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California Energy Commission

COMMISSION REPORT

Preliminary Assessment of Economic Benefits of Offshore Wind

Related to Seaport Investments and Workforce Development

Gavin Newsom, Governor
December 2022 | CEC-700-2022-007-CMD

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ABSTRACT

This report responds to the directive set forth by Assembly Bill 525 (AB 525, Chiu, Chapter 231, Statutes of 2021). The law directs that on or before December 31, 2022, the California Energy Commission (CEC) shall "complete and submit to the Natural Resources Agency and relevant fiscal and policy committees of the legislature a preliminary assessment of the economic benefits of offshore wind as they relate to seaport investments and workforce development needs and standards." This report addresses these requirements.

This report is the second of four work products that AB 525 directs the CEC to prepare, informing a strategic plan for offshore wind energy developments installed off the California coast in federal waters in coordination with federal, state, and local agencies and a wide variety of stakeholders. The strategic plan must be submitted to the California Natural Resources Agency and the Legislature no later than June 30, 2023. The strategic plan is to be informed by interim activities and products developed by the CEC that include this report and two additional reports. The first report, *Offshore Wind Energy Development off the California Coast: Maximum Feasible Capacity and Megawatt Planning Goals for 2030 and 2045,* was adopted by the CEC at the August 10, 2022, public business meeting. That report established offshore wind energy planning goals of 2,000–5,000 megawatts by 2030 and 25,000 megawatts by 2045. The other interim report, also due on or before December 31, 2022, will provide a permitting roadmap that describes the time frames and milestones for a coordinated, comprehensive, and efficient permitting process for offshore wind energy facilities and associated electricity transmission infrastructure off the California coast.

Keywords: Offshore wind energy, floating offshore wind, offshore energy, offshore development, decarbonization, coastal resources, economic benefits, infrastructure planning, investments, job-years, renewable energy, reliability, seaports, ports, supply chain, transmission, turbines, wind energy, workforce, Assembly Bill 525, Senate Bill 100

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EXECUTIVE SUMMARY

On September 23, 2021, Governor Gavin Newsom signed into law Assembly Bill 525 (AB 525, Chiu, Chapter 231, Statutes of 2021), which took effect January 1, 2022. AB 525 requires the California Energy Commission (CEC), in coordination with federal, state, and local agencies and a wide variety of stakeholders and California Native American tribes, to develop a strategic plan for offshore wind energy deployment off the California coast in federal waters. The CEC must submit the strategic plan to the California Natural Resources Agency (CNRA) and the Legislature by no later than June 30, 2023.

In August 2022, to guide the strategic plan, the CEC established preliminary offshore wind planning goals of 2–5 gigawatts (GW) of floating offshore wind technologies in federal waters offshore California by 2030 and 25 GW by 2045. The report provided a reference point for technically feasible capacity of offshore wind to achieve reliability, ratepayer, employment, and decarbonization benefits (Public Resources Code, Section 25991.1).

AB 525 also requires the CEC to complete and submit two reports to CNRA and the relevant fiscal and policy committees of the Legislature that will inform the strategic plan:

1. A preliminary assessment of the economic benefits of offshore wind as they relate to seaport investments and workforce development needs and standards by no later than December 31, 2022 (Section 25991.3[d]).
2. A permitting roadmap that describes time frames and milestones for a coordinated, comprehensive, and efficient permitting process for offshore wind energy facilities and associated electricity and transmission infrastructure off the coast of California by no later than December 31, 2022 (Section 25991.5).

This report provides a preliminary assessment of economic benefits of offshore wind as they relate to seaport investments and workforce development needs and standards.

The legislative findings and declarations for AB 525 recognize the potential for development of offshore wind energy at scale to advance California’s progress toward its renewable energy and climate mandates and provide substantial economic and environmental benefits to the state and nation. They further state that offshore wind energy presents an opportunity for California to attract investment capital and provide economic and workforce development benefits to communities. This can occur through the development and preservation of a skilled and trained workforce, the creation of long-term jobs, and support the development of an offshore wind energy supply chain.

Seaports (or ports) and waterfront facilities, such as piers and wharves, are essential for the development of a new offshore wind industry in California based on a nascent floating offshore wind technology. Ports will be an important driver of potential economic benefits, including the creation of jobs and economic development opportunities. The offshore wind industry will have the greatest impact at the local and regional levels, and benefits would be realized across the state. For example, one study related to port construction in San Luis Obispo County estimated local economic benefits of more than $2 billion and the creation of nearly 12,000 full-time construction jobs over the project duration. To capture these benefits, significant investments in ports and waterfront facilities will be required to support a domestic offshore wind industry.

In addition to the direct economic benefits from investments in ports and waterfront facilities, a new workforce will also assemble, manufacture, install, operate, and maintain offshore wind turbines and related components. These investments in the offshore wind supply chain could yield numerous types of economic benefits, where the effect of thousands of good-paying jobs will ripple throughout California's economy.

Studies show a correlation between megawatt offshore wind targets and resulting job growth and other economic benefits. Although California's 2030 planning goal is 2–5 GW, a recent study estimated that total annual jobs associated with the offshore wind industry may be as great as 5,000 jobs by 2030 for 3 GW. By 2040 and beyond this could increase up to 13,000 jobs for 10 GW. Given California's higher offshore wind planning goals, the state can expect significantly more jobs created.

With most long-term offshore wind industry jobs associated with the supply chain, hundreds of skilled labor positions could be created to staff seaport manufacturing and logistics centers for offshore wind. Much of this new workforce will require training or certification or both, particularly for the construction and supply chain workers. New training standards, curricula, and training facilities will be needed to create a trained and skilled offshore wind workforce that can grow to meet the pace of offshore wind development.

This report addresses these topics while discussing ongoing research and analyses. As CEC staff continues to develop the AB 525 strategic plan due to the Legislature in June 2023, it will continue to build on and update the information in this report and integrate it into the strategic plan.

CHAPTER 1: Background on SB 100 and Offshore Wind

California is working to reduce the pace, magnitude, and costs of climate change impacts by strengthening climate change resilience and reducing greenhouse gas emissions. With the passage of the landmark legislation, the 100 Percent Clean Energy Act of 2018 (Senate Bill [SB] 100, De León, Chapter 312, Statutes of 2018), California requires that eligible renewable energy resources and zero-carbon resources supply 100 percent of total retail sales of electricity in California to end-use customers and 100 percent of electricity procured to serve all state agencies by 2045.

SB 100 also requires that the California Energy Commission (CEC), California Air Resources Board (CARB), and the California Public Utilities Commission (CPUC) prepare a joint report every four years, evaluating the opportunities and challenges of implementing SB 100. The first report, the *2021 SB 100 Joint Agency Report*, was issued in March 2021 and finds that achieving the 2045 policy is technically feasible.[1] The report also finds California will need to roughly triple its current electric power capacity to meet the 2045 target. Furthermore, significant buildout of eligible renewable and zero-carbon energy generation will be required over the next 25 years.

In addition to renewable and zero-carbon energy goals, the state set an economywide target of reducing greenhouse gas emissions to 40 percent below 1990 levels by 2030[2] and 80 percent below by 2050.[3] The Clean Energy, Jobs, and Affordability Act of 2022 (Senate Bill [SB] 1020, Laird, Chapter 361, Statutes of 2022) revised these policy goals so that eligible renewable energy and zero-carbon resources supply 90 percent of all retail sales of electricity to California end-use customers by December 31, 2035. Further, the bill requires 95 percent by December 31, 2040; 100 percent by December 31, 2045; and 100 percent of electricity procured to serve all state agencies by December 31, 2035.

The state is taking bold action to meet these greenhouse gas reduction targets. For example, California has established a loading order to prioritize meeting energy needs first with energy efficiency and demand response; second with renewable energy, including distributed generation and utility-scale; and third with a clean, conventional electricity supply. Every three years, the CEC adopts updated *Building Energy Efficiency Standards* that guide the

1 CEC, CPUC, and CARB. 2021. *2021 SB 100 Joint Agency Report Achieving 100 Percent Clean Electricity in California: An Initial Assessment*. Publication Number: CEC-200-2021, https://efiling.energy.ca.gov/EFiling/GetFile.aspx?tn=237167&DocumentContentId=70349.

2 Senate Bill 32 (Pavley, Chapter 249, Statutes of 2016) (SB 32).

3 Senate Bill 100 (De León, Chapter 312, Statutes of 2018) (SB100).

construction of buildings to better withstand extreme weather, lower energy costs, and reduce climate and air pollution.[4]

California has also established aggressive zero emission transportation goals, including the following:

- All new passenger vehicles sold are to be zero-emission by 2035.
- Transition all drayage trucks to be zero-emission by 2035.
- All medium and heavy-duty vehicles in California are to be zero-emission by 2045 where feasible.

Wind energy developed in federal ocean waters[5] off California's coast is poised to play an important role in diversifying the state's portfolio of resources. Offshore wind can help California achieve its 100 percent renewable and zero-carbon energy goals, as well as the electrification of other sectors, such as transportation.

Resource portfolio modeling completed for the *2021 SB 100 Joint Agency Report* included a range of scenarios and technologies. The model for the Core Scenario[6] included 145 gigawatts (GW) of utility-scale capacity additions to achieve the SB 100 policy for 2045, including 10 GW of offshore wind. The estimated total resource cost of the Core Scenario in 2045 is $66 billion. Furthermore, the report included a scenario with no offshore wind, which had an estimated 2045 total resource cost of $67 billion. These modeling results indicate that including 10 GW of offshore wind reduced the modeled 2045 total resource costs by $1 billion.[7] **Figure 1** shows the projected new resource additions for the SB 100 Core Scenario, including 10 GW of offshore wind by 2045.

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4 Building Energy Efficiency Standards - Title 24 | California Energy Commission

5 Federal waters extend from 3 nautical miles (nm) offshore to the edge of the Exclusive Economic Zone ending at 200 nm offshore, except within boundaries of any National Park, National Marine Sanctuary, National Wildlife Refuge (or associated systems), or National Monument.

6 The SB 100 Core Scenario is consistent with the joint agencies (CEC, CPUC, and CARB) interpretation of SB 100 and includes only commercialized technologies with publicly available cost and performance data. The Core Scenario includes retail sales and state loads, high electrification demand, and all candidate resources available.

CEC, CPUC, and CARB. 2021. 2021 SB 100 Joint Agency Report Achieving 100 Percent Clean Electricity in California: An Initial Assessment, pages 6-7, https://efiling.energy.ca.gov/EFiling/GetFile.aspx?tn=237167&DocumentContentId=70349.

7 Ibid, pages 88–89.

Figure 1: Modeling Results from the SB 100 Joint Agency Report Core Scenario

California
Clean Electricity Resources

	Existing Resources	Projected New Resources	
	2019*	2030**	2045**
Solar (Utility-Scale)	12.5 GW	16.9 GW	69.4 GW
Solar (Customer)	8.0 GW	12.5 GW	28.2 GW
Storage (Battery)	0.2 GW	9.5 GW	48.8 GW
Storage (Long Duration)	3.7 GW	0.9 GW	4.0 GW
Wind (Onshore)	6.0 GW	8.2 GW	12.6 GW
Wind (Offshore)	0 GW	0 GW	10.0 GW
Geothermal	2.7 GW	0 GW	0.1 GW
Biomass	1.3 GW	0 GW	0 GW
Hydrogen Fuel Cells	0 GW	0 GW	0 GW
Hydro (Large)	12.3 GW	N/A†	N/A†
Hydro (Small)	1.8 GW	N/A†	N/A†
Nuclear	2.4 GW	N/A†	N/A†

**Includes in-state | **Includes in-state and out of state capacity | †New hydro and nuclear resources were not candidate technologies for this round of modeling and could not be selected*

Source: 2021 SB 100 Joint Agency Report Summary, March 2021

The *2021 SB 100 Joint Agency Report* acknowledges there are additional investments and actions that would have to occur to realize 10 GW of offshore wind by 2045. While there is a significant wind resource potential off the California coast, there are challenges to developing offshore wind energy. The report states: "Among the foremost challenges are significant anticipated transmission requirements and competing coastal uses, including shipping, fishing, recreation, marine conservation, and Department of Defense activities. Together, these factors severely limit the feasible resource potential."[8] However, the report found that offshore wind energy represents an opportunity for California to generate carbon-free energy and diversify the state's renewable energy portfolio, especially considering the scale of the climate crisis.

The Offshore Wind Energy Opportunity for California

Offshore wind has been identified as an abundant domestic source of clean energy production for the United States because offshore winds tend to be strong, fast, and uniform. However,

