Advancing Policy Measures to Drive Development of the Domestic Offshore Wind Supply Chain

LABOR ENERGY PARTNERSHIP

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FOREWORD

This paper was prepared by Liz Burdock, Ross Gould, Sam Salustro and the Business Network for Offshore Wind for the Labor Energy Partnership (LEP) Offshore Wind Workshop and is not intended to reflect the views, opinions or research of the LEP.

About the Labor Energy Partnership

The LEP is based on a shared commitment of the AFL-CIO and the 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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About the Business Network for Offshore Wind

The Business Network for Offshore Wind (the Network) is a nonprofit organization solely focused on the advancement of offshore wind and its supply chain. The Network's more than 400 members represent all levels of the supply chain, from developers to tertiary suppliers.

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EXECUTIVE SUMMARY

Accelerating the growth of the U.S. offshore wind supply chain is critical to achieving national and state-level energy goals and will require a national strategy to succeed. This paper, titled *Advancing Policy Measures to Drive Development of the Domestic Offshore Wind Supply Chain*, assesses how current policies impact potential supply chain businesses and what is needed to help them retool or gain the capabilities needed to build out the U.S. offshore wind industry and compete in the global market. Secondary market forces, such as federal leasing processes and transmission capacities, play an important role in efforts to accelerate supply chain development and are discussed. This paper is informed by specific and general conversations with Network members actively working to build out a sustainable and competitive offshore wind supply chain. These insights are augmented by research into current global and European policies impacting the United States market and into comparable renewable energy technologies and their successes or failures in growing a domestic supply chain.

CONTEXT

Offshore wind is a once-in-a-generation opportunity to create tens of thousands of new jobs and revitalize domestic manufacturing capabilities while transitioning the nation to clean, renewable and locally produced energy. Success is not ensured, however, and the need to develop a domestic supply chain is paramount, not only to create domestic jobs but also to maintain U.S. development timelines. Although current national and state policies and market structure have brought the nation to the precipice of explosive growth, a looming global supply chain shortfall could derail development and stall progress. In response, the United States must develop a coordinated action plan that pairs enhancing market visibility through the permitting process with an industrialization strategy that targets support for manufacturing, transmission and port upgrades to accelerate supply chain development.

The federal and state governments drive market demand as they seek to establish a thriving offshore wind industry that will create new jobs and economic opportunity along the Atlantic Coast, in the Gulf of Mexico and in the Pacific. The Biden-Harris administration set a national goal to deploy 30 gigawatts (GW) of offshore wind in the United States by 2030, which it estimates will employ more than 44,000 workers, will support 33,000 additional jobs in communities engaged in offshore wind activity and could drive $109 billion in financial activity.[1] States' goals, already more ambitious than federal counterparts, are poised to continue growing as new laws are passed raising renewable energy requirements and/or implementing decarbonization goals. As a clean energy technology capable of delivering power at near-baseload capacity and on a commercial scale, offshore wind will play a key role in the emerging U.S. energy mixture as it transitions to a clean grid.[2] Offshore wind is also bountiful; the National Renewable Energy Laboratory (NREL) estimates offshore wind has the technical resource potential of 2,000 GW, just less than double the United States' total current electricity-generation capacity.[3] As with all renewable energy, offshore wind helps the United States maintain its energy independence and achieve self-sufficiency.

Unlocking this potential also requires advancing and deploying floating offshore wind turbine technology. Floating offshore wind, a necessity for development on the West Coast, is critical to achieving the Biden goal of 110 GW by 2050 and will be incorporated into future planning in the Atlantic, Gulf of Mexico and Great

1 University of Delaware. (2022, April 7). *Welcome to the Special Initiative on Offshore Wind*. Retrieved from https://sites.udel.edu/ceoe-siow/; White House. (2021, March 29). *FACT SHEET: Biden Administration Jumpstarts Offshore Wind Energy Projects to Create Jobs*. Retrieved from https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/29/fact-sheet-biden-administration-jumpstarts-offshore-wind-energy-projects-to-create-jobs/.

2 International Energy Agency. (2019, November). *Offshore Wind Outlook 2019: World Energy Outlook Special Report*. Retrieved from https://www.iea.org/reports/offshore-wind-outlook-2019.

3 Wind Energy Technologies Office. (2021, Aug. 30). *Top 10 Things You Didn't Know About Offshore Wind Energy*. Retrieved from https://www.energy.gov/eere/wind/articles/top-10-things-you-didnt-know-about-offshore-wind-energy#:~:text=The%20National%20Renewable%20Energy%20Laboratory,hours%20per%20year%20of%20generation; U.S. Energy Information Administration (IEA). (2022, April 19). *Electricity Explained: Electricity Generation, Capacity, and Sales in the United States*. Retrieved from https://www.eia.gov/energyexplained/electricity/electricity-in-the-us-generation-capacity-and-sales.php#:~:text=At%20the%20end%20of%202020,solar%20photovoltaic%20electricity%20generating%20capacity.

Lakes. The NREL found that 58% of the United States' offshore wind potential will require floating technology to unlock.[4] This industry requires its own specialized supply chain, capabilities and port infrastructure system in addition to utilizing the growing fixed/bottom supply chain.

As demand grows, development will be constrained by an inadequate U.S. supply chain and an energy grid in need of upgrades to serve the offshore wind industry. Emerging and mature global offshore wind markets are experiencing remarkable growth that is eclipsing global supply chain capacity. Intense global demand and competition for offshore wind project components, services and raw materials could draw attention away from the U.S. market. Mature markets in Europe and emerging markets such as Asia provide more certainty and stability as well as appear more attractive to investors and suppliers.

Thus, building a robust and resilient U.S. supply chain is a matter of both energy independence and manufacturing self-sufficiency. Without this base, U.S. projects can be delayed, depriving the nation of maintaining control over its energy policies.

A national strategy, one built on lessons learned and best practices from other industry sectors as well as global offshore wind markets, will secure the market by increasing supply (to meet demand) and accelerating development with targeted resources. This is done by encouraging the federal government to continue efforts to bring transparency and certainty to the permitting process while laying out clear long-term development timelines and domestic content expectations to expand the market, actions the current administration has already begun. These efforts will give investors the market visibility and confidence needed to invest in the U.S. industry and its supply chains, which will be accelerated by targeted financial resources directed at manufacturers and shipbuilders. Supporting supply chain development also means addressing barriers faced by secondary and tertiary suppliers (often called *Tier 2 and Tier 3 suppliers*) or service providers, including lack of financing for expansions or upgrades, high costs to obtain needed certifications and stiff global competition. In all, there are approximately 8,000 components[5] in an offshore wind turbine that are prime targets for domestic participation, from steel, carbon fiber, electronic and mechanical assemblies to hydraulics, high-voltage cable and low-voltage wires.

Global and Domestic Offshore Wind Markets

Global offshore wind demand is being driven by climate change realities, a desire for economic development and falling prices. In late 2021, the United Nations released an Intergovernmental Panel on Climate Change (IPCC) report that forecasted a stark future: "Unless there are immediate, rapid and large-scale reductions in greenhouse gas emissions, limiting warming to close to 1.5°C or even 2°C will be beyond reach."[6] In response, nations are transitioning to renewable energy and turning to offshore wind as a utility-scale tool to achieve these goals. Global investment in the offshore wind sector reached $30 billion (in U.S. dollars [USD]) during 2020,[7] and total investment is expected to grow to $1 trillion by 2040.[8]

The Network calculates those European markets now aim to achieve a cumulative deployed capacity of 116 GW by 2030, and the globe (including the United States and an estimate for China) intends to deploy approximately 254 GW of offshore wind capacity by 2030. The U.S. goal of 30 GW represents less than 12% of cumulative global targets for 2030. With only 34 GW of offshore wind capacity installed worldwide, approximately 27 GW of offshore wind capacity must be installed every year between 2022 and 2030 to meet this collective global target. Global offshore wind commitments and goals will grow only as entirely new

4 NREL. (2020, April 2). *Floating Wind Turbines on the Rise: NREL Offshore Wind Expert Discusses Future Powered by Floating Offshore Wind*. Retrieved from https://www.nrel.gov/news/program/2020/floating-offshore-wind-rises.html.

5 Wind Energy Technologies Office. (n.d.). *Wind Manufacturing and Supply Chain*. Retrieved from https://www.energy.gov/eere/wind/wind-manufacturing-and-supply-chain#:~:text=Currently%2C%20the%20average%20utility%2Dscale,stronger%20winds%20at%20higher%20elevations.

6 Masson-Delmotte, V., Zhai, P., Pirani, A., et al. (2021). *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. IPCC. doi:10.1017/9781009157896.001. Retrieved from https://www.ipcc.ch/report/ar6/wg1/.

7 Renewables Consulting Group. (2021, Feb. 15). *RCG: Records Set for Global Offshore Wind Financial Investment in 2020*. Retrieved from https://thinkrcg.com/rcg-records-set-for-global-offshore-wind-capacity-and-investment-in-2020/.

8 IEA. (2019, Oct. 25). *Offshore Wind to Become a $1 Trillion Industry*. Retrieved from https://www.iea.org/news/offshore-wind-to-become-a-1-trillion-industry.

markets come online, including emerging industries in Brazil, Italy, Poland and Vietnam. Closer to home, U.S. state procurement targets total more than 40 GW by 2040—and that's before entire markets on the West Coast, Gulf of Mexico and Gulf of Maine develop. More mature U.S. markets, such as Massachusetts and New York, are expected to grow more than their current commitments as their state decarbonization plans develop.

The global supply chain, primarily concentrated in Europe, cannot support this exponentially growing demand, meaning that U.S. projects may not be in control of their own timelines. Continued reliance on established European suppliers exposes U.S. projects to global supply chain slowdowns. The aftermath of the pandemic has exposed the fragility of the global supply chain and shown how a supply crunch can severely impact progress, as exemplified by a microchip shortage that led to a dramatic reduction in auto production, idling many North American factories in 2021.[9] Offshore wind requires precision logistics; a U.S. offshore wind farm will consist of 100 wind turbine generators, each an assemblage of multiple components too large to transport by land and containing thousands of pieces, which must be marshalled at a single point and shipped out for assembly in small installation windows; support for construction and installation requires scores of support craft. Significant supply chain challenges would greatly derail project timelines and threaten viability.

State of the Current U.S. Offshore Wind Supply Chain[10]

The U.S. offshore wind supply chain is taking shape with the location of large-scale manufacturing operations, vessel construction announcements and increased activity among lower-tier suppliers. Progress toward the creation of this domestic supply chain greatly advanced in the first year of the Biden administration due to underlying market support at the state level and direct actions taken by the Executive Branch. Setting a 30GW national goal, laying out a multiyear leasing schedule and steadily moving more than a dozen projects through the permitting process are actions that offer the market transparency and reliability necessary to attract large- and small-scale investments. These actions are driving decisions; Network research shows that public and private investors committed $2.2 billion in new funding in 2021, including commitments to develop nine major component facilities that will manufacture the foundations, towers, cables and blades of an offshore wind turbine. Although the trends are encouraging, domestic supply chain growth will need to continue accelerating to meet the market demand created by federal and state policy goals in the face of global supply chain challenges.

