wind Turbine Installation Vessel." Offshore WIND. Retrieved from https://www.offshorewind.biz/2020/10/02/ulstein-designs-hydrogen-hybrid-wind-turbine-installation-vessel/.

125 The Explorer. (n.d.). *Green, Hydrogen-Powered Offshore Construction Support Vessel*. Retrieved from https://www.theexplorer.no/solutions/green-hydrogen-powered-offshore-construction-support-vessel/.

126 Boffey, D. (June 23, 2021). "Draft EU Policy to Cut Shipping Emissions Condemned as 'Disaster.'" The Guardian. Retrieved from https://www.theguardian.com/environment/2021/jun/23/eu-policy-to-cut-shipping-carbon-emissions-would-be-disaster-leak.

Industrial players have called on the EU to promote specific use of green hydrogen and ammonia as shipping fuels,[127] although the policy impact of these requests have not been determined. Current leaders in ammonia shipping are Samsung Heavy Industries, Wartsila and Equinor, which charters a service vessel called Viking Energy. Viking Energy runs on LNG but is poised to be converted by 2024 to use ammonia fuel cells.[128]

Green Hydrogen

The use of hydrogen as a marine fuel poses unique challenges to the OSW industry in the United States. Specifically, we do not have hydrogen fueling infrastructure (known as *hydrogen bunkering*), and virtually all of the hydrogen that we produce now is not green hydrogen produced by renewables but rather hydrogen produced from fossil fuels.

The lack of bunkering infrastructure is not unique to the United States, with Europe working to accelerate hydrogen infrastructure adoption.[129] Many of the ship designs, such as those by Ulstein referenced above, are hydrogen-ready. This means that once the infrastructure is in place, such vessels can use hydrogen. However, until U.S. ports can supply hydrogen, hydrogen-capable ships operating in the United States are expected to run on conventional shipping fuels.

The second issue is the actual production of hydrogen. Because most of our hydrogen production now comes from fossil fuel processes, the current hydrogen supply cannot be considered green. While we may see onshore renewables dedicated to the production of green hydrogen, there are several efforts in Europe to use electricity generated by the OSW farms themselves to produce hydrogen.[130, 131] Using OSW to produce hydrogen has the added benefit of introducing flexibility to the OSW farm's operations when the onshore grid becomes congested. This concept may be further away in the future for the United States but should be considered as a potential solution at the intersection of green shipping and OSW.

Although outside the scope of this paper, a national, long-term, coordinated plan to foster domestic production capacity, technology and port facilities for these vessels is necessary if the United States hopes to foster a globally competitive, low-emission shipbuilding and shipping sector.

127 Jiang, J. (March 5, 2021). "European Shipping Players Call on EU to Promote Green Hydrogen and Ammonia as Marine Fuel." Splash 247. Retrieved from https://splash247.com/european-shipping-players-call-on-eu-to-promote-green-hydrogen-and-ammonia-as-marine-fuel/.

128 Gallucci, M. (Feb. 23, 2021). "Why the Shipping Industry Is Betting Big on Ammonia." IEEE Spectrum. Retrieved from https://spectrum.ieee.org/why-the-shipping-industry-is-betting-big-on-ammonia#toggle-gdpr.

129 Dempsey, H. (April 24, 2021). "Shipping Looks to Hydrogen as It Seeks to Ditch Bunker Fuel." Financial Times. Retrieved from customs.

130 Parnell, J. (Dec. 18, 2020). "Why Offshore Wind and Energy Giants Are Chasing Off-Grid Green Hydrogen." Greentech Media. Retrieved from https://www.greentechmedia.com/articles/read/why-offshore-wind-and-energy-giants-are-chasing-off-grid-green-hydrogen.

131 Baraniuk, C. (Feb. 12, 2021). "The Global Race to Produce Hydrogen Offshore." BBC News. Retrieved from https://www.bbc.com/news/business-55763356.

CONCLUSION AND RECOMMENDATIONS

Unless there are rapid changes to existing global capacity and deployment plans, the global OSW industry faces a significant shortfall of WTIVs capable of installing next-generation wind turbines by the early to mid-2020s. The dearth is likely to pose significant challenges and could stall deployment of OSW in the United States as developers struggle to find willing and able vessels to accommodate the second half of the buildout, even using the feeder vessel method.

Domestic manufacturing of WTIVs is the most reliable option for achieving the buildout within the target timeline. With proper execution, the buildout has large potential upsides for the domestic shipbuilding industry and its supply chains. Combating climate change will take a decades-long commitment and requires a durable coalition that is centered on workers. This partnership can only be built with concrete improvements that affect workers' lives—and not only in turbine installation. To be successful, we must manufacture the clean energy future in the United States. Doing so has the potential to support thousands of workers in the shipbuilding sector alone. However, we currently lack sufficient demand signals and appropriate incentive structures to spur investment in the space, and without action, we are not on track to take full advantage of this opportunity to grow our domestic workforce.

With considerations for the condition of the U.S. shipbuilding industry and the tight timeline to achieve a 30-GW buildout by 2030, we believe that increased coordination between private-sector and labor participants and further policy actions by the federal government are necessary. Our high-level recommendations are listed below:

1. **Clarity from the federal government.** Clearer signals must be sent that shipbuilders and ship operators that invest in U.S.-built WTIVs to meet this challenge will not be undercut by subsidized foreign competition. There are several pathways that may achieve this. These must be explored and acted upon with urgency.

2. **Coordination within the private sector.** Guaranteed contracts by creditworthy counterparties are a key piece in financing OSW vessels, and it will likely take a consortium of parties in the sector to aggregate enough demand to guarantee work for new-build vessels.

3. **Proactive engagement with labor partners**. Unions in both manufacturing and construction have extensive experience with workforce development, supply chain issues and working with government officials to facilitate project development, and they often intercede to revitalize or establish new productive capacity. Resources are better spent fostering partnerships than avoiding union representation and will help ensure the benefits of these developments are broadly shared.

4. **Further research into combining CCF and LPO loan guarantees.** It seems likely that a combination of the MARAD CCF, with modifications, and LPO Title XVII programs will provide the best structure for reducing financing costs on any new-build vessels. Further conversations with the LPO and MARAD and engagement with private-sector participants to identify the best sponsors for this type of financing are critical.

5. **Federal government revamp of MARAD Title XI.** MARAD Title XI has not been seen as an accessible program for shipbuilding in the OSW sector. Government action to modify the program would create another valuable pathway to reduce financing costs for the vessel buildout, particularly in the longer term.