8 Ibid., page 107.

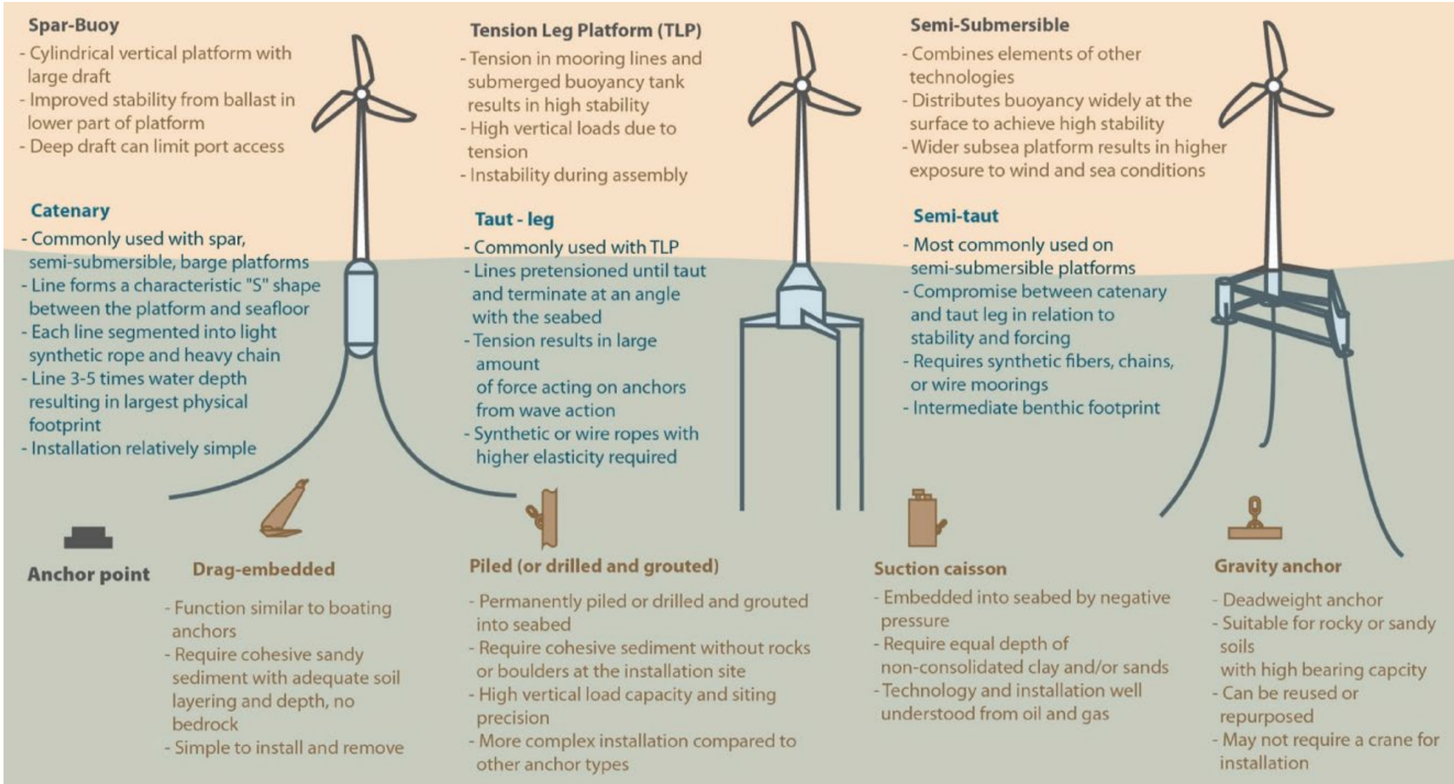
specific technologies depend on site-specific conditions and characteristics such as water depth, wind speeds, and seabed geology. Floating and fixed-bottom technologies have been deployed internationally, and there are 50,500 MW of installed capacity of fixed-bottom projects globally, including a pipeline of additional projects under development on the U.S. East Coast, as well as 123 MW of installed capacity of floating projects globally.[9] Whether floating or fixed-bottom, offshore technologies use wind turbines that essentially operate in the same way as onshore wind technologies. Offshore wind turbines and related components are larger than those used for onshore wind energy generation, and current market data indicate they are expected to continue increasing in size.[10] For example, offshore wind turbine hub height averaged 330 feet with a capacity of 6 MW in 2016 and is expected to grow to nearly 500 feet with a capacity of 15 MW or more by 2035.[11] In addition to turbines, floating offshore wind developments will likely include midwater-suspended electrical cables linking the turbines, mooring cables, and anchors attaching the turbines to the seafloor, with an electrical cable to transport the energy from the turbines to a substation, either onshore or offshore. There is also variability among floating offshore wind technologies with regard to some of the examples of currently known platform design, mooring, and anchor configurations being pursued in deep ocean waters, as seen in **Figure 2**.

9 NREL April 7, 2022. "Offshore Wind Briefing for Oregon Department of Energy" presentation. https://www.oregon.gov/energy/energy-oregon/Documents/2022-04-05-ODOE-FOSW-Public-Meeting-PPT.pdf.

10 Optis, Mike, Alex Rybchuk, Nicola Bodini, Michael Rossol, and Walter Musial. 2020. *2020 Offshore Wind Resource Assessment for the California Pacific Outer Continental Shelf*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5000-77642. https://www.nrel.gov/docs/fy21osti/77642.pdf.

11 United States Department of Energy Office of Energy Efficiency and Renewable Energy. August 30, 2021. "Wind Turbines: the Bigger the Better." https://www.energy.gov/eere/articles/wind-turbines-bigger-better.

Figure 2: Diagram of Mooring, Anchoring, and Floating Foundations

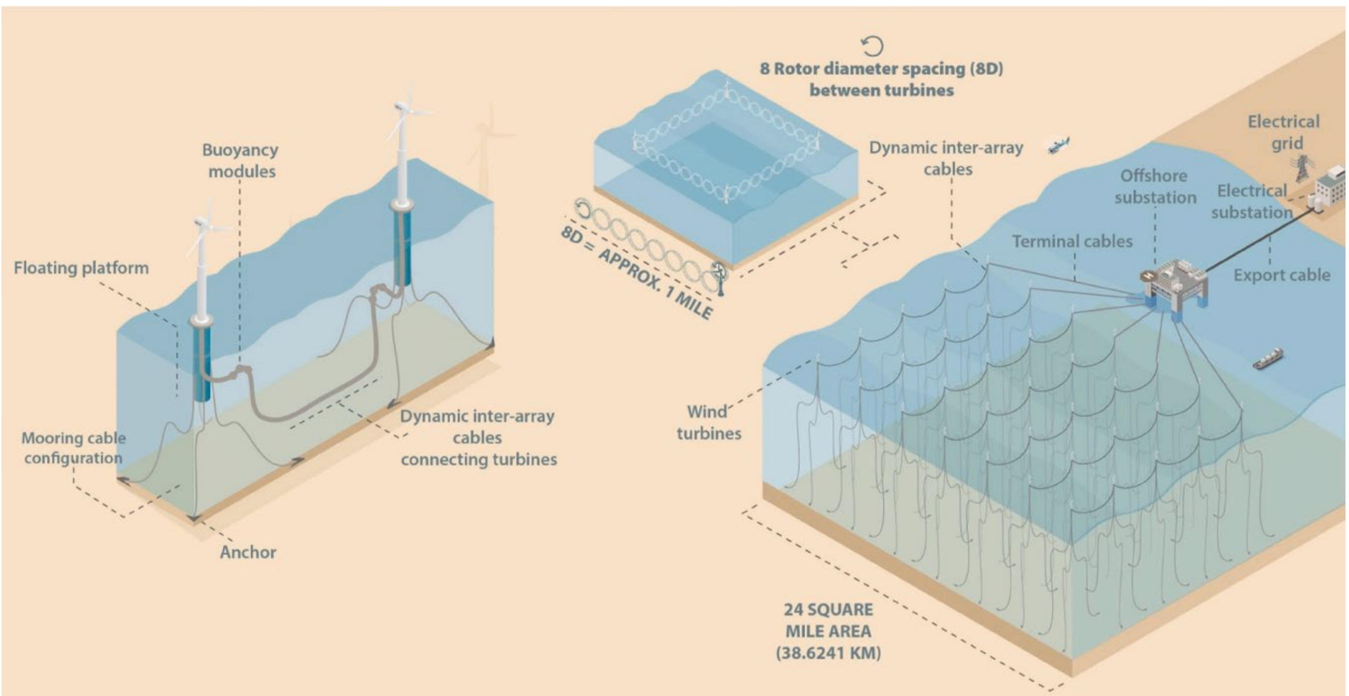


Source: Maxwell et al. 2022.[12]

12 Maxwell, Sara M., Francine Kershaw, Cameron C. Locke, Melinda G. Conners, Cyndi Dawson, Sandy Aylesworth, Rebecca Loomis, and Andrew F. Johnson. 2022. "Potential Impacts of Floating Wind Turbine Technology for Marine Species and Habitats." *Journal of Environmental Management* 307 (2022) 114577. https://doi.org/10.1016/j.jenvman.2022.114577.

To date, most offshore wind energy projects have used fixed-bottom foundations, which are more suitable for shallow waters of 60 meters (about 200 feet) or less. The deep waters of the Pacific Outer Continental Shelf off California's coast have steep drop-offs and will require offshore wind turbines installed on floating platforms to be anchored to the seabed. The schematic shown in **Figure 3** is an example of a floating offshore wind project, though no floating offshore wind projects have been developed at the scale shown in **Figure 3**. While the global floating offshore wind market is still in early stages of development, the technology is projected to advance quickly, with some estimates that the global floating offshore wind energy installed capacity could grow to more than 40 GW by 2036.[13]

Figure 3: Schematic of an Example Full-Scale Floating Wind Energy Development



Source: Image taken from California Coastal Commission CD-0001-22 April 7, 2022, hearing, Exhibit 1-3. Original source from Maxwell et al. 2022.[14]

At the national level, planning for offshore wind energy development on the Outer Continental Shelf (OCS) began taking shape starting in 2009 when the U.S. Department of the Interior (DOI) developed regulations for renewable energy development in the OCS. In 2011, DOI's Bureau of Ocean Energy Management (BOEM) was created and vested with authority for offshore renewable energy development in federal waters. BOEM's authority extends from 3

13 Guidehouse. May 2022. *California Supply Chain Needs Summary Report* https://efiling.energy.ca.gov/GetDocument.aspx?tn=242928&DocumentContentId=76513.

14 Maxwell, Sara M., Francine Kershaw, Cameron C. Locke, Melinda G. Conners, Cyndi Dawson, Sandy Aylesworth, Rebecca Loomis, and Andrew F. Johnson. 2022. "Potential Impacts of Floating Wind Turbine Technology for Marine Species and Habitats." *Journal of Environmental Management*, 307 (2022) 114577. https://doi.org/10.1016/j.jenvman.2022.114577.

nautical miles (nm) offshore ending at 200 nm offshore, except within boundaries of any National Park, National Marine Sanctuary, National Wildlife Refuge (or associated systems), or National Monument.

In March 2021, President Joseph Biden announced a national goal to deploy 30,000 MW (30 GW) of offshore wind capacity by 2030 to create a pathway to 110,000 MW (110 GW) of offshore wind capacity by 2050.[15] As of June 2021, there were 42 MW of installed offshore wind operating capacity in the United States.[16] Since 2013, BOEM has conducted nine competitive lease sales in the United States — all on the East Coast.[17] On the West Coast, BOEM designated three call areas[18] in 2018 off the coast of California, two of which BOEM identified as wind energy areas in 2021. In April 2022, BOEM announced a "call for information and nominations" for two areas off the south-central and southern coast of Oregon near the northern coast of California.[19]

The three call areas in federal waters off the coast of California are the Humboldt call area on the North Coast and the Morro Bay and Diablo Canyon[20] call areas, off the Central Coast.

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15 The White House. 2021. "FACT SHEET: Biden Administration Jumpstarts Offshore Wind Energy Projects to Create Jobs." Last modified: March 29, 2021. https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/29/fact-sheet-biden-administration-jumpstarts-offshore-wind-energy-projects-to-create-jobs/.

16 Musial, Walter, Paul Spitsen, Philipp Beiter, Patrick Duffy, Melinda Marquis, Aubryn Cooperman, Rob Hammond, and Matt Shields. 2021. *Offshore Wind Market Report: 2021 Edition*. Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy. https://www.energy.gov/sites/default/files/2021-08/Offshore%20Wind%20Market%20Report%202021%20Edition_Final.pdf. The 42 MW of operating offshore wind come from two projects, the Coastal Virginia Offshore Wind Project (12 MW) and the Block Island Wind Farm (30 MW).

17 "Fiscal Year 2022 Interior Budget in Brief, Bureau of Ocean Energy Management." (Since publication of the Budget Brief noting 8 lease sales, the New York Bight lease sale occurred.) https://www.doi.gov/sites/doi.gov/files/fy2022-bib-bh021.pdf.

18 "Call areas" are locations identified by BOEM for public comment to explore interest in commercial wind energy leases in the area.

19 "BOEM, Oregon Activities." https://www.boem.gov/renewable-energy/state-activities/Oregon.

20 The Diablo Canyon Call Area is within the area nominated by the Northern Chumash Tribal Council to become a national marine sanctuary (Chumash National Marine Sanctuary. 2022. "About the Proposed Chumash Heritage Sanctuary." https://chumashsanctuary.org/about/). In response to this nomination, NOAA has proposed a sanctuary designation that excludes "any geographical overlap with the proposed Morro Bay Wind Energy Area for offshore wind development" (NOAA, "Proposed Designation of Chumash Heritage National Marine Sanctuary." https://sanctuaries.noaa.gov/chumash-heritage/. Accessed April 14, 2022). If the proposed sanctuary designation is approved as described by NOAA with the Diablo Canyon Call Area, under current law BOEM would not have authority to lease from within the Diablo Canyon Call Area: "BOEM lacks the authority to lease within the boundaries of National Marine Sanctuaries." (BOEM. October 18, 2018. "Notice. Commercial Leasing for Wind Power Development: Outer Continental Shelf Offshore California." https://www.regulations.gov/document/BOEM-2018-0045-0001). The CEC will continue to engage with NOAA, BOEM, other stakeholders, and tribal governments during development of the AB 525 strategic plan, including identifying suitable sea space in federal ocean waters and related considerations in planning for offshore wind.

Together, these three California call areas have a potential capacity of 8.3 GW,[21] assuming 3 MW per square kilometer.[22] Based on input from California agencies, the Department of Defense, and other stakeholders, BOEM analyzed extended areas to the Morro Bay call area following a May 2021 agreement between the federal government and the state of California to advance areas for wind energy development offshore California. BOEM subsequently designated the Humboldt and Morro Bay wind energy areas (WEAs), with a combined potential generation capacity of 4.5 GW.

On May 26, 2022, the DOI announced proposed auction details and lease terms for offshore wind energy development in the Morro Bay and Humboldt WEAs, with a goal of holding a lease sale auction in fall of 2022. The California Proposed Sale Notice (PSN) includes information about potential areas that could be available for leasing within the two WEAs as well as proposed lease provisions, conditions, and auction details.[23] According to BOEM, the Humboldt WEA could bring up to 1.6 GW of energy to the grid,[24] and the Morro Bay WEA could bring up to 2.9 GW.[25] The map in **Figure 4** depicts the three 2018 call areas as well as the WEAs.

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21 One gigawatt is enough to supply the electric demand of about 1 million average California homes. "California Energy Commission, Energy Glossary," https://www.energy.ca.gov/resources/energy-glossary.