Major component manufacturers, also known as *Tier 1 suppliers* and *original equipment manufacturers* (OEM), are investing in states that have actively driven forward their offshore programs through government support, the setting of ambitious offshore wind goals and public investment. Some of the recently announced facilities include towers and transition pieces (Albany, New York), monopile foundations (Paulsboro, New Jersey; ProvPort, Rhode Island; and Baltimore), nacelle assembly (New Jersey Wind Port) and blade finishing (Portsmouth, Virginia). Existing high-voltage cable manufacturing facilities in Alabama and Connecticut are retooling or adding additional manufacturing lines to serve the offshore wind sector, a new export cable facility was opened in South Carolina and cable facilities will be constructed at Brayton Point, Massachusetts, and in Baltimore. Ørsted and Eversource announced they would construct a substation at a Corpus Christi, Texas, facility for the South Fork Wind Farm off New York's coast. Finally, a competitive procurement process in Maryland may result in the construction of another monopile, tower or interarray cable facility in Baltimore. Meanwhile, major secondary steel facilities are being located in the Albany and Delmarva Peninsula regions.

American shipbuilding has seen similar modest growth. Dominion Energy has begun building the nation's first Jones Act–compliant wind turbine installation vessel (WTIV), a $550 million investment. The vessel will support the construction of the 2.6GW Coastal Virginia Offshore Wind project and will be leased out to the Revolution Wind and Sunrise Wind projects. The vessel, which is likely to enter service in 2023, is

9 Boudette, N. E. (2021, July 2). *As Sales Climb, Automakers Struggle to Produce Enough Cars*. The New York Times. Retrieved from https://www.nytimes.com/2021/07/02/business/tesla-second-quarter-sales.html?searchResultPosition=3.

10 Information included in this section is primarily derived from the Network's internal efforts to track the U.S. offshore wind industry, including policy changes, state procurement decisions, investment announcements and contracts awarded, among others. This information is available to Network members and released to the public occasionally.

being constructed in Brownsville, Texas, with steel sourced from Alabama, North Carolina and West Virginia. Contracts have been signed for smaller vessels, including crew transfer vessels (CTV) and service operation vessels (SOV). With two small operating wind projects in the United States, three CTVs have been constructed to date, and at least a half dozen more announced. Rhode Island shipyards, including Blount Boats and Semeco Marine, have seen the most CTV construction activity; however, shipyards in Louisiana, Maryland and Massachusetts are heavily engaged.[11] After winning several state procurements, Ørsted announced a contract for an SOV built in Louisiana with a supply chain that stretches deep into the United States. Large and mid-sized U.S. companies that traditionally operate in marine construction and oil and gas sectors have invested in a rock placement vessel and feeder barges.

Many of these new vessels will need deep-water ports that can handle the construction of a large offshore wind farm. Based upon Network market analysis, there are at least 19 ports from South Carolina to Massachusetts that have been identified as sites for offshore wind activity—operations and maintenance, marshalling, manufacturing and assembly. The size, weight and deep-water access need of offshore wind project components, including blades, nacelles, towers, foundations and electrical service platforms, inhibit many ports from serving the industry without significant upgrades. Recognizing the importance of ports and few suitable sites, states such as Connecticut, New York, New Jersey, Massachusetts and Virginia as well as private developers have made investments ranging from upgrading infrastructure to constructing entirely new ports, such as the New Jersey Wind Port.

The second and third tiers of the domestic supply chain are showing similar growing engagement. The Network created and manages Supply Chain Connect (SCC), the premier national offshore wind supply chain database. More than 2,600 entities have created entries in the SCC indicating their desire and ability to supply the domestic industry with materials or services. In 2021, the SCC grew by 61%, a growth rate four times higher than the rate from the same period in 2020. This supply chain growth was fueled by U.S. companies (80% of the new registrants had U.S. addresses) and U.S. manufacturers, which saw a comparable 60% growth rate in registrants.

Signed contracts are the clearest indicator of supply chain development. The Network tracks market developments through its Offshore Wind Market Dashboard, including publicly announced project supplier contracts, and in 2021, the Network identified contracts grew 106%. Across the 17 projects under development in the United States, nearly 900 supplier contracts have been awarded, and according to the Network's analysis, 61% went to companies based solely or headquartered in the United States. This is an expected trend as essentially all U.S. projects are in the siting and permitting stage—the development phase when local knowledge is paramount.

REVIEW OF POLICIES IMPACTING OFFSHORE WIND'S SUPPLY CHAIN DEVELOPMENT

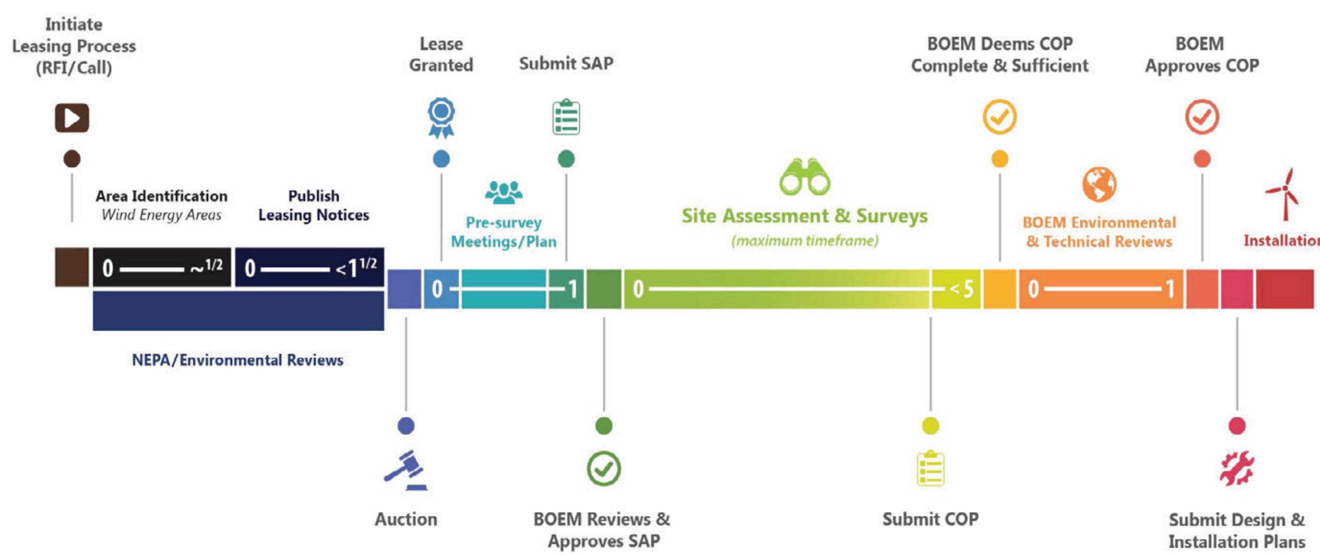
State and federal policies are already directly and indirectly impacting development of a domestic offshore wind supply chain and have led to the market structure seen today. While these early policies fostered growth, failing to adapt national or state laws to evolving market conditions could slow development or prevent the market acceleration needed to meet offshore wind demand. The federal government has oversight over the siting and construction of offshore wind farms through federal processes for leasing Wind Energy Areas in federal waters and permitting offshore wind farms and associated ocean-based transmission infrastructure. Until recently, the industry suffered from uncertainty surrounding the federal permitting process, which slowed investment. Although permitting and operational oversight of an offshore wind facility are federal responsibilities, states control the procurement process, and most directly shape supply chain decisions and the overall market by awarding contracts for new offshore wind farms and imposing economic development conditions on project agreements. At the federal level, domestic content mandates are confined to industry subsections, such as shipbuilding and vessel operation through the Jones Act, but lawmakers are debating imposing similar provisions on federal tax benefits.

11 Moore, K. (2022, Jan. 27). *Rhode Island Yards to Build Five CTVs for Ørsted and Eversource*. WorkBoat. Retrieved from https://www.workboat.com/shipbuilding/rhode-island-yards-to-build-five-ctvs-for-rsted-and-eversource.

Federal Policies

Permitting process. The Bureau of Ocean Energy Management (BOEM) is an entity within the Department of Interior (DOI) that controls the leasing and permitting processes for energy projects sited on the Outer Continental Shelf (OCS). Regulations governing offshore wind development grew out of the Energy Policy Act of 2005, which requires the BOEM to convene stakeholders to determine appropriate areas for leasing, oversee lease sales and then conduct environmental assessments of a Wind Energy Area and project proposals before construction and operations can begin. The BOEM's extensive processes ensure any development is performed in a responsible manner but require a complex review of multiple agencies, including the Army Corp of Engineers to review submarine cable systems, the National Oceanic and Atmospheric Administration to review impacts on endangered species and marine mammal protections and the Environmental Protection Agency to issue air permits, as examples. In 2017, the BOEM addressed this issue in two ways: tracking construction and operation plan (COP) reviews through Title 41 of the Fixing America's Surface Transportation (FAST) Act (FAST41) and approving the use of the design envelope in the COP. Enacted in 2015, FAST-41 established new coordination and oversight procedures for infrastructure projects reviewed by federal agencies. Even with these improvements, it can take up to 10 years for a project developer to obtain a lease, secure approval of a COP and commence construction activities. These long timelines require advanced planning by both policymakers seeking to decarbonize the economy and investors attempting to understand the expected long-term market.

FIGURE 1. **General timeline of the BOEM's offshore wind auction and permitting process by years**



Investment Tax Credit (ITC). The Taxpayer Certainty and Disaster Tax Relief Act of 2020, signed into law December 27, 2020, created a new standalone 30% ITC for offshore wind projects that begin construction after Jan. 1, 2017, and before Dec. 31, 2025; an Internal Revenue Service ruling extended safe harbor provisions even further into the future.[12] Although the legislation gave project developers a potential tax cut, states such as Maryland and Massachusetts, which had already entered into procurement contracts, required developers to pass along any savings from tax code changes to ratepayers.[13] For pending projects, the tax credit helped create larger overall projects. Staff for developer Ørsted testified before the Maryland Public Service

12 Internal Revenue Service–issued notice (2021, May).

13 Young, C. A. (2021, Jan. 8). *Mayflower Wind to Offer Cheaper Power Than Planned*. WBUR. Retrieved from https://www.wbur.org/news/2021/01/08/mayflower-wind-cost-tax-credit.

Commission that the ITC allowed the company to propose a much larger project than anticipated that would still fit under a ratepayer cost cap.[14] Proposals in the Build Back Better Act (BBB) package would extend further into the future and require project developers to pay prevailing wages to qualify for the full tax credit.

Steel capacity and Buy America policies. Policymakers have long sought to incentivize American manufacturing through domestic content policies. Congressional proposals reportedly included in the BBB package tied tax credits to domestic content requirements.