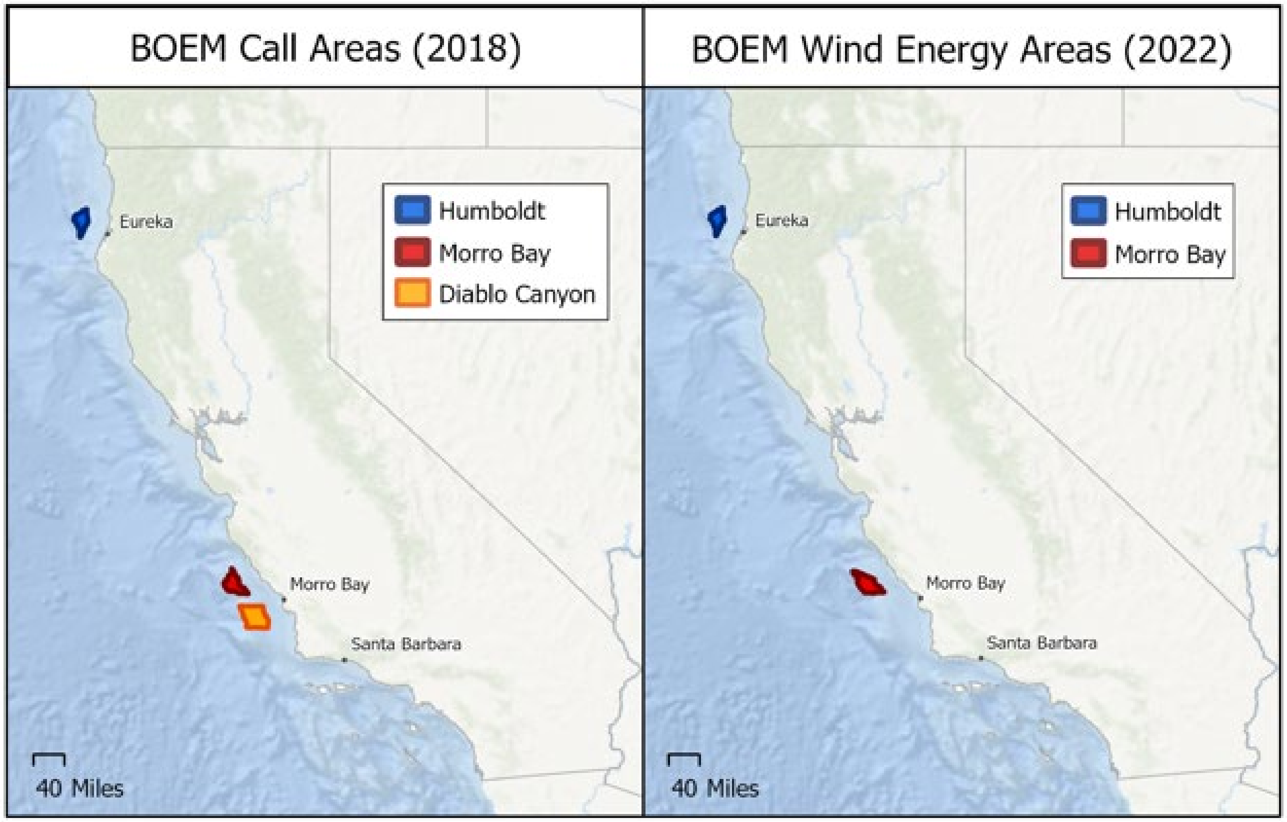
22 About 8,350 MW offshore wind modeled by the ISO (as a sensitivity in the 2021–2022 Transmission Plan) is based on three 2018 BOEM call areas, assuming 3 MW per square kilometer, as transmitted to the ISO by the CPUC in "Attachment A Modeling Assumptions for the 2021-2022 Transmission Planning Process" to Decision 21-02-008 in Rulemaking 20-05-003. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M366/K452/366452138.PDF. For further information, see page 42 of CPUC *Inputs and Assumptions, 2019-2020 Integrated Resource Planning*, November 2019 (https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2019-2020-irp-events-and-materials/inputs--assumptions-2019-2020-cpuc-irp_20191106.pdf) which uses calculations from Exhibit 8.2 on page 57 of https://laborcenter.berkeley.edu/pdf/2019/CA-Offshore-Wind-Workforce-Impacts-and-Grid-Integration.pdf.

23 Department of the Interior. May 31, 2022. "Pacific Wind Lease Sale 1 (PACW-1) for Commercial Leasing for Wind Power on the Outer Continental Shelf in California – Proposed Sale Notice." https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/california/2022-11537.pdf

24 Bureau of Ocean Energy Management. July 2021. "Area ID Memorandum: Humboldt Wind Energy Area." https://www.boem.gov/sites/default/files/documents//App.%20A%20Area%20ID%20Humboldt%20Memo%20Final.pdf.

25 BOEM. November 10, 2021. "Area ID Memorandum, Morro Bay WEA Final Signed." https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/Area-ID-CA-Morro-Bay.pdf.

Figure 4: Offshore Wind Call Areas and Wind Energy Areas off the Coast of California



Source: California Energy Commission

On December 6, 2022, BOEM held the first California lease sale for areas on the Outer Continental Shelf off Northern and Central California; as well as the first national sale in support of commercial floating offshore wind development. The online auction was conducted in a series of rounds.[26] The auction allowed qualified offshore wind developers to bid on five lease areas and resulted in winning bids for the five lease areas from five companies totaling $757.1 million.[27] BOEM's lease sales cover a total of 373,268 acres off California's coastline. The leased areas have the potential to produce 4.6 GW of offshore wind energy, enough to power more than 1.5 million homes.[28] The provisional winning bidders of the California lease areas are shown in **Figure 5.**

26 BOEM California Activities: https://www.boem.gov/renewable-energy/state-activities/california.

27 Ibid.

28 U.S. Department of the Interior. "Biden-Harris Administration Announces Winners of California Offshore Wind Auction." December 7, 2022, https://doi.gov/pressreleases/biden-harris-administration-announces-winners-california-offshore-wind-energy-auction.

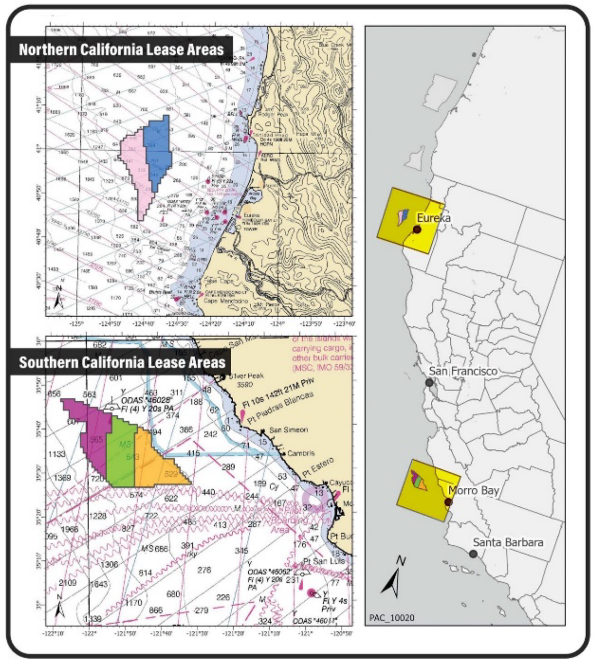
Figure 5: Winners of California Lease Areas

Provisional Winners of the California Lease Areas, $757,100,000 in High Bids

LEASE AREA

OCS-P0561	RWE Offshore Wind Holding, LLC	$157,700,000
OCS-P0562	California North Floating LLC	$173,800,000
OCS-P0563	Equinor Wind US LLC	$130,000,000
OCS-P0564	Central California Offshore Wind LLC	$150,300,000
OCS-P0565	Invenergy California Offshore LLC	$145,300,000

BOEM Bureau of Ocean Energy Management



Source, BOEM 2022.

California's Efforts in Offshore Wind Planning

Since 2016, the state has participated in the BOEM California Intergovernmental Renewable Energy Task Force, which is a partnership of members of state, local, and federal agencies and tribal governments.[29] The task force examines potential wind leasing areas in federal waters and coordinates related planning and permitting processes. The California Offshore Wind Energy Gateway[30] was created in support of the task force, with publicly available geospatial information on ocean wind resources, ecological and natural resources, commercial and recreational ocean uses, and community values. The Offshore Wind Energy Gateway helps synthesize data and identify areas off California that may be suitable for offshore wind development.

Several California state agencies, as well as the ISO, are individually and collectively working to assess the potential role and opportunity offshore wind can provide for California. Along with the CEC, these agencies include the California Department of Fish and Wildlife, the California Ocean Protection Council, the California State Lands Commission, the California Coastal Commission, the CPUC, and the Governor's Office of Planning and Research. The agencies play an important role in California's policy framework, including implementing

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29 BOEM. 2017. "California Offshore Renewable Energy Fact Sheet." https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/CA/BOEM-Offshore-Renewables-Factsheet--02-22-17.pdf.

30 "California Offshore Wind Energy Gateway." Powered by Data Basin. https://caoffshorewind.databasin.org/.

climate and clean energy goals and protecting and conserving coastal and ocean resources that are experiencing increasing impacts from climate change. The agencies have been working in partnership with BOEM to understand the implications of offshore wind as a potential energy resource and bring forward the best available science regarding environmental considerations and existing uses of the ocean to guide future state and BOEM decision making. These efforts include significant public outreach to stakeholders to identify and collect relevant data and information on existing ocean resources and uses.[31]

The California Coastal Commission implements the Coastal Zone Management Act (CZMA), which provides the state agency with the ability to review federal activities or permits outside the coastal zone, including offshore wind projects, that could influence California's coastal resources. In March 2022, California Coastal Commission staff issued a recommendation conditionally concurring with BOEM's determination that leasing activities in the Humboldt offshore WEA are consistent with the CZMA.[32] In April 2022, the California Coastal Commission voted on and approved its staff's recommendation of conditional concurrence. Similarly, in April 2022, California Coastal Commission staff issued a recommendation conditionally concurring with BOEM's determination that leasing activities in the Morro Bay WEA are consistent with the CZMA. In June 2022, the California Coastal Commission voted on and approved staff's recommendation of conditional concurrence. These conditional concurrences allow additional study of offshore wind energy development in the Humboldt and Morro Bay WEAs to move forward.

The CEC's Energy Research and Development Division administers the Electric Program Investment Charge (EPIC), which funds research leading to technological advancements and scientific breakthroughs supporting California's clean energy goals, with a focus on providing ratepayer benefits, including reliability, lower costs, and safety. The CEC's EPIC has invested $8 million into floating offshore wind energy technology innovation. In August 2020, the CEC published a report to develop priority recommendations for research and development that would lead to cost-effective offshore wind projects.[33] The EPIC Interim Investment Plan 2021 and Proposed 2021–2025 Investment Plan identify research designed to accelerate the market readiness of floating offshore wind.

The CPUC's integrated resource planning (IRP) process seeks to reduce the cost of achieving GHG reductions and other policy goals by looking across load-serving entities' (LSE)

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31 Bureau of Ocean Energy Management/California Intergovernmental Renewable Energy Task Force. "Public Information Meetings and Outreach Efforts." https://www.boem.gov/renewable-energy/state-activities/public-information-meetings-and-outreach-efforts.

32 California Coastal Commission. March 2022. *Staff Report: Consistency Determination No: CD-0001-22* (Bureau of Ocean Energy Management, Humboldt Co.). https://documents.coastal.ca.gov/reports/2022/4/Th8a/Th8a-4-2022%20staffreport.pdf.

33 Sathe, Amul, Andrea Romano, Bruce Hamilton, Debyani Ghosh, Garrett Parzygnot (Guidehouse). 2020. *Research and Development Opportunities for Offshore Wind Energy in California*. California Energy Commission. Publication Number: CEC-500-2020-053. https://www.energy.ca.gov/sites/default/files/2021-05/CEC-500-2020-053.pdf.

boundaries and resource types to identify solutions to reliability, cost, or other concerns that might not otherwise be found without an integrated planning process. The IRP process includes capacity expansion modeling of the electricity system that provides the analytical foundation for the CPUC to require LSEs to procure new energy resources, such as renewable generation and storage resources to achieve California's goals.

Based on the CPUC's portfolio of planned resources, the ISO annually conducts analysis and, if applicable, approval of the transmission needs that would be required from these future resources. The CPUC recently adopted the 2021 Preferred System Plan (PSP), which the ISO will analyze as part of its 2022–23 TPP. This planning portfolio includes 1.7 GW of offshore wind resources by 2032. The ISO's TPP results in an annual transmission plan that is based upon the state's demand forecasts, GHG emissions reductions targets, and the CPUC's adopted portfolio of future generation and storage resources. The annual transmission plan is a key route for ensuring development of the transmission needs in California to accommodate offshore wind resources.

Assembly Bill 525

In January 2022, AB 525 became effective, setting the analytical framework for offshore wind energy development off the California coast in federal waters and tasking the CEC to move swiftly to develop a strategic plan for offshore wind development.

AB 525 requires the CEC to develop the strategic plan and submit it to the California Natural Resources Agency (CNRA) and the Legislature by no later than June 30, 2023. The CEC is to develop the strategic plan in coordination with the California Coastal Commission, Ocean Protection Council, State Lands Commission, Governor's Office of Planning and Research, Department of Fish and Wildlife, Governor's Office of Business and Economic Development, the California Independent System Operator (CAISO), the California Public Utilities Commission (CPUC), and other relevant federal, state, and local agencies as needed.

AB 525 Legislative Findings

In enacting AB 525, the Legislature found and declared, among other things, that:

- If developed and deployed at scale, the development of offshore wind energy can provide economic and environmental benefits to the state and nation.
- Offshore wind energy can advance California's progress toward its statutory renewable energy and climate mandates.
- Diversity in energy resources and technologies lowers overall costs, and offshore wind can add resource and technology diversity to the state's energy portfolio.
- Offshore wind energy development presents an opportunity to attract investment capital and realize community economic and workforce development benefits in California. These benefits include, including the development and preservation a skilled and trained construction workforce to carry out projects, long-term job creation, and development of an offshore wind energy supply chain.

- Offshore wind energy can contribute to a diverse, secure, reliable, and affordable renewable energy resource portfolio to serve the electricity needs of California ratepayers and improve air quality, particularly in disadvantaged communities.
- Offshore wind should be developed in a manner that protects coastal and marine ecosystems.
- Investment in offshore wind energy development can offer career pathways and workforce training in clean energy development.

Strategic Plan

AB 525 requires that the CEC's development of the strategic plan "shall incorporate, but not delay, progress to advance responsible development of offshore wind in other relevant policy venues."

The strategic plan must include, at a minimum, the following five chapters:

1. Identification of sea space
2. Economic and workforce development and identification of port space and infrastructure
3. Transmission planning
4. Permitting Roadmap
5. Potential impacts on coastal resources, fisheries, Native American and Indigenous peoples, national defense, and strategies for addressing those potential impacts

Each chapter must be developed with specific content and public review process as described in section 25991 of the California Public Resources Code.

Identification of Sea Space

The CEC, in coordination with the California Coastal Commission, Department of Fish and Wildlife, Ocean Protection Council, and State Lands Commission, is required to work with stakeholders,[34] other state, local, and federal agencies, and the offshore wind energy industry to identify suitable sea space for wind energy areas in federal waters sufficient to accommodate the offshore wind MW planning goals the CEC is required to establish under AB 525.

AB 525 specifies a sequence of actions requiring that the CEC first identify the sea space identified by the Bureau of Ocean Energy Management (BOEM) in its 2018 call for nominations for areas offshore the California coast and any other relevant information necessary to achieve the 2030 offshore wind MW planning goals the CEC is required to establish under AB 525. The

[34] The term "stakeholders," as used by AB 525, includes, but is not limited to, fisheries groups, labor unions, industry, environmental justice organizations, environmental organizations, and other ocean users. California Public Resources Code, §25991.6.

CEC, in coordination with the California Coastal Commission, Department of Fish and Wildlife, Ocean Protection Council, and State Lands Commission, shall next identify suitable sea space for a future phase of offshore wind leasing to accommodate the 2045 offshore wind planning goal the CEC is required to establish under AB 525.

In identifying suitable sea space, the CEC shall consider:

- Existing data and information on offshore wind resource potential and commercial viability.
- Existing and necessary transmission and port infrastructure.
- Protecting cultural and biological resources with the goal of prioritizing least-conflict ocean areas.

In addition, AB 525 requires the CEC to:

- Incorporate the information developed by the Bureau of Ocean Energy Management's California Intergovernmental Renewable Energy Task Force.
- Use the California Offshore Wind Energy Gateway, or functionally equivalent publicly accessible, commission-approved internet website, to provide relevant information developed under this section to the public.
- Coordinate with the California Coastal Commission; the Department of Fish and Wildlife; the Ocean Protection Council; the State Lands Commission; stakeholders; other state, local, and federal agencies; and the offshore wind energy industry. These organizations are encouraged to make recommendations regarding potential significant adverse environmental impacts and use conflicts, such as avoidance, minimization, monitoring, mitigation, and adaptive management, consistent with California's long-term renewable energy, greenhouse gas emission reduction, and biodiversity goals.

Economic and Workforce Development and Identification of Port Space and Infrastructure

Based on the identified sea space, the CEC, in coordination with relevant state and local agencies and representatives of key labor organizations and apprenticeship programs, must develop a plan to improve waterfront facilities that could support a range of floating offshore wind energy development activities. These activities include construction and staging of foundations, manufacturing of components, final assembly, and long-term operations and maintenance facilities. AB 525 directs that the strategic plan must include:

- A detailed assessment of the necessary investments in California seaports to support offshore wind energy activities, including construction, assembly, and operations and maintenance. The assessment shall consider the potential availability of land and water acreage at each seaport, including competing and current uses, infrastructure feasibility, access to deep water, bridge height restrictions, and the potential impact to natural and cultural resources, including coastal resources, fisheries, and Native American and Indigenous peoples.

- An analysis of the workforce development needs of the California offshore wind energy industry, including occupational safety requirements, the need to require the use of a skilled and trained workforce to perform all work, and the need for the Division of Apprenticeship Standards to develop curriculum for in-person classroom and laboratory advanced safety training for workers.
- Recommendations for workforce standards for offshore wind energy facilities and associated infrastructure, including prevailing wage, skilled and trained workforce, apprenticeship, local hiring, and targeted hiring standards that ensure sustained and equitable economic development benefits.

Regarding port infrastructure, the strategic plan must:

- Emphasize and prioritize near-term actions, particularly related to port retrofits and investments and the workforce, to accommodate the probable immediate need for jobs and economic development.
- Strive for compatibility with other harbor tenants and ocean users to ensure that the local benefits related to offshore wind energy construction complement other local industries when considering port retrofits.
- Emphasize and prioritize actions that will improve port infrastructure to support land-based work for the local workforce.

Transmission Planning

The CEC, in consultation with the CPUC and ISO, must assess the transmission investments and upgrades necessary, including subsea transmission options, to support the 2030 and 2045 offshore wind MW planning goals. The assessment must include relevant cost information for subsea transmission and network upgrades, as well as the extent to which existing transmission infrastructure and available capacity could support offshore wind energy development.

Permitting Roadmap

The CEC must develop and produce a permitting roadmap that describes time frames and milestones for a coordinated, comprehensive, and efficient permitting process for offshore wind energy facilities and associated electricity and transmission infrastructure off the California coast. The roadmap must:

- Include a goal for the permitting time frame.
- Clearly define local, state, and federal agency roles, responsibilities, and decision-making authorities.
- Include interfaces with federal agencies, including timing, sequence, and coordination with federal permitting agencies, and coordination between reviews under the California Environmental Quality Act and the federal National Environmental Policy Act of 1969.

The permitting roadmap must also be developed in consultation with all relevant local, state, and federal agencies, including the California Coastal Commission, the Department of Fish and Wildlife, the State Lands Commission, interested California Native American tribes, and other affected stakeholders.

Potential Impacts on Coastal Resources, Fisheries, Native American and Indigenous Peoples, National Defense, and Strategies for Addressing those Potential Impacts

The CEC, in coordination with the California Coastal Commission, the Department of Fish and Wildlife, the Ocean Protection Council, the State Lands Commission, stakeholders, other state, local, and federal agencies, and the offshore wind energy industry, shall make recommendations regarding the potential impacts on coastal resources, fisheries, Native American and Indigenous peoples, and national defense. This coalition of agencies and industry are requested to assist as CEC develops strategies for addressing those potential impacts.

The strategic plan chapters will also be guided by:

1. The report *Offshore Wind Energy Development off the California Coast: Maximum Feasible Capacity and Megawatt Planning Goals for 2030 and 2045*, which was adopted by the CEC at its August 10, 2022, public Business Meeting. This report established offshore wind energy planning goals of 2,000–5,000 megawatts by 2030 and 25,000 megawatts by 2045 and addressed the requirement to evaluate and quantify the maximum feasible capacity of offshore wind to achieve ratepayer, employment, and decarbonization benefits.
2. A preliminary assessment of the economic benefits of offshore wind as they relate to seaport investments and workforce development needs and standards, due December 31, 2022.
3. A permitting roadmap that describes time frames and milestones for a coordinated, comprehensive, and efficient permitting process for offshore wind energy facilities and associated electricity and transmission infrastructure off the coast of California, due December 31, 2022.

This report meets the requirement for a preliminary assessment of the economic benefits of offshore wind as they relate to seaport investments and workforce development needs and standards.

Offshore wind development will create a brand-new industry with a nascent technology. This is expected to create significant economic benefits for California. With the passage of AB 525, the legislature found that offshore wind energy can advance California's progress towards its renewable energy and climate mandates, and that if developed at scale offshore wind energy can provide substantial economic and environmental benefits to both the state and the nation. Further, offshore wind energy presents an opportunity to attract investment capital and provide economic and workforce development benefits to communities through the development and preservation of a skilled and trained workforce, the creation of long-term jobs, increased economic activity, and new sources of fiscal revenues.

As discussed below, California offshore wind industry could create a wide range of good-paying jobs that require skills, training, and education. The majority of jobs are expected to be in local and regional supply chain and manufacturing sectors, although many other important jobs, such as longshoreman, tugboat and other watercraft operators, and others would also be required to support this new industry. Investing in seaport and waterfront facilities is essential for a durable and thriving California floating offshore wind industry.

As floating offshore wind energy develops off the coast of California, ports and waterfront facilities are expected to play an essential supporting role if the state is to realize the economic benefits from developing this resource. Significant investments may be needed to upgrade and expand California's existing port facilities and waterfront infrastructure to support a broad range of offshore wind development activities, including but not limited to the assembly, fabrication, installation and maintenance of offshore wind turbines and related components. The construction of new facilities may also be needed. **Table 1** identifies a potential deployment schedule for offshore wind resources off the California coast used in a recent study to assess port facility needs. Under these scenarios, California will potentially require more than 10 port terminal sites to support the full offshore wind supply chain need to meet the 25 GW by 2045 goal. This could require a multi-port strategy, with sites varying in size (5 to more than over 100 acres) and use for staging and integration, and the manufacturing of blades, towers, nacelles, floating foundations, and operations and maintenance. The potential development of port facilities and waterfront infrastructure should consider technology changes and the projected increase in size of offshore wind components over time, so that waterfront facilities and infrastructure can meet the needs of a growing industry.

To ensure California has the necessary port infrastructure and a skilled and trained workforce readily available to support a robust offshore wind industry, a combination of federal and state investment would be needed. The Consolidated Appropriations Act 2021 made $230 million available from the United States Department of Transportation's Port Infrastructure Development Program, with $205 million reserved for grants to coastal seaports and Great Lakes ports.[35] The CEC and other agencies are exploring opportunities to leverage state funds to attract federal funding to support offshore wind development in California. Additionally, state funding is supporting early offshore wind port development (See California Investments to Advance Seaport and Waterfront Facilities to Support Offshore Wind Activities section below). Finally private investment, including investment from developers, could play a role in supply chain, construction, operation, and maintenance workforce development.

[35] United States Department of Transportation. March 29, 2021. *U.S. Department of Transportation Announces Funding Availability for Port Infrastructure Development Program*. https://www.transportation.gov/briefing-room/us-department-transportation-announces-funding-availability-port-infrastructure

Table 1: Potential Rates of Offshore Wind Deployment off the California coast

Year	Target Deployment				
	Low		Medium	High	
Rate	0.5 GW/yr	1 GW/yr	1.5 GW/yr	2 GW/yr	2.5 GW/yr
2030	1 GW	2 GW	**3 GW**	4 GW	5 GW
2035	3.5 GW	7 GW	10.5 GW	14 GW	17.5 GW
2038	5 GW	10 GW	15 GW	20 GW	25 GW
2045	8.5 GW	17 GW	**25 GW**	34 GW	42.5 GW
2048	10 GW	20 GW	30 GW	40 GW	50 GW
2050	11 GW	23 GW	33 GW	44 GW	55 GW

Source: Moffat & Nichol, 2022

CHAPTER 2:
Seaports and Waterfront Facilities

Seaports (or ports) and waterfront facilities are essential for the development of a new offshore wind industry in California and will also be an important driver of potential economic benefits, including jobs and economic growth opportunities. Initially, California ports may not be able to handle all the required activities to support industry development. However, they have the potential to serve as strategic hubs to support a workforce that can assemble, fabricate, install, and operate and maintain offshore wind turbines and related components.

Seaport and Waterfront Facilities Defined

The American Association of Port Authorities (AAPA) defines a port as a harbor area where ships are docked.[36] The California State Legislature Analyst's Office defines ports as facilities where goods are loaded and unloaded from ships, as well as where goods are processed and prepared for further distribution to retailers and consumers.[37] The American Society of Civil Engineers (ASCE) 2021 Infrastructure Report Card shows that the nation's more than 300 coastal and inland ports are significant drivers of the United States economy, supporting 30.8 million jobs in 2018 and 26% of the total GDP.[38]

Seaports in the United States are often located in or adjacent to large coastal metropolitan areas. Port facilities vary widely in terms of productivity, footprint, customers, and governance. Some ports are privately owned and operated, while others are managed by a government or quasi-government authority representing a city or state. The owner of a port may lease space or infrastructure to a tenant, most commonly a terminal operator. Terminal operators are responsible for maintaining equipment and buildings, but typically partner with a public agency for major capital projects. The varied ownership structures contribute to the uniqueness of each port. Many United States ports, including the waterways and facilities connecting them, are complicated elements that integrate water, rail, road, and even airborne transportation modes.[39]

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[36] American Association of Port Authorities. *Glossary*. Accessed 12/9/22. https://www.aapa-ports.org/advocating/content.aspx?ItemNumber=21500

[37] Legislative Analyst's Office. August 2022. *Overview of California's Ports*. https://lao.ca.gov/Publications/Report/4618

[38] 2021 Report Card For America's Infrastructure. January 2017. *Ports*. https://infrastructurereportcard.org/wp-content/uploads/2017/01/Ports-2021.pdf

[39] United States Department of Transportation Maritime Administration. July 2019, *Ports*. https://www.maritime.dot.gov/ports/strong-ports/ports

The nation's economy is highly dependent its ports and port facilities – everyday, trains, trucks, barges and ships move goods into, around, and through the nation's ports to meet the commercial and military needs of the county. Ports receive shipments from farms and factories destined for markets throughout the world. In addition, goods flow from factories in Europe, South America, and the Far East through the country's ports on the way to factories and stores throughout the country. Petroleum, chemicals, and raw materials move across the oceans through our ports to reach United States industries. The seas and rivers, ports and terminals and their nearby transportation links, and interstate rail, road, and marine highway systems are a critical and intertwined transportation network that deliver goods to the market. Containers, bulk, breakbulk, neo-bulk, project cargo, automobiles and trucks, and petroleum and other bulk liquids all flow through the transportation system that begins at the nation's ports and port facilities. This system requires an advanced and sophisticated network of both ports and terminals, as well as fleets of trucks, rail cars, and barges that carry cargo to customers. This network system requires highly trained personnel on and offshore, and requires support services and industries to remain operational. A failure of any one of these parts prevents the efficient functioning of the rest of the system.[40]

Port Governance

The American Association of Port Authorities (AAPA) presents a concise overview of port governance in the United States, which is summarized here.[41] There are approximately 183 commercial deep draft ports in the United States including Alaska, Hawaii, Guam, Puerto Rico, Saipan, and the United States Virgin Islands. Of these, approximately 115 are state, local, county, or independent public port authorities. The ports are dispersed along the Atlantic, Gulf, and Pacific coasts, and Great Lakes.

Unlike other countries, there is no national port authority in the United States. Instead, authority is diffused throughout the government at the federal, state, and local levels. The United States Constitution grants the federal government jurisdiction over navigable waters including channels and harbors. This authority is primarily delegated to the Coast Guard and the United States Army Corps of Engineers. However, the federal authority ends at the water's edge. Port authorities in the United States are instruments of state or local government that are established by enactment or grants of authority by the state legislature. Some port activities are subject to federal law and jurisdiction but, in general, port authorities operate without significant federal oversight or control. The range of authority exercised in some cases extends to other infrastructure that supports port operations such as bridges, tunnels,

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[40] Great Lakes Maritime Research Institute. January 2009. *America's Ports and Intermodal Transportation System*. http://www.glmri.org/downloads/Ports&IntermodalTransport.pdfhttp://www.glmri.org/downloads/Ports&IntermodalTransport.pdf

[41] American Association of Port Authorities. Accessed 12/9/22. *Seaport Governance in the United States and Canada*. https://www.aapa-ports.org/files/pdfs/governance_uscan.pdfhttps://www.aapa-ports.org/files/pdfs/governance_uscan.pdf

commuter rail systems, industrial parks, airports, foreign-trade zones, world trade centers, railroads, shipyards, commercial vessels, dredges, marinas, and other public recreational facilities. Some authorities are empowered to levy taxes. Many have police powers as it relates to securing facilities and enforcing ordinances. Some exercise regulatory powers such as licensing of stevedores, enforcement of state or local environmental and land use regulations, and management of submerged or tidal lands.

California Ports and Harbors

California ports vary in size, governance, cargo type, and purpose. Located throughout the state are several large public and private ports. In addition to these larger ports, there are many small craft harbors that provide water access for fishing and recreational uses. California's ports and harbors developed over many years to serve the local and regional communities and to support nation-wide supply chain and goods movement needs. Typically, the state's ports and harbors are in sheltered waters that are provided by natural harbors or man-made structures.