While the United States has extensive steel production capacity, it does not currently have the capability to produce some specific steel products needed by the industry. For instance, fixed-bottom offshore wind turbines, presently the most common foundation design, employ a structure called the *monopile*, a massive steel column driven directly into the sea floor. Monopiles can have single-piece weights of up to 3,000 metric tons each, will be up to 400 feet long, have a diameter of up to 45 feet and be made using steel plates ranging from 3 inches to 5 inches thick. Currently, there are only four steel mills in Europe and three mills in Korea and Japan that are qualified to manufacture monopile-quality steel plates. In the United States, current manufacturing capacity can produce offshore steel plates with thicknesses up to 2 inches thick, far short of the 3 to 5 inches required for monopile fabrication. A new $1.7 billion (in USD) steel facility is being constructed in Kentucky with an operation date of the mid-2020s. Although the facility was built to meet demand in other sectors, it is expected to have the capacity to supply offshore wind industry–required steel plates at limited capacity.[15]

Reliance on a single facility to source a critical component of the offshore wind farm could result in project delays and would drive greater market uncertainty.[16] Even if the facility agreed to dedicate the entirety of its capacity to the production of offshore wind steel (1.2 million tons), demand could eventually outpace supply.[17] The NREL projects that the offshore wind industry's steel demand will reach 886,000 annual tons by the mid-2020s, 1.1 million tons by the mid-2030s and 2.1 million tons by the mid-2040s.[18] However, not all steel consumed in the wind industry is used in monopiles. The NREL attributes this increase in steel demand to the rise of floating turbine deployment in later years, which requires much more steel cabling.

Knowledge about market needs and capacities is extremely important, and thorough evaluation of structural deficiencies in the domestic steel and other materials' industries should be undertaken to identify critical product needs. This analysis should be undertaken by the administration's new Manufacturing and Energy Supply Chains Office (MESCO). Market formations frequently require tax subsidies to create domestic sources; however, these supports can be ineffective without adequate information and planning. The MESCO should be responsible for resolving any supply chain shortages potentially driven by domestic content rules.

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14 Hearings Before the Maryland Public Service Commission, Case No. 9666. (2021, Aug. 25). Direct Testimony of Deborah Lynn Henry.

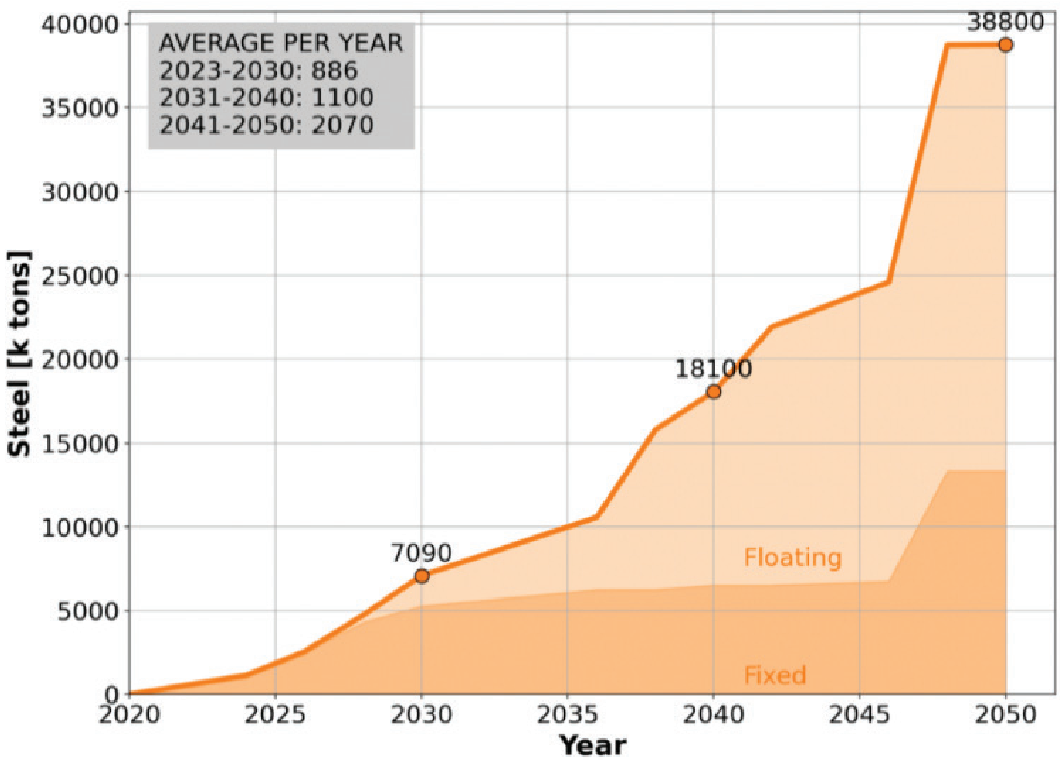
15 Otts, C., & Ragsdale, T. (2020, Oct. 23). *Nucor Starts Work on Brandenburg, Ky., Steel Mill*. WDRB.com. Retrieved from https://www.wdrb.com/in-depth/nucor-starts-work-on-brandenburg-ky-steel-mill/article_68b6530c-156b-11eb-8d81-ffc75a1b85c1.html; LEP. (2021, April). *Roundtable Summary: The Future of Offshore Wind Energy in the United States*. Retrieved from https://static1.squarespace.com/static/58ec123cb3db2bd94e057628/t/607dbdb77460cd389f468b00/1618853310890/LEP+Offshore+Wind+Roundtable+Summary.pdf.

16 Bazilian, M., Cuming, V., & Kenyon, T. (2020, November). *Energy Strategy Reviews*, *32*, 100569. https://doi.org/10.1016/j.esr.2020.100569. Retrieved from https://www.sciencedirect.com/science/article/pii/S2211467X2030122X.

17 Coyne, J. (2021, Nov. 18). *Nucor to Add Blast, Prime Line at Kentucky Steel Plate Mill*. S&P Global Commodity Insights. Retrieved from https://www.spglobal.com/commodity-insights/en/market-insights/latest-news/metals/111821-nucor-to-add-blast-prime-line-at-kentucky-steel-plate-mill.

18 Lantz, E., Barter, G., Gilman, P., et al. (2021, August). *Power Sector, Supply Chain, Jobs, and Emissions Implications of 30 Gigawatts of Offshore Wind Power by 2030*. NREL/TP-5000-80031. Retrieved from https://www.nrel.gov/docs/fy21osti/80031.pdf.

FIGURE 2. **Projected steel requirements for U.S. offshore wind industry**



While efforts are underway to map the supply chain and find gaps, a similar effort on critical components of an offshore wind farm, such as steel plates, is needed to identify gaps and target resources efficiently. Industry and stakeholders must work together to ensure integrated supply chain growth matches market acceleration. Policymakers must target funding to ensure the U.S. supply chain can supply necessary components, as was done in the United Kingdom.

The Jones Act. Offshore wind's shipbuilding industry operates under conditions similar to Buy America mandates. The Jones Act, initially created by the Merchant Marine Act of 1920, mandates that ships moving between U.S. points of call be constructed domestically, manned by an American crew and U.S.-flagged. Due to the sheer number of vessels needed to construct, operate and maintain an offshore wind facility, the shipbuilding industry should automatically be incentivized. In fact, a recent NREL, Network and DNV study found that meeting 30 GW will require five WTIVs, four cable laying vessels, more than 13 SOVs and two scour protection vessels. However, elevated shipbuilding costs are a factor in attracting investment and securing development timelines. Dominion Energy, a vertically integrated Virginia utility, has begun construction on a Jones Act–compliant WTIV, with steel sources from Alabama, North Carolina and Texas, at a cost of $550 million—more than $200 million higher than the cost of a recently ordered WTIV in South Korea by offshore installation company Eneti.[19] Although this price difference sounds high, when amortized over the life of the vessel, the additional cost does not affect the business case or viability of offshore wind projects. U.S. steel production is less carbon-intensive and more energy-efficient than that of foreign competitors,[20] which could be a factor as countries look to consider emissions within their trade policies.[21] This class of vessel is critical to an offshore wind facility's construction but is in short supply domestically and globally, meaning that new ships will be required in any case as well as, due an increase in turbine size,

19 Tomic, B. (2021, May 12). *Eneti Orders $330M Wind Turbine Installation Vessel. Eyes U.S. Offshore Wind Market, Too*. Offshore Engineer. Retrieved from https://www.oedigital.com/news/487571-eneti-orders-330m-wind-turbine-installation-vessel-eyes-u-s-offshore-wind-market-too.

20 Hasanbeigi, A., & Springer, C. (2019). *How Clean Is the U.S. Steel Industry? An International Benchmarking of Energy and CO_2 Intensities*. Global Efficiency Intelligence. Retrieved from https://static1.squarespace.com/static/5877e86f9de4bb8bce72105c/t/60c136b38eeef914f9cf4b95/1623275195911/How+Clean+is+the+U.S.+Steel+Industry.pdf.

21 Friedman, L. (2021, July 19). *Democrats Propose a Border Tax Based on Countries' Greenhouse Gas Emissions*. The New York Times. Retrieved from https://www.nytimes.com/2021/07/19/climate/democrats-border-carbon-tax.html.

larger ships than are in use now. The Dominion Energy–owned WTIV has been contracted to construct approximately 4 GW of projects in the United States out of a current pipeline of 17 GW. Despite this apparent market opportunity, the Dominion vessel is the only U.S. vessel to reach a financial decision. This is another potential challenge to be addressed by the MESCO.

Federal procurement. Although using federal government procurement power has helped develop solar- and land-based wind, a regulatory limitation would impede its use for offshore wind for all federal agencies except for the Department of Defense (DOD). Federal energy procurement process is governed by the Energy Policy Act of 2005 which required federal agencies to meet 7.5% of electricity demand through renewable resources but limited the length of a power purchase agreement (PPA) to 10 years—half the term of a normal U.S. offshore wind procurement agreement. The DOD was granted an exemption to enter energy contracts up to 30 years. In 2009, the U.S. Senate introduced legislation that would have expanded the federal government's authority to enter into 30year agreements for renewable energy, and complementary legislation in the U.S. House of Representatives would have approved a 20year authority, but neither bill became law.[22] In December 2021, President Biden issued an Executive Order that, in part, requires federal government to achieve 100% carbon pollution–free electricity (CFE) by 2030, half of which would be supplied locally.[23] The Biden administration estimates that federal demand for CFE will catalyze more than 10 GW of clean energy production.[24] Linking longer-term procurement contracts with higher-domestic-content rules for suppliers would also provide greater market certainty in supply chains.

State Policies

Power procurement and economic development requirements. Offshore wind market demand is currently driven primarily at the state level, and, as such, state government decision- making has been the determining factor in supply chain development. States create market demand for offshore wind through state-level, technology-specific mandates to procure offshore wind–generated electricity. These can be specific offshore wind energy mandates or targets followed by procurement processes or parts of broader policies, such as a renewable portfolio standard or decarbonization goal. Three current procurement models are in use: Connecticut, Massachusetts and Rhode Island utilize PPAs; Maryland, New Jersey and New York use Offshore Wind Renewable Energy Certificates (OREC); and Virginia's Dominion Energy operates in a vertically integrated, utility-owned model that is currently unique to the U.S. offshore wind industry.[25]

Each state involved in offshore wind has established policies and procurement methods calling for various levels of in-state economic activity associated with offshore wind project development. This creates a significant built-in local content mandate for U.S. projects, especially in states utilizing ORECs, which require much more significant local economic development commitments and so far usually result in higher procurement prices. Maryland is often seen as the state with the highest net economic benefit requirements;

22 S. 1462: American Clean Energy Leadership Act of 2009. 111th Congress (2009–2010). Introduced July 16, 2009. Senate Report 111-48. Retrieved from https://www.congress.gov/bill/111th-congress/senate-bill/1462; Solar Energies Industry Association (SEIA). (2018, September). *Long-Term Clean Energy Contracting Authority for Federal Agencies: Reducing Energy Bills and Creating Jobs With Solar*. Retrieved from https://www.seia.org/sites/default/files/SEIA-Long-Term-Contracting-Authority-Factsheet-2018-Sept.pdf.