The port authorities that comprise the California Association of Port Authorities (CAPA) are responsible for handling 40 percent of all containerized imports and 30 percent of all exports in the United States California ports are a major driver of quality, good-paying jobs. More than 1 million California jobs and 3 million jobs nationally are linked to trade through CAPA member ports. Over the years, CAPA member ports have invested significantly in new and promising technologies and innovative port facilities and operations. In addition to the commercialization of shore-side power for oceangoing vessels that was developed nearly two decades ago, CAPA member ports are market leaders in the development of low-emission and zero-emission trucks and terminal equipment. In the United States, California ports are also leading in the development of digital infrastructure for supply chain efficiency. This effort includes the development of Port Community system technology.[42]

Types of Port Facilities

Large port facilities, such as the Port of Los Angeles (see **Figure 6**), include multiple terminals, including industry-specific terminals, piers, wharves, yards, marinas, deep-water channels, and sheltered harbors. Port components include the following:[43]

Barge: A large, flat-bottomed boat used to carry cargo that is typically navigated and powered by a tug or towboat

[42] This includes technology that provides line-of-sight, origin-to-destination cargo tracking, giving cargo owners and logistics providers more ability to manage the flow of their goods. California Association of Port Authorities. Accessed 12/9/22. *About CAPA*. https://californiaports.org/about-capa/

[43] American Association of Port Authorities. *Glossary*. Accessed 12/9/22. https://www.aapa-ports.org/advocating/content.aspx?ItemNumber=21500

Berth: The space at a terminal at which a ship docks. A terminal may have multiple berths, depending on the length of incoming ships.

Breakwater: A barrier built into a body of water to protect a coast or harbor from the ocean wave conditions

Cargo: The freight (goods, products) carried by a ship, barge, train, truck, or plane.

Dock: A dock is a structure built along, or at an angle from, a navigable waterway so that vessels may lie alongside to receive or discharge cargo.

Harbor: A sheltered location where ships may anchor.

Marina: A protected harbor for mooring of small craft vessels for fishing and recreational purposes.

Terminal: A single location within a port to transfer cargo to and from a vessel. Depending on the type of terminal, connections to land transportation such as road, rail, pipelines, etc. are provided.

Terminal Equipment: Various vehicles and specialized equipment that is used to operate a terminal and move cargo around the terminal such as cranes, trucks, and other specialty vehicles or equipment.

Pier: A type of marine structure, typically perpendicular to the shoreline, for mooring vessels and cargo handling.

Port: This term is used both for the harbor area where ships are docked and for the agency (port authority) that administers use of public wharves and port properties.

Tug: Strong and powerful boats used for maneuvering ships into and out of port safely.

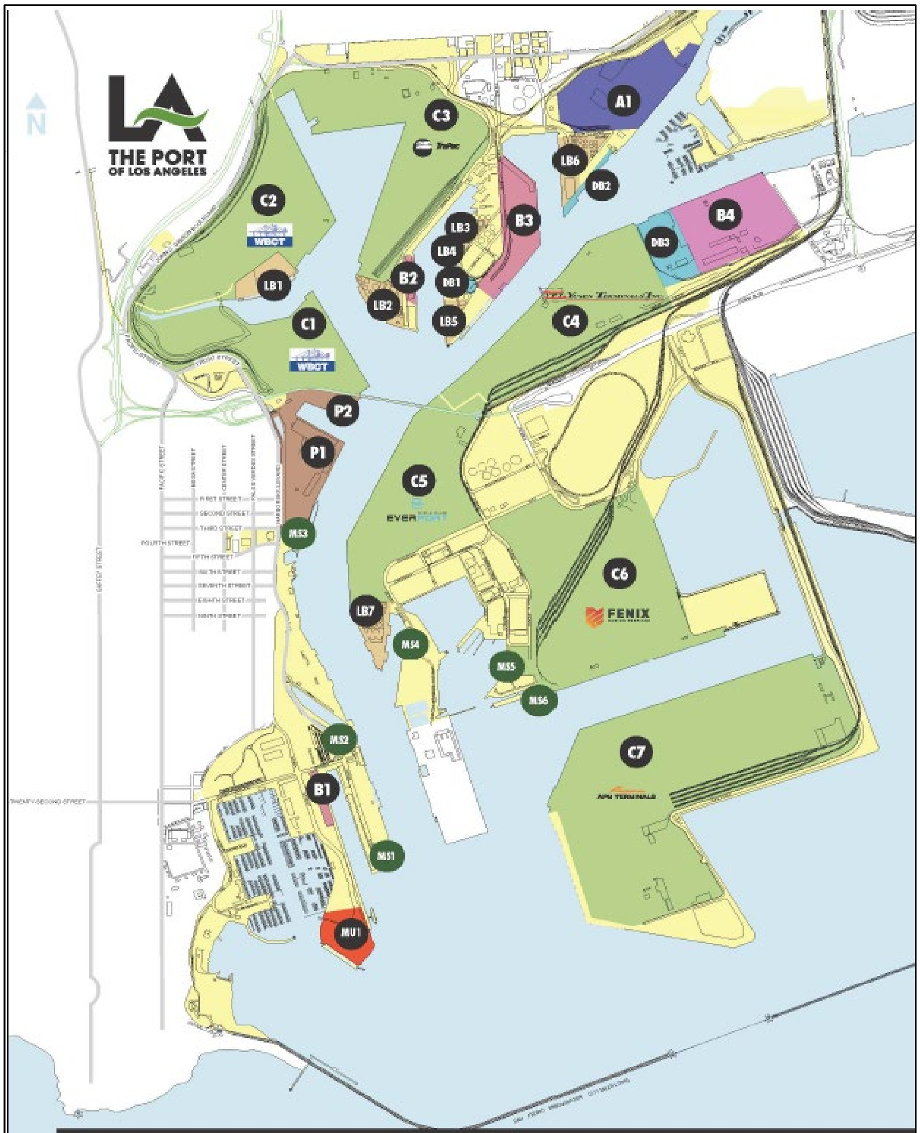
Vessel: A ship or large boat used to move cargo from one port to another.

Wharf: A type of marine structure, typically parallel to the shoreline, where vessels moor to transfer cargo.

Yard: An upland area adjacent to the berth where cargo is staged and/or stored either before vessel loading or after vessel unloading.

The seaside operations of seaports are served by marine vessels that carry passengers or deliver cargo. In addition to waterside port components, seaports typically include administrative buildings and warehouses. **Figure 7** shows an example pathway for goods movement from production to consumers.

Figure 6:The Port of Los Angels is an example of a large intermodal seaport



Example of a Port, Map Courtesy of Port of Los Angeles

Source: Moffat & Nichol, 2022

Figure 7: Port Cargo Supply Chain

Source: https://lao.ca.gov/Publications/Report/4618

Port Facilities Required to Support Offshore Wind Energy Development

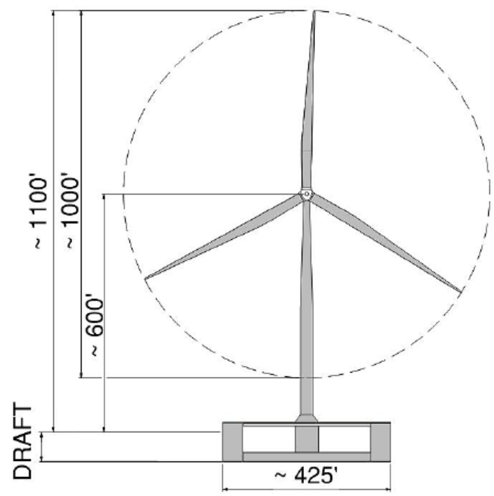
The Pacific Outer Continental Shelf (OCS) is characterized by rapidly increasing water depths that exceed the feasible operating limits of traditional fixed-bottom offshore wind turbines. Thus, floating offshore wind technology is more suitable for this region. To construct floating offshore wind turbines, the turbine components will need to be fabricated, assembled, and transported from a sheltered port or harbor to the offshore wind energy area. Existing port infrastructure on the United States West Coast is not adequate to support these activities and significant investment is required to develop offshore wind energy port facilities.[44] This is discussed more in Chapter 3.

[44] Bureau of Ocean Energy Management. March 2022. *BOEM Pacific Region: Ongoing Study*. https://www.boem.gov/sites/default/files/documents/regions/pacific-ocs-region/environmental-science/PR-21-PRT_0.pdf

As illustrated in **Figure 8**, floating offshore wind turbines are constructed with components larger than any now used or assembled at California's ports. Their construction and maintenance will require new configurations and upgrades of ports and port facilities. The offshore wind industry will require port facilities with sheltered harbor areas, large laydown areas, deep navigable waters, and heavy load capacity.[45]

Figure 8: Dimensions of Floating Offshore Wind Turbines

Floating Offshore Wind Turbine	Approximate Dimension [ft]	Approximate Dimension [m]
Foundation Beam / Width	Up to 425 ft x 425 ft	Up to 130 m x 130 m
Foundation Draft (Before Integration)	15 – 25 ft	4.5 – 7.5 m
Foundation Draft (After integration)	20 – 50 ft	6 – 15 m
Hub/Nacelle Height (from Water Level)	Up to 600 ft	Up to 183 m
Tip Height (from Water Level)	Up to 1,100 ft	Up to 335 m
Rotor Diameter	Up to 1,000 ft	Up to 305 m



Source: Moffatt Nichol. October 2022.

The ideal ports to serve California's offshore wind industry will be located close to lease areas to reduce transportation-related greenhouse gas emissions, risk and cost. Many supply chain activities are also expected to co-locate at or near the ports.[46]

These ports will need to service construction and assembly of the foundations of floating offshore wind turbines, which are likely to be semi-submersible and made of concrete, steel, or a hybrid. A key issue will be developing a method for transporting these foundations from land to water, likely using a semi-submersible barge with a sinking basin, ramps, or direct transfer methods.

Wet storage areas are large, protected basins within ports. They will be required within port facilities as a place where the floating foundations or integrated turbines can be safely moored until they can be towed to their generation sites. These storage areas will provide transport flexibility, reducing the risk of weather downtime, conflicts with vessel traffic, and entrance channel downtime.

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[45] Moffatt Nichol. October 2022. CEC Workshop on Assembly Bill 525: Assessing CA Seaports for OSW, Staus Update. https://efiling.energy.ca.gov/GetDocument.aspx?tn=247222&DocumentContentId=81564

[46] Ibid

To support different phases of offshore wind development and operation, port facilities may be within existing ports or harbors, or they may be constructed at undeveloped or former industrial sites outside of existing ports.

The following types of port terminals will be required to support offshore wind development (see **Figure 9**):[47]

1. **Staging and Integration (S&I) Facility:** a site to receive, stage, and store offshore wind components and to assemble the floating turbine system for towing to the offshore wind area. This facility is likely to support the following services:
   a. **Construction Support Facility:** a home port for the fleet of construction vessels necessary for construction and commissioning of the offshore wind farm.
   b. Turbine Maintenance Facility: a facility to perform major maintenance on a fully assembled turbine system that cannot otherwise be performed in the offshore wind area such as replacement of a nacelle or blade.
2. **Operations and Maintenance (O&M) Facility:** a home port site with warehouses/offices that supports the following O&M vessels during the operation period of the offshore wind farm:
   a. **Crew Transfer Vessel (CTV):** transfers small crews to offshore wind turbine installations for day-trip O&M visits and inspections.
   b. **Service Accommodation Transfer Vessel (SATV):** intermediate between SOVs and CTVs, with ability to sleep onboard for multiday trips.
   c. **Service Operating Vessel (SOV):** vessels that loiter and operate as in-field accommodations for workers and platform assist for wind turbine servicing and repair work.
3. **Manufacturing / Fabrication (MF) Site:** a site that receives raw materials via road, rail, or waterborne transport; creates larger components in the offshore wind supply chain; and includes factory and/or warehouse buildings. It is typically located on the water to export the completed components via waterborne transport.

These facilities must be able to support the construction and transport of floating offshore wind turbines.

[47] Ibid

Figure 9: Staging and Integration Facility and Manufacturing and Fabrication Site

Staging and Integration

Source: Moffatt Nichol. October2022.

Manufacturing Port (Towers Shown)

Turbine Components

Port facilities may serve as manufacturing or assembly sites for turbine components, including those known as tier-1, tier-2, tier-3 and tier-4 components. These components required to construct floating offshore wind turbines are defined as follows:

Tier 1: Finished components. Finished components are the major products that are purchased by an offshore wind energy project developer, such as the wind turbine, foundation, or cables.

Tier 2: Subassemblies. Subassemblies are the systems that have a specific function for a Tier 1 component, which may include subassemblies of a few smaller parts, such as a pitch system for blades.

Tier 3: Subcomponents. Subcomponents are commonly available items that are combined into Tier 2 subassemblies, such as motors, bolts, and gears.

Tier 4: Raw materials. Raw materials, such as steel, copper, carbon fiber, concrete, or rare-earth metals, are directly processed into Tier 2 or 3 components. [48]

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[48] TETHYS. March 2022. *The Demand for a Domestic Offshore Wind Supply Chain*. https://tethys.pnnl.gov/publications/demand-domestic-offshore-wind-energy-supply-chain

CHAPTER 3: Potential Economic Benefits of Offshore Wind Related to Seaport Investments

In this chapter, the potential economic benefits and need for investments related to the development of ports and waterfront facilities to support a new floating offshore wind energy industry in California are discussed. Offshore wind development offers California an opportunity to develop a robust offshore wind infrastructure that can lead to in-state manufacturing for blades, turbines, transport vessels, and other related technologies. California can also benefit from two recent federal offshore wind events. In August 2022, President Biden signed the Inflation Reduction Act, the largest investment in clean energy in our nation's history, with more than a billion dollars of tax incentives for investments in offshore wind production and manufacturing.[49] More recently, as a result of BOEM's December 6, 2022, California lease auction, the winning bidders all received a 20 percent bidding credit, totaling more than $117 million. This commitment of monetary contributions will fund programs or initiatives that support workforce training programs for the floating offshore wind industry, the development of a U.S. domestic supply chain for the floating offshore wind energy industry, or both.[50]

However, California ports may not be able to handle all the required activities to support the industry initially, even with investments and significant upgrades. Until the state can build out the infrastructure in a responsible manner, offshore wind components will have to be manufactured elsewhere and imported to California. Types of port facilities needed to support the industry may vary depending on the type of floating turbine design, location, mooring systems, distance from shoreline, and water depths for turbine operation. Regardless of the specific floating technology, port facilities will eventually need to receive, stage, store, assemble, and load offshore wind components; support operation and maintenance vessels; and provide sites where raw materials are received and larger components are manufactured and assembled.[51]

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[49] Inflation Reduction Act, HR 5376. 117th Congress (2021-2022). https://www.congress.gov/bill/117th-congress/house-bill/5376/text.

[50] United Stated Department of the Interior. December 2022. *Biden-Harris Administration Announces Winners of California Offshore Wind Energy Auction*. https://doi.gov/pressreleases/biden-harris-administration-announces-winners-california-offshore-wind-energy-auction

[51] Ibid.

Types of Economic Benefits

Economic benefits are benefits that can be quantified in terms of money generated, such as net income and revenue.[52] Economic benefits from offshore wind development and activities may include business output or/sales, increases in Gross Domestic Product (GDP) or Gross State Product (GSP), the number of jobs created, and increased wages. Economic benefits can also come from increased tax revenue: property taxes on land improvements, sales tax on personal consumption and offshore wind capital expenditures, as well as corporate taxes on value added in the regional supply chain.

Studies show that there are essentially four categories of economic benefits from construction and use of seaports:[53,54]

1. **Direct benefits:** Benefits directly related to the port operations and growth of the port for offshore wind development; for example, workers who work at the port or facility and are directly involved. These may include construction workers constructing the offshore wind farms or upgrading the associated infrastructure such as ports, as well as offshore wind workers operating on and maintaining the offshore wind resources. These types of benefits relate to direct spending on development and construction labor and services, including engineering, design, and other professional services for offshore wind project development. For operations and maintenance of an offshore wind project, direct benefits come from onsite labor, including from field technicians, administration, and management.
2. **Indirect benefits:** Benefits related to economic growth in associated industries spurred by spending at the port on offshore wind, such as supply chain[55] development and component manufacturing. In other words, indirect benefits come from expanded demand from developers or contractors for equipment, materials, and services for CA's offshore wind industry. For example, for port upgrades, the labor that does construction and upgrades the port (and the income they earn) represent a direct economic benefit. However, materials and components (steel, concrete, electrical components, etc.) that are purchased to support port upgrades measure indirect economic benefits (materials

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[52] Market Business News. Accessed 12/6/2022. *Financial Glossary*. https://marketbusinessnews.com/financial-glossary/economic-benefit/

[53] Shields, Matt, Ruth Marsh, Jeremy Stefek, Frank Oteri, Ross Gould, Noé Rouxel, Katherine Diaz, Javier Molinero, Abigayle Moser, Courtney Malvik, and Sam Tirone. June 2022. *The Demand for a Domestic Offshore Wind Energy Supply Chain*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5000-81602. https://www.nrel.gov/docs/fy22osti/81602.pdf.

[54] Hamilton, Stephen F., Cyrus Ramezani, Christopher Almacen, and Ben Stephan. April 2021. *Economic Impact of Offshore Wind Farm Development on the Central Coast of California*. California Polytechnic State University. https://reachcentralcoast.org/wp-content/uploads/Economic_Value_OSW_REACH.pdf.

[55] A supply chain is the network of individuals, organizations, resources, activities, and technology involved in the creation and sale of a product. In this report, this definition will refer to the creation and sale of all offshore wind components making up the completed offshore wind plant.

purchased and jobs created to support the port upgrades). For offshore wind operations and maintenance, indirect benefits capture economic and employment benefits from spending on turbine equipment, materials, and other offsite purchases of goods and services. Another example of indirect economic benefits from port upgrades, is a regional asphalt provider hired to provide road access to a specialized wind port. While the asphalt provider's job is directly attributable to the needs of the port, it has no direct impact on port operations and therefore represents an indirect impact.

3. **Induced benefits:** Benefits related to ripple effects that occur at all points in the supply chain from both direct and indirect impacts. For example, an induced impact from a road expansion project (to transport offshore wind components) would be an asphalt quarry that hires additional employees to help service the increased demand for asphalt from the road expansion project to serve the port. Increased local spending at existing businesses (from increased employment) can also be an example of indirect benefits.
4. **Tax revenue:** Benefits that are generated from offshore wind activities (local and state, property, and sales tax, etc.). Tax revenue can be generated through increased business transactions from the construction and operation of offshore wind resources, as well as land improvements from port upgrades.[56]

All economic benefits defined above (direct, indirect, induced, and tax revenue), can be short-term or long-term. Building or upgrading a port to support offshore wind development can provide economic benefit during the upgrade, but not after. The same is true for construction and assembly of wind turbines at the port; these activities produce economic benefits until the construction and assembly is complete. Both of these offshore wind activities are examples of short-term economic benefits, as they are expected to be completed in the short-term (up to 5-years). In contrast, economic benefits are realized from operating and maintaining offshore wind resources over their operational life (25 to 30 years).

Economic Benefits of Offshore Wind Energy Development

Staff reviewed several studies to understand the potential economic benefits associated with port investments needed to support offshore wind activities. The studies made a number of differing assumptions about port locations and cost, the sourcing and content of materials (i.e. foreign v. domestic), as well as the scope of supply chain, the geographic scope of economic benefits, and the timing, technology, and sequencing of offshore wind deployment. The studies indicate that to realize the economic benefits of offshore wind, it must be developed at

56 Hamilton, Stephen F., Cyrus Ramezani, Christopher Almacen, and Ben Stephan. April 2021. *Economic Impact of Offshore Wind Farm Development on the Central Coast of California*. California Polytechnic State University. https://reachcentralcoast.org/wp-content/uploads/Economic_Value_OSW_REACH.pdf.

scale. Developing at scale will require seaports and associated waterfront facilities with sufficient capacity to meet industry needs, which requires investment.

In its August 2022 report titled *Offshore Wind Energy Development off the California Coast, Maximum Feasible Capacity and Megawatt Planning Goals for 2030 and 2045*, the CEC explained that the largest economic benefits for California from an offshore wind industry would be realized with the development of a local supply chain where offshore wind components such as floating platforms, towers, mooring lines, and anchors could be manufactured in-state. The report discussed two studies in this regard. A University of Southern California (USC) Schwarzenegger Institute for State and Global Policy study published in 2021 and a study by the U.C. Berkeley Center for Labor Research and Education. [57]

The USC study provided a broad analysis of the economic potential of offshore wind development in California including direct benefits and various co-benefits. According to the study, economic benefits include job gains and resource cost savings of at least $1 billion annually in providing clean electricity. Based on an assumption of 10 GW by 2040, the study estimated job gains of 97,000 to 195,000 job-years through 2040 for the construction of the wind generating facilities and another 4,000 to 4,500 annual operation and maintenance jobs, which is equivalent to an additional 120,000 to 180,000 job-years of employment. [58,59]

Importantly, the USC study compared scenarios with different levels of in-state manufacturing of offshore wind project components. The study found that scenarios with higher in-state manufacturing substantially increased projected employment and economic benefits to California from offshore wind development.[60] To encourage development of a local supply chain, sufficient future offshore wind projects should be identified and begin development in order to provide confidence in the market and support early investment.

The American Jobs Project (AJP) studied the potential for offshore wind to create jobs in California.[61] The study suggests that a California offshore wind industry has the potential to

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[57] *Adam Rose, Dan Wei, Adam Einbinder*, USC Schwarzenegger Institute for State and Global Policy. August 2021. CALIFORNIA'S OFFSHORE WIND ELECTRICITY OPPORTUNITY.
http://schwarzeneggerinstitute.com/images/files/OSW_Report.pdf

[58] One job-year measures one year of full-time work for one person. For example, 10 job-years could mean one person working full time for ten years, 5 people working full time for 2 years each, or even 10 people working full time for one year each.

[59] *Adam Rose, Dan Wei, Adam Einbinder*, USC Schwarzenegger Institute for State and Global Policy. August 2021. CALIFORNIA'S OFFSHORE WIND ELECTRICITY OPPORTUNITY.
http://schwarzeneggerinstitute.com/images/files/OSW_Report.pdf

[60] Ibid

[61] American *Jobs Project, Schatz Energy Research Center, Humboldt State University, Pacific Ocean Energy Trust, BVG Associates.* February 2019. The California Offshore Wind Project: A Vision for Industry Growth.
http://americanjobsproject.us/wp/wp-content/uploads/2019/02/The-California-Offshore-Wind-Project.pdf

bring in new investment from new "industrial clusters" to support a domestic supply chain that could displace imported sources of equipment with local production. The study describes clusters as regionally situated groups of interconnected companies and institutions engaged in a particular industry and supported by repeated exchanges of information and resources. The study concluded that cluster development requires comprehensive planning and strong leadership. According to the AJP report, in industries dependent on offshore wind, studies have shown that clusters can expand access to talent and boost economic activity. The report suggests that if California pursues cluster-based strategies to achieve 18 GW of installed offshore wind capacity by 2045 and strengthen its supply chain to serve local projects, the industry could support over 17,500 full-time California jobs in 2045.[62] That is more than 1,700 jobs per year, assuming 17,500 jobs are created from 2036 through 2045.

The National Renewable Energy Laboratory (NREL) and Bureau of Ocean Energy Management (BOEM) studied two hypothetical, large-scale offshore wind deployment scenarios for California: A 16 GW by 2050 scenario and a 10 GW by 2050 scenario.[63] The BOEM/NREL study indicates total state gross domestic product (GDP) impacts of $16.2 billion from construction plus an additional $3.5 billion for long-term operations and maintenance for the 10 GW scenario. The 16 GW scenario would result in $39.7 billion total state GDP impacts from construction plus and $7.9 billion for long-term operations and maintenance.[64] Both scenarios assume that large equipment would be produced in California, including nacelles and towers, as well as smaller equipment and other materials and services. The study also indicates that establishing an in-state supply chain can dramatically increase the economic impact of offshore wind deployment.

The estimates in these studies assume that necessary seaports and associated waterfront facilities will be in place. In contrast, a California Polytechnic State University (CPSU) analysis[65] [66] dated April 3, 2021, considered construction, and use of a specialized wind port in the central coast region based on 7 GW of offshore wind projects in and around the BOEM-identified Morro Bay call area. CPSU estimated that the construction of this port over a five-year period from 2024-2028 would create approximately 1,100 construction jobs per year

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[62] Ibid

[63] Page 15 Table 4-1 and page 17 Table 4-3. *Bethany Speer, David Kaiser, Suzanne Tegen*, National Renewable Energy Laboratory, Bureau of Ocean Energy Management. April 2016. Floating Offshore Wind in California: Gross Potential for Jobs and Economic Impacts from Two Future Scenarios. Accessed at: https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Pacific-Region/Studies/BOEM-2016-029.pdf

[64] Ibid

[65] Hamilton, Stephen F., Cyrus Ramezani, Christopher Almacen, and Ben Stephan. April 2021.Table 4.1, page 47 *Economic Impact of Offshore Wind Farm Development on the Central Coast of California*. California Polytechnic State University. https://reachcentralcoast.org/wp-content/uploads/Economic_Value_OSW_REACH.pdf.

[66] The study used an Input-Output model called "REMI PI+" to evaluate the economic benefits of adding 7 GW of offshore wind to an expanded version of the Morro Bay call area.

using a local workforce.[67] The study assumed that the floating structures, towers, and turbines would be manufactured outside the United States and transported to California.

The CPSU study further indicates that direct construction spending for a specialized wind port would result in local economic stimulus to San Luis Obispo County of $2.02 billion (or $405 million per year for 5 years) and create approximately 11,825 full-time equivalent (FTE) jobs (or 2,365 per year for 5 years). [68] This would also stimulate the economy of neighboring counties, providing 234 jobs and $39 million in economic output to Santa Barbara County and 28 jobs and $5.8 million in economic output to Monterey County.[69] Therefore, the overall impact to California, including spill-over impacts to other regions, is $3.00 billion (or $599 million per year for 5 years) and the creation of 15,925 FTE jobs (or 3,185 annually for 5 years).[70] Another study found as many as 13,620 direct annual jobs in manufacturing, construction, and installation, and up to 4,330 permanent jobs in operations and maintenance from 2040 through 2050.[71]

Necessary Seaport and Waterfront Facility Investments to Realize Economic Benefits

California ports and waterfront facilities supporting the offshore wind industry would need to be upgraded to support offshore wind development activities. These activities include constructing and assembling the offshore wind turbines and components, staging and storing offshore wind turbine equipment, transporting and installing the offshore wind turbines at the offshore site, and operation and maintenance activities. Depending on port development strategies and needs, port sites could require onsite space to manufacture, construct, store, and assemble wind farms, and perform operations and maintenance of them. Additionally, wet storage or water locations within ports where foundations or fully integrated turbine systems can be moored until they are transported to final locations for install will be important. Industrial equipment like heavy lift cranes may also be needed to enable the ports to construct and conduct operations and maintenance on offshore wind turbines.

Along with investments to the dry port areas, berths and navigation channels may also require dredging, so they are wide and deep enough to accommodate offshore wind turbines being transported in and out of ports. Impacts to the navigation channel, like sea level rise and dredging needs should be considered when planning upgrades. However, the scope of these

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67 Ibid

68 Ibid

69 Ibid

70 Ibid

71 *Center for Labor Research and Education, University of California, Berkeley.* Collier, Robert, Sanderson Hull, Oluwafemi Sawyerr, Shenshen Li, Manohar Mogadali, Dan Mullen, and Arne Olson. September 2019. *California Offshore Wind: Workforce Impacts and Grid Integration*. https://laborcenter.berkeley.edu/pdf/2019/CA-Offshore-Wind-Workforce-Impacts-and-Grid-Integration.pdf

upgrades is somewhat uncertain and vary depending on the type of floating structures used. Some designs require more draft (water depth) because the floating components have more weight and therefore more dredging in berth may be needed, at additional cost. Furthermore, based on the design of each component or substructure, the amount of space needed for construction and assembly, and the weight bearing capacity, may differ.

Port construction requires both labor and materials. Port upgrades can create construction jobs, labor income, and add to GSP. Economic benefits may also come from increased purchase and sales of construction materials and specialized equipment such as heavy lift cranes. Port upgrades could also create induced economic benefits from construction workers spending in the local area based on increased wages and income.

Although port construction jobs may be temporary, they can provide direct and indirect economic benefits. The direct benefits would come from construction job creation and output (in dollars) from the construction upgrades, that could directly impact port operations. Indirect economic benefits would come from purchases of materials and equipment needed to upgrade the port, but do not directly impact port operations (from supply chain activity). For example, an asphalt provider or steel manufacturer, that hires more labor, can directly support the needs of the port upgrades, but it does not have a direct impact on the port operations. Tax revenue can be generated from increased port property value and labor wages can contribute to direct and indirect benefits.

Considering the upgrades and capabilities that may be needed to develop floating offshore wind and the expected cost of transporting both equipment and workers from ports to wind farm locations, California may need more than a single port to support the emerging offshore wind industry and a multi-port strategy may be required. Moffat and Nichol examined existing seaports along the California coast and found that more than 10 port terminal sites may be needed to support California's offshore wind planning goal of 25 GW by 2045.[72] Further, additional economic benefits may be realized if industrial clusters are developed near ports where offshore wind related business units are geographically concentrated. This could enable economies of scale, reduce transportation and logistics costs, and reduce supply chain costs and issues.