23 U.S. General Services Administration (GSA). (2021, Dec. 8). *GSA Statement on the President's Executive Order Catalyzing America's Clean Energy Economy Through Federal Sustainability*. Retrieved from https://www.gsa.gov/about-us/newsroom/news-releases/gsa-statement-on-the-presidents-executive-order-catalyzing-americas-clean-energy-economy-through-federal-sustainability-12082021.

24 White House. (2021, December). *Federal Sustainability Plan: Catalyzing America's Clean Energy Industries and Jobs*. Retrieved from https://www.sustainability.gov/pdfs/federal-sustainability-plan.pdf.

25 The various procurement methods active in the United States are explored in depth by the NREL: Beiter, P., Heeter, J., Spitsen, P., & Riley, D. (2020). *Comparing Offshore Wind Energy Procurement and Project Revenue Sources Across U.S. States*. Retrieved from https://www.nrel.gov/docs/fy20osti/76079.pdf.

in its first solicitation, it received guarantees to spend 19% and 34% of its capital expenditures in state.[26] Massachusetts officials, often seen on the other side of the spectrum, are looking to reform their bidding process to capture more economic development commitments.[27]

Without federal investment support encouraging regional collaboration, the state-driven procurement system could disincentivize first movers or non-project-aligned investment, preventing the supply chain acceleration needed in the United States. The current state system incentivizes developers to invest in new or utilize existing in-state factories, even if others exist elsewhere domestically, for higher points on procurement bids. Large component investments wait for states to undergo procurement bids, particularly those utilizing the OREC structure, due to developer commitments that guarantee work. While this system may have spurred many investment decisions, the overall impact slows overall OEM and Tier 1 investment markets and leaves asset investments scattered rather than located in cost-efficient locations. To date, only one facility, Nexans, has made a sizeable investment independent of state procurement. Addressing the benefits of regional collaboration should be another key goal of the MESCO and woven into federal investments.

The same state-driven procurement model has also led to fragmented and inefficient port development. States, as a rule of practice, have required the use of an in-state port to marshal components and install and operate offshore wind projects supplying power to said state. Currently, at least 19 ports along the East Coast have been designated for offshore wind usage, creating enormous logistical challenges and necessitating significant state or private capital investments to ensure the ports can handle the large and heavy components.

Through the state-led procurement process, a number of states have encouraged or required local content targets for minority- and women-owned business enterprises (MWBE).[28] Maryland, for example, requires significant MWBE procurement commitments from developers and that they make "serious, good-faith efforts" to solicit MWBE investors on their projects; as a result, the state secured MWBE goals of approximately 15% and 29% from developers (but failed to recruit any MWBE investors).[29] Maryland law further requires its offshore wind development grant and capital programs to support MWBEs.[30] Likewise, New York law requires that at least 35% of funds invested in clean energy benefit disadvantaged communities, a mandate that includes state-level funding for training and development.[31] Massachusetts recently reformed its procurement process to place a larger focus on equity.[32] Developers are workshopping potential programs and outreach efforts to achieve these goals. Ocean Wind, a project off the New Jersey coast, created the Pro-NJ Grantor Trust with $15 million to give grants to small MWBEs working to break into the industry. States such as Maryland, New Jersey and Virginia are funding Foundation 2 Blade, a business training program to help companies better understand where they fit into the offshore wind supply chain and the contracting process. While the training is open to all businesses within these three states, outreach is prioritized to MWBEs. Constant evaluation of these programs will be needed to ensure their desired outcome is achieved.

26 Hearings Before the Public Service Commission of Maryland. Case No. 9431. Order No. 88192. (2017, May 11). Retrieved from http://www.psc.state.md.us/wp-content/uploads/Order-No.-88192-Case-No.-9431-Offshore-Wind.pdf.

27 Fraser, D. (2021, Oct. 21). *Harnessing the Wind: Competition Fierce for Offshore Wind's a 'Once in a Generation Opportunity'*. Cape Cod News. Retrieved from https://www.heraldnews.com/in-depth/news/2021/10/21/labor-market-jobs-manufacturing-offshore-wind-cape-wind-southcoast-cape-cod-massachusetts/6083449001/; Young, C. A. (2021, Oct. 13). *In Big Day for Offshore Wind, Baker Scraps Price Cap and Seeks $750 Million for Clean Energy Fund*. WBUR. Retrieved from https://www.wbur.org/news/2021/10/13/baker-offshore-wind-clean-energy-investment-fund-price-cap.

28 Karp, R. (2021, April 14). *Commentary: Equitable Procurement, Hiring Crucial to Offshore Wind Growth*. Energy News Network. Retrieved from https://energynews.us/2021/04/14/commentary-equitable-procurement-hiring-crucial-to-offshore-wind-growth/.

29 Hearings Before the Public Service Commission of Maryland. Case No. 9431. Order No. 88192. (2017, May 11).

30 Maryland Energy Administration. (2020, Oct. 29). *Maryland Energy Administration Announces $2.8 Million for Offshore Wind Supply Chain Development Grants*. Retrieved from https://news.maryland.gov/mea/2020/10/29/maryland-energy-administration-announces-2-8-million-for-offshore-wind-supply-chain-development-grants/.

31 Trimarchi, P. C., Stanton, D. P., & Lobe, S. (2020, Oct. 23). *The Impact of New York's Climate Leadership and Community Protection Act*. Bloomberg Law. Retrieved from https://news.bloomberglaw.com/environment-and-energy/the-impact-of-new-yorks-climate-leadership-and-community-protection-act.

32 Wasser, M. (2021, March 12). *Bids for Next Offshore Wind Project in Mass. Will Have Greater Focus on Equity*. WBUR. Retrieved from https://www.wbur.org/news/2021/03/12/massachusetts-offshore-wind-project-bids-equity-diversity.

U.S. OFFSHORE WIND SUPPLY CHAIN DEVELOPMENT CHALLENGES

Policymakers must work to attract new manufacturing investments or support the diversification of existing industries because offshore wind manufacturing facilities have unique siting and staging requirements. The sheer size of major offshore wind components—blades, nacelles, towers, foundations and electrical service platforms—require larger manufacturing facilities than are currently available and for those facilities to be located at deep-water ports without height restrictions. The well-developed, land-based wind industry supplies components that are smaller in size than their offshore counterparts and are (predominantly) located inland, which limits diversification opportunities. Similarly, the country's oil and gas and defense industries, both well suited for diversification, face their own barriers to entry. Although both sectors have companies with the quality certifications, expertise and, in some cases, water access to supply many components in the offshore wind sector, they often lack the serial and batch production ability required by the industry. For example, in the oil and gas sector, platform manufacturing is frequently a customized bespoke component process offering higher margins. In offshore wind, suppliers must deliver serially manufactured components, creating the necessary throughput to meet deployment timelines and provide the service or product at the lowest cost possible to protect ratepayers.

Until recently, uncertainty surrounding the U.S. permitting process and the federal government's commitment to offshore wind stifled supply chain activity and investment. The long-term stable pipeline of projects in the United States is now sufficient to support significant investments in domestic U.S. manufacturing. The timeline for developing and building a large-scale manufacturing facility can run from 18 months to 30 months (two to three years). This creates a conundrum for potential investors: If they wait until an offshore wind project is permitted to make a facility investment, they will have missed the window of opportunity. Furthermore, with many projects looking to begin construction around 2025, supply chain companies that do not make financial commitments soon will miss the first wave of U.S. offshore wind projects, lowering their overall potential market and yielding the market to international competitors.

Recent actions by the Biden-Harris administration have helped provide market certainty to domestic companies seeking to enter the offshore wind sector. Early in his presidency, President Biden set a national goal of 30 GW of offshore wind by 2030. The BOEM subsequently approved the first large-scale offshore wind project, Vineyard Wind, and in late 2021, it released timelines for additional offshore wind leasing in nearly all U.S. waters—an especially notable action considering that the last lease sale occurred in 2018. These actions combine to help establish a predictable roadmap to—and beyond—30 GW by 2030.

Intense price competition further decreases diversification attractiveness. Developers face enormous pressure to deliver projects at the lowest possible cost to reduce the financial impact on electricity ratepayers while also contending with escalating costs to secure site control. During the last offshore wind lease auction, conducted in late 2018, the winning bid price for the lease of a Wind Energy Area was $135 million (in USD). Market speculation sees prices continuing to rise, as they did recently in the United Kingdom. To recoup the market prices, developers will look to either pass costs on to ratepayers or force tighter margins for downstream supplier agreements.

The domestic companies that choose to diversify or invest in the offshore wind industry must compete against experienced and reputable European and Asian suppliers, many of which receive financial assistance from their governments. The United Kingdom created a grant pool of $217 million (in USD) designed specifically to attract large component manufacturers as a central element of their industrial strategy. Even without assistance, established business relationships between companies, formed over years of working together in the European market, create another barrier to U.S. suppliers looking to break into the industry.

Special focus must be given to the smaller businesses (Tier 2 and 3 suppliers) that perform secondary- and tertiary-level supply chain operations for original equipment manufacturers or other top-tier project suppliers. These companies are important links in the supply chain because they ensure the major facilities are supplied and operating at peak effectiveness and to project developers looking to achieve local content mandates. Owing to the inherent risk of an offshore wind project, Tier 1 suppliers and developers require these businesses undertake costly and time-consuming quality audits and certification requirements to become an approved or preferred supplier. National Institute of Standards and Technology (NIST) Manufacturing Extension Partnerships (MEP) or other agencies should develop a program to help small- and medium-sized enterprises obtain these certifications, much has they have with International Organization for Standardization (ISO) 9000, ISO 4000 and other standards.

MWBEs face their own challenges in addition to these common barriers to market entry. As an emerging industry, offshore wind has the potential to break traditional models and bring new opportunities to communities and businesses traditionally kept from participating, but work must be done to ensure opportunities are extended to MWBEs. Despite government-level efforts to reduce disparities, barriers still exist for MWBEs. A U.S. Department of Commerce study found that MWBEs typically secure a lower number and lower dollar amount of public contracts in proportion to the number of available MWBEs in a market.[33] The study argued that barriers arise from informal networks in which contract opportunities are learned about or obtained, a particular issue in the offshore wind industry reliant on using preexisting networks to de-risk investments and secure contracts. MWBEs also face higher barriers to accessing needed capital even though recent business creation and employment growth has been driven by MWBE entrepreneurs. Employment has grown faster at MWBEs than at nonminority firms,[34] and Black Americans are more likely to start a business than are their nonminority counterparts.[35] This has been accomplished despite MWBEs being less likely to receive loans, receiving lower dollar amounts in loans secured and having their applications denied at a higher rate than their nonminority counterparts. In fact, 33% of MWBEs do not even apply for business loans due to their expectation of rejection, a rate twice as high as that of their nonminority counterparts.[36] If an MWBE does secure a loan, the business owner pays a higher rate on interest. Instead, MWBE owners rely more heavily on personal and family savings or personal debt vehicles (e.g., credit cards) to start a business.[37] Considering the present wealth gap in the United States, this puts MWBEs at a disadvantage as they look to expand and diversify into offshore wind.

Although this is beyond the scope of this paper, transmission and grid integration limitations are critical barriers to the long-term success of the U.S. offshore wind industry. Expanding capacity of this supply-constrained resource must be addressed in the near term and at a large scale.

33 Minority Business Development Agency (MBDA). (2016, December). *Contracting Barriers and Factors Affecting Minority Business Enterprises: A Review of Existing Disparity Studies*. Retrieved from https://archive.mbda.gov/news/news-and-announcements/2017/01/contracting-barriers-and-factors-affecting-minority-business.html.

34 MBDA. (2017, Nov. 14). *Executive Summary: Disparities in Capital Access between Minority and Non-Minority Businesses*. Retrieved from https://archive.mbda.gov/page/executive-summary-disparities-capital-access-between-minority-and-non-minority-businesses.html.

35 Samuel Dubois Cook Center on Social Equity at Duke University. (2019, Oct. 10). *Entering Entrepreneurship*. Retrieved from https://socialequity.duke.edu/portfolio-item/entering-entrepreneurship/.

36 MBDA, 2017.

37 Robb, A., & Morelix, A. (2016, October). *Startup Financing Trends by Race: How Access to Capital Impacts Profitability*. Annual Survey of Entrepreneurs Data Briefing Series. Ewing Marion Kauffman Foundation. Retrieved from https://www.kauffman.org/wp-content/uploads/2019/12/ase_brief_startup_financing_by_race.pdf.

A NATIONAL OFFSHORE WIND INDUSTRIAL STRATEGY: DRIVING DEVELOPMENT OF THE U.S. OFFSHORE WIND INDUSTRY SUPPLY CHAIN

To meet the market demand set by the federal government and collectively by states, a national offshore wind industrial strategy is needed to accelerate development of a supply chain capable of supporting the U.S. industry. This strategy will drive investment to U.S. shores and help domestic companies expand by addressing barriers currently stalling progress. The positive steps taken in the first year of the Biden administration to provide more market certainty, visibility and demand and proposals in the BBB reconciliation framework are all elements of a national industrial strategy.[38] In February 2022, the Department of Energy (DOE) released *Wind Energy: Supply Chain Deep Dive Assessment*, which set forth actions required to address offshore wind supply chain challenges; again, the assessment contained elements of an industrial strategy.[39] More is needed, however, to match the attractiveness of foreign markets, which are also experiencing explosive demand.[40] This section outlines what is needed to continue to drive the development of the U.S. offshore wind industry supply chain.[41]

Experiences in mature European offshore wind markets, successful domestic and foreign policy measures, and previous experiences in U.S. renewable energy or other emerging manufacturing development offer lessons and precedence.[42] These case studies make it clear a domestic offshore wind supply chain can be supported by robust market viability (often in the form of renewable energy goals) and government financial support. In the United States, the land-based wind industry achieved moderate success in localizing a domestic supply chain thanks to generous tax provisions and strong market demand. A recent DOE study sets out that 57% of the dollar value of land-based wind farm components are obtained from domestic sources.[43] Likewise, nonenergy technologies such as micro-electronics, biotechnology and aviation thrived with concentrated government support. Lessons can also be taken directly from the European offshore wind history. France's history of offshore wind development, which included high-local-content requirements without developing internal capabilities, show how an industry can be derailed before really beginning. The United Kingdom, on the other hand, has embarked on a national industrialization strategy that combines ambitious development goals with significant targeted public investment, a model that should be adopted in the United States.

In 2016, the DOE and DOI jointly released the first-ever *National Offshore Wind Strategy: Facilitating the Development of the Offshore Wind Industry in the United States* to outline ways in which the federal government could facilitate offshore wind development.[44] The agencies called for actions focused on reducing cost and technical risk, expanding lease area stewardship and increasing understanding of the costs and benefits of offshore wind. This report came at a critical juncture, when the offshore wind industry was just finding key support in state governments, a federal permitting system was taking shape and global prices were falling significantly. Since then, the U.S. industry has made enormous strides and found itself at another critical juncture with new barriers and challenges. Some of these issues are also articulated in recent analyses from the DOE and in a separate report by a team composed of Network, NREL and DNV staff.[45] In

38 U.S. House of Representatives. *Build Back Better Act—Rules Committee Print 117-18. Section by Section*. Retrieved from https://rules.house.gov/sites/democrats.rules.house.gov/files/Section_by_Section_BBB_RCP117-18___.pdf.

39 Baranowski, R., Cooperman, A., Gilman, P., & Lantz, E. (2022, Feb. 24). *Wind Energy: Supply Chain Deep Dive Assessment*. DOE. Last reviewed April 8, 2022. Retrieved from https://www.energy.gov/sites/default/files/2022-02/Wind%20Energy%20Supply%20Chain%20Report%20-%20Final.pdf.

40 This call to action is not only for the federal government; a successful national industrial strategy requires partnerships between industry, government, labor unions, academia and nongovernmental organizations. This calls for all parties that are seeking to build a domestic supply chain.

41 Recent federal actions can be found in Appendix A.

42 An in-depth discussion of these points can be found in Appendix A.

43 Baranowski et al., 2022, p. 12.

44 DOE, DOI. (2016, September). *National Offshore Wind Strategy: Facilitating the Development of the Offshore Wind Industry in the United States*. DOE/GO-102016-4866. Retrieved from https://www.energy.gov/sites/default/files/2016/09/f33/National-Offshore-Wind-Strategy-report-09082016.pdf.

45 Baranowski et al., 2022; Shields, M., Marsh, R., Stefek, J., et al. (2022, March 28). *The Demand for Domestic Offshore Wind Supply Chain*. Business Network for Offshore Wind. Retrieved from https://www.offshorewindus.org/2022/03/25/the-demand-

addition to implementing suggestions such as the BOEM aligning its process with state policies and available offtake mechanisms that remain valid should be more robustly explored, an expanded national strategy is needed that will accelerate the growth of the entire U.S. supply chain, from manufacturers and shipbuilders to service providers and tertiary suppliers.

A national offshore wind industrial strategy must focus on incentivizing domestic supply chain development by targeting dedicated resources to manufacturers, shipbuilders, and ports engaged in offshore wind. U.S. service providers and manufacturers, both large and small, face significant barriers to entry, diversification and/or expansion that make traditional financing difficult or impossible to obtain. Federal intervention in the form of credits, loans or other financial programs can break through these barriers and realize domestic content. And with project deadlines fast approaching, new financing options must be created quickly to allow existing and new U.S. manufacturing facilities to participate in the first wave of buildout. Policymakers have recognized this need and incorporated several provisions in the BBB package introduced and debated in late 2021. Lower-tier suppliers, which will form the backbone of any supply chain, face their own unique and costly barriers, in terms of time and money, to scale that call for state and federal solutions to overcome.

Financial incentives must be paired with efforts to make the U.S. market more attractive to investors seeking clarity and long-term market potential. The federal government can build market certainty by making a long-term commitment to offshore wind, consistent across several administrations, regardless of the political party, and taking the actions to unlock new areas and bring certainty to the permitting process. Until the federal government's recent efforts to accelerate offshore wind, which started around March 2021, the long-term pipeline in the U.S. offshore wind market was highly uncertain despite a flurry of state procurements. Building new manufacturing facilities is inherently capital-intensive and requires long lead times; however, in the face of intense global competition, attracting investment becomes even more difficult. Port improvements have their own lead times and must be planned, permitted, financed and constructed completely before facility construction can commence. Stability and certainty are required to stimulate first-mover activity.

The U.S. offshore wind market faces an artificial cap to growth even if factories are built, domestic businesses scale up and new areas are opened for leasing, due to an inadequate transmission system. This issue is not unique to offshore wind—all renewable energy development is dependent on an upgraded system—but the scale of power generation proposed to come ashore (and the potential solutions available) requires its own consideration. The federal government must assume an overall leadership and planning role that engages national, regional and state stakeholders to drive toward an integrated and holistic energy grid upgrade strategy. That strategy must ensure states can meet their renewable targets, increase system reliability, save long-run ratepayer and public funding and mitigate environmental impact.

Finally, other nonfinancial programs and policies are needed to support industry growth and ensure that domestic suppliers are ready to compete on the international stage. Offshore wind has developed over three decades in Europe—that means three decades of relationship-building between suppliers and developers. Domestic suppliers diversifying in the industry must make themselves known and trusted to established market participants through national supply chain databases, international export trips and establishing key relationships with OEMs and offshore wind developers. As with other industries, offshore wind faces a skilled workforce gap. States, local education institutions and unions are already stepping in to fill the void, but these efforts need further support and replication to achieve market acceleration. Other supply chain solutions include supporting regional cooperation and maintaining research and development (R&D) funding.

for-a-domestic-offshore-wind-energy-supply-chain/.

Enhancing and Sustaining Market Visibility and Demand

The most fundamental actions the U.S. government can take to support supply chain development are sustaining a long-term commitment to offshore wind across administrations and taking predictable and deliberate actions to meet those commitments.

Proposed Executive Actions to Support Offshore Wind

Plan toward 110 GW and set a leasing schedule by leasing 40 GW of offshore wind capacity by 2024 and 45 GW by 2028 and laying out longer development timelines.

Review existing regulatory policies to identify and mitigate unintended barriers that pose a threat to the development of the offshore wind sector.

De-risk and shorten the leasing and permitting processes while maintaining environmental protection. A lengthy offshore wind process leaves the developer with too much risk. The U.S. government should adopt best practices, such as a one-stop-shop approach.[46]

Enhance agency coordination. An intergovernmental office can help coordinate permitting complexities between agencies, liaise among the various economic development–focused agencies and present a clear voice to other branches of the federal government.

Institute direct pay. Direct-pay provisions for existing tax credits will make up-front capital available to developers to accelerate offshore wind projects and supply chain and job development. As with other proposed credits, Congress may choose to include certain provisions for accessing direct pay, including labor, domestic content or other provisions.

Addressing Grid and Transmission Issues to Unlock Potential

Fully tapping into the baseload generation potential of offshore wind requires upgrades to the current energy system.

Proposed Executive Actions

Enhance internal coordination. The Federal Energy Regulatory Commission (FERC) and the BOEM must be encouraged to deepen their cooperation regarding renewables on the OCS as first outlined in an April 2009 Memorandum of Understanding.[47]

Proposed Legislative Actions

Support stakeholder process conclusions. Congress needs to lend its support and attention to this collaborative stakeholder process and its consensus-driven conclusions for a holistic upgrade to the electricity grid.

Provide continued funding and support for transmission projects and immediate funding and expand FERC authority. Addressing the scale and challenge of transitioning to renewable energies, including offshore wind, will require more support. The FERC can require regional grid operators to better accommodate state and federal policies in their transmission planning processes and direct the grid operators to develop mechanisms for enhancing interregional planning.

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46 Centre of Excellence for Offshore Wind and Renewable Energy. (2021, Sept. 8). *The Danish Offshore Wind Tender Model*. Retrieved from https://coe-osw.org/the-danish-offshore-wind-tender-model/.

47 BOEM. (n.d.). *Partnering With Federal Energy Regulatory Commission*. Retrieved from https://www.boem.gov/environment/environmental-studies/partnering-federal-energy-regulatory-commission.