In 2016, the Bureau of Ocean Energy Management (BOEM) assessed California's ports for capabilities to support offshore wind development and found that port capabilities would need to be addressed for California to realize economic benefits from offshore wind development.[73] They also found that the vessel fleet required to support offshore wind activities is less

[72] Moffatt & Nichol. October 31, 2022. "Status Update." Workshop on Assembly Bill 525: Assessing California's Seaports to Support Offshore Wind Energy. https://efiling.energy.ca.gov/GetDocument.aspx?tn=247222.

[73] Porter, Aaron, and Shane Phillips. March 2016. *Determining the Infrastructure Needs to Support Offshore Floating Wind and Marine Hydrokinetic Facilities on the Pacific West Coast and Hawaii*. US Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, Camarillo, CA. OCS Study BOEM 2016-011. https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Pacific-Region/Studies/BOEM-2016-011.pdf.

developed on the Pacific coast than in Europe. The exact vessel fleet for installation and maintenance could depend on offshore wind technology, availability, timelines, and other factors. BOEM also found that specific service vessels to be used for offshore wind development are not currently available on the West Coast and would likely need to be purpose-built to meet the demand of the high swell conditions in the Pacific Ocean.

In 2020, the Schatz Energy Research Center estimated the cost to upgrade the Port of Humboldt to support offshore wind activities (multi-use port[74,75]) between $100 million for a small 48 MW wind project, and $400 million to $750 million for a large 1,800MW project. Job and economic output impacts from building and operating an offshore wind project and an associated industry complex are also substantial. Construction impacts on California's economic output range from approximately $330 million from small 48 MW project to over $2.5 billion for large project of approximately 1,800 MW. This could create between 1,600 construction jobs for the small project and over 13,000 construction jobs for the large project. Annual operations and maintenance impacts to California's economic output range from approximately $3.2 million to about $117 million and could also create up to 960 new operations and maintenance jobs.

California Funding to Advance Seaport and Waterfront Facilities for Offshore Wind Activities

Recognizing that port and waterfront facilities are critical to opening the opportunity for offshore wind development in California, the state has already made early strategic investments to prepare port infrastructure that can support offshore wind activities.

In March 2022, the CEC approved a $10,450,000 million grant to the Humboldt Bay Harbor, Recreation, and Conservation District "Humboldt Harbor District" to support the development of a new multipurpose offshore wind marine terminal at the Port of Humboldt. The CEC grant is supporting early project efforts including environmental review studies and engineering and design work.

The Port of Humboldt is well suited to support offshore wind development in the North Coast. The Port is only 30 miles from the Humboldt lease areas, has no overhead lines or bridges that would obstruct port access, and has an existing 168-acre marine terminal where offshore wind components can be assembled and where vertical integration and on-site manufacturing can take place. However, heavy lift port facilities and infrastructure would need to be constructed before offshore wind development could occur.

The Humboldt Harbor District, in conjunction with local, state, and federal partners, has initiated a phased plan to develop the new Humboldt Bay Offshore Wind Heavy Lift Marine

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[74] A multi-use port is a port that can do construction, staging, assembly, and operations and maintenance activities for offshore wind.

[75] Hackett, Steve, and Julia Anderson (Schatz Energy Research Center). September 2020. *Economic Development Impacts*. http://schatzcenter.org/pubs/2020-OSW-R10.pdf.

Terminal. The Humboldt Harbor District will renovate the existing Redwood Marine Terminal which will include redeveloping underdeveloped or vacant industrial areas on the Samoa Peninsula along the Port of Humboldt Bay to support offshore wind activities.[76] The project will be designed as a multi-purpose heavy lift port facility that can attract and service one or more major offshore wind energy industry tenants. The project would also accommodate a variety of vessels and traditional port-based commerce to allow for a variety of other potential tenants and/or sub-tenants.

The proposed modern port facilities would repurpose the existing approximately six (6) acre Redwood Marine Terminal I (RMT I) and surrounding approximately 168-acre industrial area located adjacent to the east and southeast of the Town of Samoa in Humboldt County, California. The project area will be used for offshore wind component manufacturing and fabrication, marshalling, laydown, dockside vertical integration, and other associated and ancillary uses. The area may also be utilized for forest product manufacturing, decking, and laydown, as well as for upland aquaculture and related/ancillary uses and structures, and broadband data facilities and data centers associated with the adjacent existing trans-pacific fiber optic line.

The Humboldt Harbor District presented initial concepts for potential port upgrades to support offshore wind, including preliminary cost estimates to build a multipurpose marine terminal, at port of Humboldt, at its July 1, 2021, special committee meeting. The expected cost to upgrade the Port of Humboldt to support offshore wind is more than $120 million.[77]

In September 2022, Assembly Bill 209 (AB 209, Chapter 251, Statutes of 2022) authorized the CEC to create and administer a new program "to support offshore wind infrastructure improvements in order to advance the capabilities of California ports, harbors, and other waterfront facilities to support the buildout of offshore wind facilities and maximize the economic and environmental benefits of an offshore wind industry in California."[78] AB 209 includes the following eligible funding activities:

> (1) Category I activities support developing individuals or regional retrofit concepts for activities that may include planning feasibility and environmental analyses, business case development, engineering and design work, and other offshore wind energy related planning and development activities.

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[76] Humboldt Bay Harbor District. November 2021. *Request for Qualifications: Redwood Marine Multipurpose Terminal Replacement Project – Design and Permitting*. Accessed at: https://humboldtbay.org/sites/humboldtbay2.org/files/7591.21%20HBHRCD%20Multipurpose%20Terminal%20Replacement%20RFQ%2020211118_WithAttachments_0.pdf

[77] *Humboldt Bay Harbor, Special Meeting of Board Commissioners*. July 1, 2021. Accessed at: https://humboldtbay.org/meeting-documents-2021

[78] Assembly Bill 209, Section 25666. https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202120220AB209

(2) Category II activities support a range of retrofit activities to support deployment of offshore wind energy, including land expansion for component assembly, staging, and transportation, facility updates such as adding laydown and storage areas, increasing heavy-lift crane weight and height capabilities, and other improvements to support the long-term operation and maintenance of offshore wind generation facilities, and other offshore wind energy related design and development activities.

(3) Providing cost share funding to an eligible applicant that receives a federal award for purposes consistent with Category I or Category II activities. Moneys allocated pursuant to this paragraph shall be known as Category III funds.

(4) Preliminary engineering and environmental review work, including taking actions and preparing material to comply with the California Environmental Quality Act (Division 13 (commencing with Section 21000)) or federal environmental laws.

The 2022-2023 State Budget also appropriated $45 million to the CEC for this program, which will be developed in early 2023 following public process that allows for stakeholder and tribal input.

Experiences from the East Coast

While offshore wind is being deployed at scale on the East Coast, most of these deployments to date use fixed bottom technology, which is more mature than the floating offshore wind technology required on the West coast. The studies below provide insight into the level of investment and economic activity expected from seaport development.

New Jersey has allocated over $500 million in public funding to develop the New Jersey Wind Port (NJWP), which will be the first purpose-built offshore wind marshalling and manufacturing port in the United States[79] The project will have capability for staging, assembly, and manufacturing activities.[80] The NJWP is expected to create over 1,000 jobs and $500 million in economic output during construction using union workers and targeted hiring practices.[81] The New Jersey Offshore Wind Strategic Plan, developed in July 2020, provides a roadmap for the state to meet its offshore wind planning goal of 7,500 MW by 2035.[82] The plan found that building the NJWP would provide market confidence to developers and is critically important to meeting the state's 7,500 MW offshore wind planning goal by 2035. In February 2021, New

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[79] Bureau of Ocean Energy Management, New York, New Jersey. January 2022. *A Shared Vision on the Development of an Offshore Wind Supply Chain*. https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/BOEM%20NY%20NJ%20Shared%20Vision.pdf.

[80] New Jersey Office of the Governor. June 16, 2020. *Governor Murphy Announces Plan to Develop the New Jersey Wind Port: First Purpose-Built Offshore Wind Port in the U.S.* https://www.nj.gov/governor/news/news/562020/20200616a.shtml.

[81] Ibid.

[82] Ramboll US Corporation. July 2020. *New Jersey Offshore Wind Strategic Plan*. Draft. Prepared for New Jersey Board of Public Utilities and the Interagency Taskforce on Offshore Wind. https://www.nj.gov/bpu/pdf/Draft_NJ_OWSP_7-13-20_highres.pdf.

Jersey allocated $200 million to invest in the NJWP.[83] The New Jersey Economic Development Authority (NJEDA) released a notice to sublease property for offshore wind development at the wind port [84,85,86] and received 16 non-binding offers in October 2021 from six of the largest turbine manufactures and offshore wind developers in the world. Offshore wind activities, including manufacturing, construction, and operations and maintenance, are expected to produce thousands of jobs per year, and up to $500 million in economic output per year.

In January 2018, the New York State Energy Research and Development Authority (NYSERDA) published *The New York State Offshore Wind Master Plan* (Master Plan).[87] As part of developing the Master Plan, NYSERDA conducted an assessment of existing ports and infrastructure to better understand which ports and waterfront facilities could potentially be used to support construction and maintenance of offshore wind farms.[88] In 2019 New York passed the Climate Leadership and Community Protection Act, which calls for the development of 9 GW of offshore Wind by 2035.[89] In January 2022, New York Governor Kathy Hochul announced a plan to advance New York's offshore wind industry, including a $500 million investment in offshore wind port infrastructure and supply chain development, bringing the state's total public commitment to offshore wind to $700 million to date.[90] These investments are expected to leverage more than $2 billion in private capital while creating more than 2,000

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83 State of New Jersey. February 23, 2021. *Governor Murphy Presents Fiscal Year 2022 Budget: Investing in a Stronger, Fairer, and More Resilient Post-Pandemic New Jersey*.

84 New Jersey Economic Development Authority. October 28, 2021. "Global Offshore Wind Leaders Submit Offers for Space at NJ Wind Port." Press release. https://www.njeda.com/global-offshore-wind-leaders-submit-offers-for-space-at-nj-wind-port/.

85 State of New Jersey. "New Jersey Wind Port." https://nj.gov/windport/index.shtml.

86 New Jersey Economic Development Authority. 2020. "2020-RFI-OET-NJ Wind Port Lease RFI-110- New Jersey Wind Port Tenant Leasing Approaches." Expired Requests for Information. https://www.njeda.com/expired-rfis/. Accessed on September 27, 2022.

87 New York State Energy Research and Development Authority. *The New York State Offshore Wind Master Plan*. 2018. https://www.nyserda.ny.gov/-/media/Project/Nyserda/Files/Publications/Research/Biomass-Solar-Wind/Master-Plan/Offshore-Wind-Master-Plan.pdf

88 New York State Energy Research Development Authority, New York State Offshore Wind Master Plan: Assessment of Ports and Infrastructure. December 2017. https://www.nyserda.ny.gov/-/media/Project/Nyserda/Files/Publications/Research/Biomass-Solar-Wind/Master-Plan/17-25b-Assessment-of-Ports-and-Infrastructure.pdf

89 Climate Leadership and Community Protection Act, 2019

https://legislation.nysenate.gov/pdf/bills/2019/S6599

90 Presentation: New York Offshore Wind ORECRFP22-1, Supply Chain Investment Plan Approach, July 2022

https://www.nyserda.ny.gov/-/media/Project/Nyserda/Files/Programs/Offshore-Wind/NYSERDA-OSW-ORECRFP22-1_Supply-Chain-Webinar-Presentation-Slides.pdf jobs.[91] Additionally, the United States Department of Transportation's Maritime Administration's Funding Opportunity Announcement via the Port Infrastructure Development Program awarded New York's Port of Albany $29.5 million to develop a vacant industrial area into a tower manufacturing facility and the South Brooklyn Marine Terminal in New York $25 million to add a barge berth and an additional crane pad.[92]

As noted in **Figure 10**, both the port and supply chain facilities are being developed along more than 100 miles of Hudson River riverfront.

Figure 10: Port and Supply Chain Facilities Planned in New York

Source: New York State Energy Research and Development Authority

In June 2019, Maine launched an offshore wind initiative with $2 million in grant funding to explore offshore wind opportunities and develop a roadmap for floating offshore wind in the

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[91] New York State of the State: A New Era for New York, 2022

https://www.governor.ny.gov/sites/default/files/2022-01/2022StateoftheStateBook.pdf

[92] United States Department of Energy, Office Energy Efficiency & Renewable Energy. *Offshore Wind Market Report: 2022 Edition*.

https://www.energy.gov/sites/default/files/2022-08/offshore_wind_market_report_2022.pdf

Gulf of Maine.[93,94,95] In November 2019, the Maine Department of Economic and Community Development created a ten-year economic development strategy (2020-2029), which found that developing offshore wind can be a major economic driver for Maine. [96]

In August 2021, the Port of Virginia secured a $20 million grant from the US Department of Transportation for upgrades to the Portsmouth Marine Terminal to support offshore wind development.[97] Dominion Energy agreed to lease the Portsmouth Marine Terminal and is developing 72 acres for deep-water multi-use, including as a staging and pre-assembly area for foundations and turbines.[98] Port construction and readiness is expected to create 900 direct and indirect jobs between 2020 -2026, and once construction complete, annual operations and maintenance of the offshore wind facilities will support 1,100 direct and indirect jobs. Up to 5,500 additional jobs could be created as new business is attracted to the area.

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93 Maine Offshore Wind Initiative. 2019. *Maine Offshore Wind Initiative*. Accessed at: https://www.maineoffshorewind.org/about/

94 Partner agencies involved with the offshore wind initiative: Department of Transportation, Department of Environmental Protection, the Department of Marine Resources, Maine Technology Institute, and the Maine International Trade Center.

95 United States Economic Development Administration. October 2020. Press Release. *U.S. DEPARTMENT OF COMMERCE INVESTS $2.166 MILLION TO SUPPORT DEVELOPMENT OF OFFSHORE WIND POWER INDUSTRY IN MAINE*. Accessed at: https://www.eda.gov/archives/2021/news/press-releases/2020/10/01/augusta-me.htm

96 Maine Department of Economic and Community Development. November 2019. *Maine Economic Development Strategy 2020 – 2029, a Focus on Talent and Innovation*. Accessed at: https://www.maine.gov/decd/strategic-plan

97 Adrijana Buljan, December 2021. https://www.offshorewind.biz/2021/12/24/two-us-offshore-wind-ports-secure-nearly-usd-50-million-in-federal-grants/.

98 Potential Impact of the Offshore Wind Industry on Hampton Roads and Virginia, Magnum Economics, September 2020

CHAPTER 4: Economic Benefits from Offshore Wind Investments as they Relate to Workforce Development Needs and Standards

Creating a durable domestic floating offshore wind industry in California can provide good paying jobs and career paths for Californians, particularly those in communities near ports and waterfront facilities. To ensure these opportunities are realized California will need to develop a skilled and trained workforce capable of developing offshore wind to meet AB 525's offshore wind planning goals of 2-5 GW for 2030 and 25 GW for 2045. The skilled workforce will include jobs in construction, manufacturing, engineering, operations and maintenance, sales, and maritime services. Many other jobs will also be created, such as longshoreman, tugboat and other watercraft operators. This chapter discusses the need for an offshore wind-ready workforce and some of the skills and training that may be needed to capture economic benefits, as well as studies and experiences from the East Coast and Europe related to workforce investments.