Provide dedicated offshore wind transmission planning. The proposed BBB framework encouragingly includes $100 million in dedicated offshore wind transmission funding to convene stakeholders and conduct transmission planning, modeling and analysis for interregional and offshore wind projects.[48]

Building a Competitive Supply Chain

To overcome intense global competition and scale up to meet domestic content project demands, U.S. manufacturers, service providers and suppliers need dedicated strategies and support under a national industrial strategy.

Proposed Executive Actions

Support businesses seeking quality certifications. The Department of Commerce through the NIST should establish a collaborative certification and training program to qualify manufacturers for the offshore wind supply chains. The program should be implemented at the state level through the NIST-funded MEP.

Support existing tools, such as a national supply chain database, to help domestic companies compete internationally. Over the past decade, industry and nongovernmental entities, along with the support of the state and federal government, have built tools to support growth in the domestic supply chain. The federal government should support those existing tools while integrating them into the NIST and MEPs.

Adopt European-style voluntary supply chain reporting. Financial programs designed to spur supply chain development can be made more effective with information gathering to identify gaps or supply chain barriers. Information gleaned from this reporting requirement can bring awareness of domestic supply chain development expectations. The MESCO can play a critical role in disseminating this information to state and local economic development offices.

Encourage regional cooperation. This is another tool to accelerate market development and help mitigate the unintended impacts of the current state procurement system.[49] The federal government could help promote regional partnerships, creating larger or shared market areas or allowing manufacturers preferred access to other markets. The BOEM announced it would hold quarterly supply chain coordination meetings between itself, New Jersey and New York[50] and should look to replicate this model in other regions.

Create a national clearinghouse for information. There should be a national clearinghouse for supply chain businesses that supplies information about potential grants and communicates the efforts of the multiple agencies affecting offshore wind and other public resources.

Implement domestic content and Buy American requirements. Require the MESCO to review the impact of all offshore wind tax credit domestic content requirements and relevant Buy American provisions; develop collaborative implementation plans with industry, manufacturers and developers; and design an appropriate waiver system, consistent with long-term supply chain growth.

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48 Howland, E. (2021, Nov. 19). *House Passes Build Back Better, Tees Up Senate Vote on Funding for Climate, Clean Energy and Electric Vehicles*. Utility Dive. Retrieved from https://www.utilitydive.com/news/550b-clean-energy-climate-spending-build-back-better-credit-renewable-congress/609151/.

49 In fall 2020, the governors of Maryland, North Carolina and Virginia announced the formation of the Southeast and Mid-Atlantic Regional Transformative Partnership for Offshore Wind Energy Resources (SMART-POWER) agreement. The states agreed to collaboratively work to advance offshore wind within the region and develop its supply chain and workforce. As they are smaller markets, this allows the three states to better compete with other larger market regions and could help accelerate market development by pooling resources. The following year, the Western Governors' Association (WGA) called for a regional approach to offshore wind development on the Pacific Coast. In their resolution, the WGA said a collaborative approach "send[s] a clear signal to the intensely competitive global market that the Western states are attractive markets for offshore wind and associated investments," which allows the states to overcome development hurdles such as "ports, transmission, supply chain and workforce development."

50 DOI. (2022, Jan. 12). *Interior Department Announces Historic Wind Energy Auction Offshore New York and New Jersey* [Press release]. Retrieved from https://www.doi.gov/pressreleases/interior-department-announces-historic-wind-energy-auction-offshore-new-york-and-new.

Proposed Legislative Actions

Renew and expand the 48C Advanced Energy Manufacturing Tax Credit. The House-passed version of the BBB allocated almost $27 billion in grants, loans and tax credits for clean energy manufacturing. Congress should fully pass such legislation and allocate a certain portion to the offshore wind industry supply chain with additional credits to promote regional strategies.[51] Additional supply chain support to spur shipbuilding should be allocated through the MARAD program.

Expand the mission of the Loan Program Office (LPO). The DOE LPO program was designed to help finance emerging energy technologies during their first three commercial deployments to mitigate risk. The mission of the LPO should be expanded to accelerate the deployment of offshore wind and to mitigate the risk of supply chain companies expanding into the U.S. market.

Provide specialized port infrastructure grants. With the weight and size requirements of offshore wind components, scores of aging U.S. ports will need funding to expand and ready their berths. To effectively support the industry, the funding should be guaranteed to projects that support the administration's goal of deploying offshore wind capacity.

Help smaller businesses scale up with loans and grants for certifications, equipment, and workforce training. Best practices can be drawn from state and developer-led capital programs and scaled up.

Create or support green banks. Offshore wind projects are marine construction projects with high risks and costs. State and federal institutions designed to carry higher risk, such as green banks, can help provide financing, letters of credit, or other financial mechanisms.

Create small business gap loans. Once a small business is an offshore wind supplier, it may be exposed to longer payment cycles. Due to this risk, it is difficult for them to bid on work. This can be alleviated by setting up a zero-interest revolving loan fund that provides payments with a verified purchase order.

Developing a Skilled Labor Force

Currently, the U.S. lacks a sufficient skilled offshore wind energy workforce at all levels; it must train tens of thousands of qualified workers quickly to diversify into and address gaps between varying energy resource industries and their supply chains.

Construction unions have also played an important role in augmenting the future workforce by incorporating offshore wind training into their apprenticeship training programs through an expanded curriculum and investing in facilities and training equipment.[52] In addition, developers and construction unions have

51 In 2021, Sen. Ed Markey (Mass.) introduced the Offshore Wind American Manufacturing Act, which proposes production tax credits and ITCs for offshore wind component manufacturing investments and shipbuilding. The credit specifically identifies offshore wind components such as "blades, towers, nacelles, generators, gearboxes, foundations and related vessels" as eligible for the credit. The success of the 48C Advanced Manufacturing Tax Credit, passed in 2009 and enacted during the Great Recession, shows how the Offshore Wind American Manufacturing Act could spur domestic manufacturing. The 2009 bill enacted a 30% ITC for clean energy projects that was oversubscribed three to one when unveiled and eventually recommended $2.3 billion go to nearly 200 projects across the nation, leveraging $5.4 billion in private funding. More than $200 million of the credit was awarded to land-based wind projects, including new blade facilities in Colorado, Iowa and Nebraska; tower facilities in Arkansas, Oklahoma and Texas; and other turbine component parts in the upper Midwest. Importantly, land-based wind was forced to compete with other energy sources, such as battery storage and nuclear, for access to the 48C credit.

52 Examples include the Massachusetts chapter of the Electrical Workers, which is establishing a high-voltage and fiber-optic training program for Vineyard Wind project; the Ironworkers' offer of wind turbine training programs incorporating offshore wind into its apprentice training curriculum; and the United Brotherhood of Carpenters and Joiners of America's enhancement of a New Jersey training facility for pile-driving training and provision of opportunities for hands-on offshore wind training.

signed agreements up and down the East Coast to tap into unions' skilled labor for a variety of wind farm construction roles.[53] However, an assessment needs to be performed on the needs of supply chain companies, particularly in manufacturing.

Proposed Executive Actions

Department of Labor (DOL)/DOE workforce assessment. The DOL and DOE should be required to perform a workforce needs assessment for the administration's 30GW target. This assessment should include both the construction of wind farms and the buildout of the required supply chains. The study should identify the programs, points of entry in the workforce training system and role of existing employers and unions.

Encourage collegiate-level programs. The United States must educate hundreds of engineers each year to support offshore wind industry. Support is needed for engineering and graduate programs, such as those at Tufts University and the University of Massachusetts Amherst.

Proposed Legislative Actions

Provide funding to scale training programs. A substantial amount of funding is needed to upgrade facility upgrades, capital improvements and equipment, and operational funding for the accreditation and education of trainers, including union apprenticeship programs. Grants and loans funds are required.

Spurring Innovation

Any national industrial strategy must maintain the generous funding already afforded by the U.S. federal government. The United States has a rare opportunity to catch up with the global offshore wind industry by focusing on next-generation offshore wind advancements such as floating turbines and alternative-use technologies, including hydrogen and other energy-storage mechanisms.

Proposed Actions

Support floating offshore wind development.[54] The 2016 National Offshore Wind Strategy alluded to the need for collaboration between industry, public policymakers and other key stakeholders to accelerate planning for large-scale deployment of floating offshore wind installations.

Maintain funding for R&D. Generous federal R&D funding helped the land-based wind industry develop a domestic supply chain and continues to speed development of all renewable industries.

53 Late in 2020, project developer Ørsted announced an agreement with the North America's Building Trades Union (NABTU) to train a construction workforce. Other examples include Vineyard Wind signing a project labor agreement with the Southeastern Massachusetts Building Trades Council, which covered 500 jobs; Atlantic Shores signing a job training agreement with six New Jersey labor unions; Dominion Energy, the NABTU and their state affiliate, Virginia State Building Trades, collaborating on discussions with suppliers to transition union construction workers into the offshore wind industry; and U.S. Wind signing an agreement with the United Steelworkers to transform the former Sparrows Point steel mill into a monopile facility.

54 The Network convened a working group of members dedicated to floating offshore wind market development, producing a policy briefing in mid-2021 that can be found at https://www.offshorewindus.org/2021/06/08/floating-wind-policy-brief/.

CONCLUSION

Embracing offshore wind is a generational opportunity to advance reliable clean energy, create thousands of well-paying domestic jobs and help rebuild the U.S. manufacturing sector. Global demand for offshore wind project components and services is skyrocketing, and the United States must move aggressively to localize a supply chain that will capture economic benefits while ensuring the nation retains control over its own development. A national industrial strategy is needed that creates a stable, attractive market and targets assistance to develop the entire supply chain. Several pieces of a national industrial strategy were incorporated into the 2021 federal bipartisan infrastructure bill and the BBB, which laid out a solid framework to support manufacturing, port infrastructure and transmission development. However, more action is needed. By working in partnership, industry, labor unions and government can build a competitive and innovative supply chain that delivers and sustains quality jobs, creates export opportunities and domestic economic benefits and supports offshore wind as a core and cost-effective part of the long-term electricity mix along with other marine renewables.

APPENDIX A: LESSONS LEARNED

European Offshore Wind Market Experience

The United States is not alone in viewing offshore wind as a key tool to drive economic development and job creation, and countries have implemented various policies to encourage the use of local businesses or procurement of services from the buying nation. These requirements are often colloquially referred to as *local content requirements*. While many factors influence local content policies and regulatory framework of countries around the world, including market size, geographic location and experience in the offshore wind industry, lessons can be taken from the histories of mature markets, such as those in France, Germany and the United Kingdom. In particular, the United Kingdom's recent coordinated policy response to drive domestic supply chain creation should be a future model for the United States.

First-mover advantage and R&D. Denmark and Germany, both with significant offshore wind experience, utilized first-mover advantage and leveraging the reality that most development was confined to Northern Europe, which created a supply chain as the industry developed. As a result, both countries did not develop local content mandates.[55] In particular, Germany's commitment to the R&D of offshore wind technology, combined with large installation goals, allowed the country to tap into existing manufacturing capabilities bolstering its competitive advantage. At the turn of the century, Germany began its offshore wind research activity, embarking on several climatology and ecology projects in the North Sea.[56] That country launched several testing initiatives, including the Alpha Ventus offshore test site in 2010, influencing the future of the country's offshore wind expansion through superior information acquisition. Direct investment from the state, paired with market dictated growth in the supply chain, has positioned Germany as a one of the largest players in the market for the advanced and specialized manufacturing required for offshore wind projects.[57]

Local mandates. By contrast, France shows how restrictive local content requirements can greatly slow development. France has Europe's second longest coastline and recognized the opportunity for offshore wind to be a major player in its renewable energy portfolio.[58] It offered its first two offshore wind tenders in 2012 and 2014 and implemented a top-down approach to local content, enforcing an offer evaluation mechanism within the bidding process that heavily weighed domestic industrial factors.[59] As a result, building manufacturing facilities for major offshore wind components within the country were functionally the only way to access the market, leading to the deployment of state-owned nacelle and blade facilities. France's offshore wind industry suffered; the resulting cost of energy for the first six awarded projects was about €200 per megawatthour, significantly more than those of projects in neighboring markets.[60] Further, numerous disruptions on the manufacturing front, combined with political turmoil, caused continuous delays to projects, regularly pushing back project timelines. To date, France does not have an operational offshore wind farm.

Industrial strategy. The United Kingdom, 20 years into its development and currently the global offshore wind leader, has 10.4 GW of deployed offshore wind capacity and a pipeline of 7.2 GW. It offers a compelling test case for the United States as it initially created the largest offshore wind market without investing in

55 Danish Energy Agency. (n.d.). *New Offshore Wind Tenders in Denmark. 1,350 MW Before 2020*. Retrieved from https://www2.deloitte.com/content/dam/Deloitte/dk/Documents/public-sector/megaprojects/Horns-Rev3-and-Kriegers-Flak-Peter-Sehestedt.pdf.

56 Offshore-Windindustry.com. (n.d.). *Status Offshore-Windpower.* Retrieved from https://www.offshore-windindustry.com/19-forschung.

57 International Renewable Energy Agency, Global Wind Energy Council. (2013, January). *30 Years of Policies for Wind Energy: Lessons from 12 Wind Energy Markets*. Retrieved from https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2013/GWEC/GWEC_Germany.pdf?la=en&hash=DD3A50E77910814C87F7E9B783273289F64F0F76.

58 Jacquemin, J. (2016, November). *French Offshore Wind: Let the Grand Reboot Begin!* Everoze. Retrieved from https://everoze.com/french-offshore-wind-let-the-grand-reboot-begin/.

59 Foxwell, D. (2019, June 11). *Top-Down Approach to Local Content 'Drove Costs Up' in France*. Riviera. Retrieved from https://www.rivieramm.com/news-content-hub/news-content-hub/top-down-approach-to-local-content-lsquodrove-costs-uprsquo-in-france-55156; Thomas, T. (2019, June 25). *French Connection*. Offshore Wind Industry. Retrieved from https://www.offshorewindindustry.com/news/french-connection.

60 Reuters staff. (2018, June 20). *France Cuts Tariffs on Controversial Offshore Wind Projects*. Thomson Reuters. Retrieved from https://www.reuters.com/article/us-france-windpower-offshore/france-cuts-tariffs-on-controversial-offshore-wind-projects-idUSKBN1JG1N8.

supply chain or port infrastructure, leaving it dependent on the North Sea supply chain.[61] As the U.K. offshore wind market progressed through the 2000s and early 2010s, local content requirements emerged. Instead of implementing strict local content thresholds for projects, the United Kingdom instilled voluntary local content requirements and reporting. Through prescriptive guidance and voluntary supply chain reporting, the United Kingdom managed to reach 48% local content across all its domestic projects by 2017. Still, that level concerned policymakers as local content was heavily weighted toward development and operations expenses, whereas the country captured only 29% of capital expenditure.[62]

In response, U.K. policymakers recently launched a national industrial strategy to develop local manufacturing by creating longer-term market certainty through its increase of nationwide development goals to 40 GW by 2030, significant government financial support and tighter local content mandates. Early in 2021, the Offshore Wind Industry Council released a report noting that turbine blades and towers were “prime areas” for future manufacturing development, with foundation and cables as secondary targets.[63] Soon after, the government created the Offshore Wind Investment Programme to provide $217 million (in USD) grant funding to large component manufacturing operations.[64] The support program has already attracted an expanded blade facility, tower facility, monopile facility and transition piece facility, totaling nearly $600 million (in USD) in private sector investments.[65] One year earlier, the 2020 Offshore Wind Sector Deal set an industrywide target of achieving 60% of local content by 2030. Before entering the U.K. procurement process (contract for difference [CFD]), project developers will have to set out specific expected local content levels within a mandatory supply chain plan (SCP) that will be evaluated before a CFD is awarded. SCPs have existed since 2015; however, under the new stipulations presented in the sector deal, failure to follow the local content agenda established within a SCP can result in the loss of contract for a project.

In recent years, an increasing number of countries have announced offshore wind development plans and formulated policies to encourage local content, following existing models. Poland, which currently lacks a supply chain and has not seen construction for several years, requires developers to submit an SCP.[66] Like the U.K. model, the Polish SCP requires investors “to submit a plan for local devices and services to participate—from the construction phase to initial power generation” but does not include a minimum level of local content nor any punishment for a failure to comply. Taiwan, on the other hand, has been adamant that local content plans will be assessed within the project qualification process and will have substantial influence in the project selection process.[67] Developers and international partners have criticized the country’s high-local-content expectations, claiming the steep expected threshold discourages the development of a competitive supply chain and ultimately leads to higher costs for consumers.[68] For the country’s recent third round of offshore wind development, Taiwan’s Industrial Development Bureau established a 60% local content threshold.[69]

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61 Musial, W., Spitsen, P., Beiter, P., et al. *Offshore Wind Market Report: 2021 Edition*. DOE. DOE/GO-102021-5614. Retrieved from https://www.energy.gov/sites/default/files/2021-08/Offshore%20Wind%20Market%20Report%202021%20Edition_Final.pdf.

62 RenewableUK. (2017, September). *Offshore Wind Industry Investment in the U.K.: 2017 Report on Offshore Wind U.K. Content*. Retrieved from https://cdn.ymaws.com/www.renewableuk.com/resource/resmgr/publications/Offshore_Wind_Investment_V4.pdf.

63 Penman, H. (2021, April 2). *Turbine Blades and Towers Among ‘Prime Areas’ for U.K. Supply Chain Growth, Says OWIC*. Energy Voice. Retrieved from https://www.energyvoice.com/renewables-energy-transition/296626/turbine-blades-towers-renewables-supply-chain/.

64 Department for Business, Energy and Industrial Strategy. (2021, February). *Offshore Wind Manufacturing Investment Scheme: Offshore Wind Investment Programme Guidance*. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/964305/owmis-offshore-wind-investment-programme-guidance.pdf.

65 GOV.UK. (2021, Aug. 9). *Wind of Change for the Humber Region* [Press release]. Retrieved from https://www.gov.uk/government/news/wind-of-change-for-the-humber-region; EE Online. (2021, July 9). Huge Green Jobs Windfall for the North-East and Yorkshire. Retrieved from https://electricenergyonline.com/article/energy/category/wind/141/909591/huge-green-jobs-windfall-for-the-north-east-and-yorkshire-.html.

66 Solytsinski Kawecki Szeezak. (2021, February). *The Polish Offshore Wind Act*. Retrieved from https://skslegal.pl/wp-content/uploads/2021/02/Legal-Alert-Ustawa-offshore-final_3439009@1.pdf.

67 Jones Day. (2018, February). *Taiwan Offshore Wind Farm Projects: Guiding Investors through the Legal and Regulatory Framework*. Retrieved from https://www.jonesday.com/files/Publication/391679ef-9fca-4142-a4c1-df4e06b1d574/Preview/PublicationAttachment/ebe8c0fb-1e42-4d95-be45-f914d4a6f1f9/Taiwan%20Offshore%20Wind%20Farm%20Projects%20White%20Paper.pdf.

68 Oung, A. (2021, April 1). *Minister Defends Wind Farm Local Content Policy*. Taipei Times. Retrieved from https://www.taipeitimes.com/News/biz/archives/2021/04/01/2003754851.

69 Huan Li, C. (2021, May 12). *‘Taiwan’s New Policy Can Turn It Into a Major Regional Offshore Wind Hub’*. Recharge. Retrieved

Coordinated grid policies. The United States is not alone in confronting the issues of transmission coordination and integration. Lessons regarding piecemeal or holistic upgrades can be taken from Europe, which is already dealing with its own growing renewable energy goals. The United Kingdom is a worldwide leader in offshore wind deployment, with its more than 10 GW already installed, and is looking to deploy 40 GW of offshore wind capacity by 2030. A study by National Grid ESO found that adopting an integrated approach by 2025 will save consumers 18% (approximately $8 billion [in USD]), primarily by reducing new electricity assets (including beach crossings) by 50%. What is key is that beginning the integrated approach just five years later will cut the expected savings in half. Other European nations are considering innovative solutions. Germany and Denmark recently connected their electricity grids in the Baltic Ocean to increase grid reliability. Denmark is moving toward an ambitious plan to build energy islands in the North Sea and Baltic Sea to ease cross-country energy trading and increase reliability.

Successful Policies Measures for U.S. Renewables

The history of U.S. land-based wind and solar energy development shows the importance and need for clear and long-term development goals to coincide with favorable tax policies and other public financing. As of today, the United States has deployed 93 GW of solar capacity and 122 GW of land-based wind capacity, respectively growing by 19.2 GW and 16.8 GW during the past year.[70] While solar and land-based wind generation technologies have existed for many decades, a mixture of new (or revamped) federal tax policies, declining capital costs and state renewable energy targets (the same ones currently propelling the offshore win market) has fueled both industries' development, most notably since the mid-2000s.

Domestic content rose in land-based wind production, from 35% in 2005 to 2006 to approximately 67% in 2011 to 2012[71]; a recent analysis by Bloomberg, included in DOE findings, projects the dollar value of domestic content more conservatively at 57% due to the industry's reliance on foreign steel and equipment such as pitch-and-yaw systems, bearings, bolts and controls.[72] Although the land-based wind industry has succeeded in capturing significant larger component manufacturing, such as nacelle assembly annual capacity, which grew from 1.5 GW in 2006 to 15 GW as of today,[73] it is still reliant on foreign imports for project completion, most notably in blades and turbine hubs, of which 50% to 70% are imported.

Development goals and tax policies. Offshore wind and land-based wind supply chain development both require large components that present logistical supply challenges, making them opportunity targets for localizing manufacturing operations. The success of land-based wind at building a domestic supply chain is encouraging and relevant. Researchers surveying various countries' renewable energy policies and subsequent domestic supply chain growth, including the United States, found that the policy (and tax) stability of at least three-year periods and significant government-led development goals have driven land-based wind local supply chain development. The researchers argue that the longer-term policy stability allows investors to overcome the capital requirements and workforce development timelines.[74] A second review of renewable energy development and local content mandates in Brazil, India and South Africa confirm the importance of long-term market visibility to the manufacturing sector as investors were reluctant to invest in South Africa due to uncertainty about when future auctions would take place or if procurement price guarantees would expire.[75]

The need for consistent tax policies is evident in the uneven history of land-based wind's primary tax incentive: the Production Tax Credit (PTC), a per-kilowatt-hour credit. The credit was enacted in its most

from https://www.rechargenews.com/wind/taiwans-new-policy-can-turn-it-into-a-major-regional-offshore-wind-hub/2-1-1010192.

70 Lantz et al., 2021; Wiser, R., Bolinger, M., Hoen, B., et al. (2021, August). *Land-Based Wind Market Report: 2021 Edition*. DOE, Office of Scientific and Technical Information. Retrieved from https://www.energy.gov/sites/default/files/2021-08/Land-Based%20Wind%20Market%20Report%202021%20Edition_Full%20Report_FINAL.pdf.

71 Wiser, R., & Bolinger, M. (2012, August). *2011 Wind Technologies Market Report*. DOE, Office of Scientific and Technical Information. Retrieved from https://www.nrel.gov/docs/fy12osti/53474.pdf.

72 Wiser et al., 2021.

73 Ibid.

74 Barua, P., Tawney, L., & Weischer, L. (2012, November). *Delivering on the Clean Energy Economy: The Role of Policy in Developing Successful Domestic Solar and Wind Industries*. Working paper. World Resources Institute. Retrieved from https://files.wri.org/d8/s3fs-public/pdf/delivering_clean_energy_economy.pdf.

75 Bazilian et al., 2020.

recent form in 1992 and has required 13 extensions since then, many times after it had lapsed, most of which lasted for only a year or two. The uncertainty led to a so-called boom-bust cycle for land-based wind development as projects raced to begin construction within the tax credit's window, as shown in a 2018 study that examined the impact of expiring tax credits.[76] Development was greatest—and only recently surpassed in 2020—under the stability created by the American Recovery and Reinvestment Act of 2009, which extended the PTC for three years.[77]

The solar industry has enjoyed more consistent tax policy and seen steadier growth; the industry largely utilizes the ITC, which has been in existence since the 1970s and was increased from 10% to a 30% credit in 2005. The credit was further extended until 2016 in the Emergency Economic Stabilization Act of 2008, leading to consistent and significant growth.[78] The Solar Energy Industries Association reports that the industry has seen an average 50% growth rate over the past decade.[79] This impressive and consistent growth has not translated into U.S. manufacturing expansion, however, as BloombergNEF reports that just 1% of the world's solar panels are made in the United States, down from 20% 20 years ago.[80] Unlike the land-based wind industry, whose supply chains must at least be partially dictated by the logistical realities of large components, the solar industry is driven by cost and quality and not by local development goals.[81] China's rise to solar domination is attributed to generous state and local subsidies, including the fact the government is the largest customer of panels, which helped lead to advanced manufacturing breakthroughs.[82] Previous U.S. presidents responded by increasing tariffs on Chinese goods, but those are easily undermined—for example, with the Chinese government's decision to cut back on domestic installations in 2018, flooding the world market with low-cost panels.[83]

Federal procurement. More than 40 years ago, President Jimmy Carter famously placed solar panels on the White House roof. As one of the largest customers on the planet, the federal U.S. government wields considerable market power that is often utilized to support both early and mature industries. Since the 1970s, policymakers have sought to unleash government procurement to support domestic industries through Buy America or Buy American policies. Early government procurement drove "commercialization and maturation" in many emerging technologies[84] as a tool that can quickly create market growth and bring down costs through scale. The Energy Policy Act of 2005 required federal agencies to meet 7.5% of electricity demand through renewable resources. The federal government has used PPAs to procure 2.3 megawatts (MW) of solar power at the NREL and other solar systems in California and at a Coast Guard site.[85] The U.S. Air Force entered into a PPA for a 14-MW solar installation at Nellis Air Force Base, which provides 25% of the annual electricity consumption needed for the base and saves $1 million per year in reduced costs.[86]

This tool was recently used by the Biden administration to incentivize use in the electric vehicle industry. Early in 2021, President Biden directed federal agencies to procure carbon pollution–free electricity and clean,

76 Frazier, A., Marcy, C., & Cole, W. J. (2019, July 25). *Wind and Solar PV Deployment After Tax Credits Expire: A View From the Standard Scenarios and the Annual Energy Outlook*. NREL/JA-6A20-71947. DOE PAGES. https://doi.org/10.1016/j.tej.2019.106637. Retrieved from https://www.osti.gov/pages/servlets/purl/1548263.

77 Congressional Research Service. (2020, April 29). *The Renewable Electricity Production Tax Credit: In Brief*. R43453. Retrieved from https://sgp.fas.org/crs/misc/R43453.pdf.

78 Congressional Research Service. (2018, Nov. 2). *The Energy Credit: An Investment Tax Credit for Renewable Energy*. 7-5700. Retrieved from https://sgp.fas.org/crs/misc/IF10479.pdf.

79 SEIA. (n.d.). *Solar Investment Tax Credit (ITC)*. Retrieved from https://www.seia.org/initiatives/solar-investment-tax-credit-itc.

80 Dlouhy, J. A. (2021, June 4). *How China Beat the U.S. to Become World's Undisputed Solar Champion*. Bloomberg. Retrieved from https://www.bloomberg.com/news/articles/2021-06-04/solar-jobs-2021-how-china-beat-u-s-to-become-world-s-solar-champion.

81 Barua et al., 2012.

82 Dlouhy, 2021.

83 Groom, N. (2018, Aug. 30). *China's Solar Subsidy Cuts Erode the Impact of Trump Tariffs*. Reuters. Retrieved from https://www.reuters.com/article/us-usa-solar/chinas-solar-subsidy-cuts-erode-the-impact-of-trump-tariffs-idUSKCN1LF18K.

84 Seltzer, M. (2020, Dec. 15). *Big but Affordable Effort Needed for America to Reach Net-Zero Emissions by 2050, Princeton Study Shows*. Princeton University. Retrieved from https://www.princeton.edu/news/2020/12/15/big-affordable-effort-needed-america-reach-net-zero-emissions-2050-princeton-study.

85 Office of Energy Efficiency & Renewable Energy. (n.d.). *Federal On-Site Renewable Power Purchase Agreements*. Retrieved from https://www.energy.gov/eere/femp/federal-site-renewable-power-purchase-agreements.

86 SEIA. (n.d.). *Fact Sheet: Long-Term Clean Energy Contracting Authority for Federal Agencies: Reducing Energy Bills and Creating Jobs With Solar Power*. Retrieved from https://www.seia.org/research-resources/long-term-clean-energy-contracting-authority-federal-agencies.

zero-emission vehicles.[87] The federal government currently operates approximately 645,000 vehicles and spent $4.4 billion on its fleet in 2019.[88] One analyst commented that the Executive Order amounted to the "the most significant vehicle purchase announcement to date" and would help accelerate a manufacturer's "learning curve" and reduce the cost for all drivers in a shorter time frame.[89]

R&D. The federal government has long been a leader in renewable energy research and currently is the largest funder of land-based wind research. This commitment helped support initial development of the land-based wind industry and its current market against foreign competitors. Researchers at the Lawrence Berkeley National Laboratory estimated the cumulative return on investment since 1976 exceeded 18 to one for land-based wind research projects.[90] Public R&D funding, while not a game changer, has helped the United States compete on land-based wind exports with countries such as Germany, which also invested heavily in R&D for the renewable energy industry.[91]

Direct Government Support of Emerging Industries

Direct federal government support of a new industry is not a new concept in the United States as the federal government has long supported emerging technologies with favorable policies and direct funding. The National Research Council identifies telecommunications, aerospace, semiconductors, computers, pharmaceuticals and nuclear power as industries that were started as research projects at taxpayer-supported universities and national laboratories and later received "federal research grants, small-business loans and government and military procurement." Support for these industries at critical junctures led to explosive growth and placed the United States at the vanguard of a new innovative industry; many of these manufacturers are now major market exporters.[92]

Although the chemical drug companies largely emerged from Europe, their recent success in the United States has been fueled in part by significant federal support for basic research through the National Institutes of Health (NIH), which saw its budget double between 1998 and 2003 and has continue to grow.[93] The federal government also acts as a market buyer on the other spectrum by funding federal health care policies. Federal support for the drug companies' industry is more directly tied to R&D funding (and patent law changes); the aerospace and microchip industries show how early government procurement buoyed them. The United States currently leads the world in commercial aerospace product exports led, and the aerospace industry is the largest export in U.S. industry, sending as much as $162 billion in 2018 abroad.[94] The early aviation industry was buoyed by military uses in World War I, but with the war over, new markets were needed. In 1925, the Air Mail Act was passed allowing for the U.S. Post Office to pay private companies to ferry mail, supporting the birth of the commercial service airline.[95] The extent the United States continues

87 White House. (2021, Jan. 27). *Executive Order on Tackling the Climate Crisis at Home and Abroad*. Retrieved from https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/.

88 St. John, J. (2021, Jan. 27). *Biden Executive Orders Set Broad Federal Role in Clean Energy and Climate Change Mitigation*. Greentech Media. Retrieved from https://www.greentechmedia.com/articles/read/biden-executive-orders-set-broad-federal-role-in-climate-change-and-clean-energy.

89 Walton, R. (2021, Jan. 27). *Biden Plan to Electrify Federal Fleet Will Boost EV Market, but Many Questions Remain, Experts Say*. Utility Dive. Retrieved from httpsu://www.utilitydive.com/news/biden-plan-to-electrify-federal-fleet-will-boost-ev-market-but-many-questi/594029/.

90 Wiser, R., & Millstein, D. (2020, March 1). Evaluating the Economic Return to Public Wind Energy Research and Development in the United States. *Applied Energy*, *261*, 114449. https://doi.org/10.1016/j.apenergy.2019.114449. Retrieved from https://www.sciencedirect.com/science/article/pii/S0306261919321373?via%3Dihub.

91 Barua et al., 2012.

92 Wessner, C. W., & Wolff, A. W. (Eds.). (2012). *Rising to the Challenge: U.S. Innovation Policy for the Global Economy*. National Research Council (U.S.) Committee on Comparative National Innovation Policies. Washington, D.C.: National Academies Press. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK100307/.

93 Congressional Budget Office. (2021, April). *Research and Development in the Pharmaceutical Industry*. Retrieved from https://www.cbo.gov/publication/57126.

94 U.S. Department of Commerce, International Trade Administration. (n.d.). *Aerospace & Defense*. Retrieved from https://www.trade.gov/leading-economic-indicators-aerospace-industry; Federal Aviation Administration. (2016, November). *The Economic Impact of Civil Aviation on the U.S. Economy*. Retrieved from https://www.faa.gov/air_traffic/publications/media/2016-economic-impact-report_FINAL.pdf.

95 Bugos, G. E. (2001, Aug. 28). History of the Aerospace Industry. In R. Whaples (Ed.), *EH.Net Encyclopedia*. Retrieved from https://eh.net/encyclopedia/the-history-of-the-aerospace-industry/.

directly supporting commercial aerospace (especially compared to other nations) is hotly debated; however, federal and state governments have supported infrastructure improvements and operations.[96] Beginning in the private sector, the microchip industry was buoyed by significant military support, which "funded the first pilot production lines," and the rest of the federal government made up to 40% to 45% of R&D funding in its early days. Sizable purchases from the DOD helped "establish the scale that led to a dramatic drop in prices between 1962 and 1968."[97]

96 Markovich, S. J. (2015, May 28). *Backgrounder: U.S. Aviation Infrastructure*. Retrieved from https://www.cfr.org/backgrounder/us-aviation-infrastructure.

97 Wessner & Wolff, 2012.