Workforce Needs for Offshore Wind

A wide range of skill sets and occupational types will be required for the offshore wind workforce. NREL has determined that offshore wind jobs "represent an inclusive workforce, which requires many different occupations, roles, and skillsets. Manufacturing and supply chain will support plant-level workers, plant-level management, design and engineering, quality and safety, and facilities maintenance.[99] Plant-level workers typically are highly skilled roles, such as welders, electricians, machine operators, and assemblers.[100] Plant-level management oversees the plant-level workers and includes roles such as production engineers, manufacturing engineers, and plant and operations managers.[101] Design and engineering roles support component design prior to production, such as design engineers, testing engineers, and supply chain analysts.[102] Facilities maintenance workers are typically in supervisor and technician roles that ensure the plant is operating by performing preventative and corrective maintenance. **Figure 11** below shows of the types of occupations needed for

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[99] Shields, Matt, Ruth Marsh, Jeremy Stefek, Frank Oteri, Ross Gould, Noé Rouxel, Katherine Diaz, Javier Molinero, Abigayle Moser, Courtney Malvik, and Sam Tirone. 2022. The Demand for a Domestic Offshore Wind Energy Supply Chain. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5000-81602

[100] Ibid

[101] Ibid

[102] Ibid

the offshore wind workforce, by percentage of overall workforce. A wide range of skill sets and occupational types will be required for the offshore wind workforce.

Most economic benefits from offshore wind workforce development will be from good-paying jobs created in the manufacturing and supply chain sectors. These jobs will be realized across the state, as the offshore wind supply chain matures and offshore wind businesses acquire materials, services, and parts from across California, comprised of long-lasting (more than 30 years) and be good-paying jobs in the trades and technical skills that do not require a bachelor's degree.

Jobs related to environmental monitoring during the permitting, construction, operation, maintenance, and decommissioning of offshore wind farms can also generate economic benefits. Creating an offshore wind workforce can yield numerous other types of economic benefits as good-paying jobs ripple throughout the state economy.

Creating a new workforce will yield numerous types of economic benefits, where the impact of the thousands of good-paying jobs will ripple throughout the state economy. Offshore wind-related income will be spent back into local, regional, and greater state economies, bolstering economic activity throughout the state but especially around large supply chain facilities where hundreds of jobs could be created. In addition to the direct benefits of creating thousands of new good-paying jobs, systemic economic benefits can also be realized from workforce development. These types of benefits include improved quality of life, property value increases, decreased unemployment, integrated equitable hiring, increased fiscal tax revenues, and increased human capital.

Due to the proximity to offshore wind farms and local communities, seaports will be a focal point for workforce development, and most of the offshore wind industry jobs created will be at the ports. This is especially true for multi-use ports that do manufacturing, construction, assembly, and maintenance activities as most of economic benefits from offshore wind workforce development are expected to come from creating these good-paying jobs centered at ports. Some studies estimate that upwards of 80 percent of the offshore workforce could be in the supply chain.[103] It will take time for this new industry to attract and develop manufacturers, fabricators, and assembly facilities, and offshore wind projects will likely rely on materials and components from the East Coast and abroad while supply chain businesses develop in California. This scenario implies that benefits from the supply chain workforce will initially be low and increase significantly over time as the supply chain matures.

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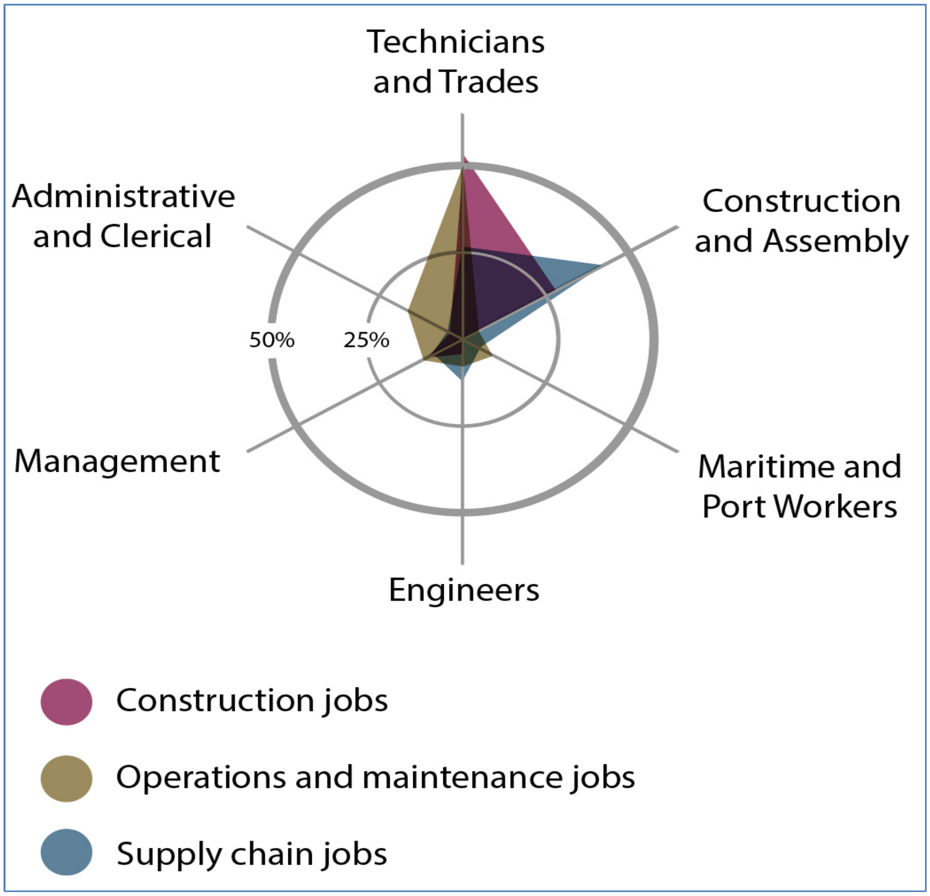
[103] Jeremy Stefek, Chloe Constant, Caitlyn Clark, Heidi Tinnesand, Corrie Christol, Ruth Baranowski. National Renewable Energy Laboratory. October 2022. U.S. Offshore Wind Workforce Assessment. Accessed at: https://www.nrel.gov/docs/fy23osti/81798.pdf

Figure 11: Radar Graph of Workforce Skills by Job Sector



Source: BVG 2017[104]

California supports the national offshore wind energy goal of 30 GW by 2030, and a related national domestic supply chain and workforce. However, much of the workforce and supply chain for California's floating offshore wind industry is expected to come from residents in the regions near the ports and waterfront facilities or from elsewhere within the state. In a joint letter to BOEM on the PACW-1 proposed sale notice, nine California state agencies supported BOEM's proposal for a multiple factor bidding auction format with opportunities for bidders to pursue monetary and nonmonetary bidding credits. In particular, the agencies supported supply chain investments necessary to develop *floating* technologies because the Pacific Outer Continental Shelf is suitable only for floating technologies.

The BOEM *Pacific Wind Lease Sale 1 (PACW–1) for Commercial Leasing for Wind Power on the Outer Continental Shelf in California—Final Sale Notice* (final sale notice), issued October 21, 2022, set December 6, 2022, as the auction date. BOEM utilized a multiple-factor auction

[104] BVG Associates Limited, 2017. *U.S. Job Creation in Offshore Wind A Report for the Roadmap Project for Multi-State Cooperation on Offshore Wind.* Report prepared for NYSERDA, Massachusetts Clean Energy Center, Massachusetts Department of Energy resources, Rhode Island Office of Energy Resources, Clean Energy States Alliance, October. Available at: https://www.cesa.org/wp-content/uploads/US-job-creation-in-offshore-wind.pdf

format, with a multiple-factor bidding system, for the lease sale. Under this system, BOEM considered a combination of a monetary bid and bidding credits to determine the outcome of the auction. Bidding credits are designed to enhance, through training, the offshore wind workforce; stand-up the domestic supply chain for offshore wind manufacturing, assembly, or services; or mitigate potential impacts stemming from Lease Area development. To qualify for the workforce training and/or supply chain development bidding credit, the bidders needed to commit to making qualifying monetary contribution to programs or initiatives that support workforce training programs and development of a United States domestic supply chain for the offshore wind energy industry, or both.

The contribution to workforce training must result in a better trained and/or larger domestic offshore wind work force that would provide more efficient operations via an increase in the supply of fully trained personnel. The contribution for workforce training and/or domestic supply chain development can be made in support of existing programs, or for the establishment of new programs or incentives. This includes activities associated with the planning, design, construction, operation, maintenance, or decommissioning of offshore wind energy projects, or manufacturing or assembling of their components, in the United States.

The contribution to domestic supply chain development must result in a more stable domestic supply chain by reducing the upfront capital or certification cost for manufacturing offshore wind components, including the building of facilities, the purchasing of capital equipment, and the certifying of existing manufacturing facilities. It must also result in overall benefits to the offshore wind supply chain for all potential purchasers of offshore wind services, components, or subassemblies, not solely the Lessee's project. In addition, the contribution must result in either the demonstrable development of new domestic capacity (including vessels) or the demonstrable buildout of existing capacity.[105]

Needs, Standards, and Requirements for an Offshore Wind Workforce

A majority of the new offshore wind-related workforce will require training and/or certification that matches the pace of deployment for offshore wind, particularly the construction and supply chain workers. Since floating offshore wind will be a new industry in California, there will be a need for new training standards, curriculums, and facilities to create a trained and skilled offshore wind workforce that can match the pace of floating offshore wind development. A competent and skilled workforce can attract private investors that seek a capable and reliable workforce. States on the East Coast have invested in training centers that can consistently produce workers with the appropriate skill sets in supply chain production and offshore wind construction.

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[105] BOEM. May 2022. *Draft Bidding Credits – Requirements and Restrictions.* https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/CA%20BFF%20Addendum.pdf

According to NREL, "timing is critical for workforce development in the manufacturing and supply chain industry segment."[106] The number of jobs is expected to increase throughout this decade (2022-2030) at different rates for each component. For example, floating platforms may start production much sooner than nacelle assembly facilities.[107] It is likely that the initial components will be imported into the United States while domestic manufacturing and supply chain facilities are built, suppliers are contracted to provide parts and materials, and a domestic workforce is trained and hired. [108,109] Educational institutions, unions, original equipment manufacturers, and developers could work together to ensure workers are adequately trained and ready to hire as United States manufacturing begins production.[110]

NREL further notes that manufacturing and supply chain occupations will have the largest potential demand if United States-based suppliers are used to produce subcomponents, parts, and materials for offshore wind energy components. Many of these roles are also in high demand in other industries; therefore, it should be a high priority for workforce development efforts to attract and retain workers in these roles. The manufacturing and supply chain occupations can be categorized into six main types: regional professionals, factory-level management, design and engineering, quality and safety, factory level worker, and facilities maintenance.

Port and staging occupations can be categorized into four main types: marine crew, terminal crew, port and logistics management, and facilities management. The marine crew comprises: staff who work on the shipping vessel that brings the materials and products to be stored and deployed for the offshore wind installation or maintenance; staff and pilots who work on the tugboats that help guide the shipping vessel into the harbor and correct terminal. The port terminal crew includes those occupations that are involved with docking the shipping vessel, as well as receiving, inspecting, and documenting the material and products at the terminal and transporting the material and products to the marshalling area.

Occupations for installation vessels can generally be grouped into three categories; the marine crew responsible for vessel-specific operating activities, the project crew who oversee the installation activities, engineering, and crew safety and quality control, and the construction

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106 Jeremy Stefek, Chloe Constant, Caitlyn Clark, Heidi Tinnesand, Corrie Christol, Ruth Baranowski. National Renewable Energy Laboratory. October 2022. *U.S. Offshore Wind Workforce Assessment*. Accessed at: https://www.nrel.gov/docs/fy23osti/81798.pdf

107 A nacelle is the part of the wind turbine that consists of a generator, low- and high-speed shafts, gearbox, brake, and control electronics.

108 Ibid

109 Ibid

110 Ibid

crew who complete the installation. Because these jobs operate in an offshore environment, offshore-specific health, safety, and environmental training is required for these roles.[111]

Offshore wind operations and maintenance occupations are generally categorized into two types: the onshore operations and maintenance crew and offshore wind plant operations crew. There are three worker categories on the operations and maintenance crew – wind turbine technicians, onshore (office) staff, and foundation and support structure maintenance engineers. The foundation and support structure maintenance engineers are structural specialists, usually with a bachelor's degree and engineering license in civil or structural engineering, surveying, or a related field.

To support the offshore wind planning targets and industry needs, different types of apprenticeship, safety requirements, and training programs will be needed to prepare the workforce. Examples of California apprenticeship programs that may be related to offshore wind include the following:[112]

- Carpentry
- Cement masons
- Electric services
- Electrical and electronic machinery, equipment, and supplies
- Engineer
- Fabricated metal products
- Sheet metal
- Iron – steel workers
- Water transportation
- Lineman
- Transportation Equipment

Resources are available at the state level to potentially fund workforce development. For example, the California Workforce Development Board (CWDB) high road construction careers initiative includes the following: career building partnerships, pre-apprenticeship partnerships

[111] For example, Basic Offshore Safety Induction and Emergency Training or Global Wind Organization safety training.

[112] California Division of Apprenticeship Standards. California Apprenticeship Registration Dashboard. https://public.tableau.com/app/profile/california.apprenticeship/viz/RegistrationDashboard_16301055851260/RegistrationDashboard. Updated: September 18, 2022. Accessed September 27, 2022.

that connect programs/projects directly to regional labor market demand, apprenticeship readiness programs, community workforce agreements, and targeted hiring.[113]

The CWDB and other stakeholders are also working to advance best practices and support development of an equitable clean energy workforce applying key concepts from *Putting California on the High Road: A Jobs and Climate Action Plan for 2030,* including the following:[114]

- Labor should be considered an investment rather than a cost, because well-trained workers are key to delivering GHG emissions reductions and moving California closer to its climate targets.
- Identifying high-quality careers that offer family-supporting wages, employer-provided benefits, worker voice, and opportunities for advancement, along with building pathways into such careers, is critical to ensuring investments in workforce education and training meaningfully improve workers' economic mobility.
- Deliberate policy interventions are necessary to advance job quality and social equity as California transitions to a carbon-neutral economy.

Experiences from Europe and East Coast Workforce Development and Training for Offshore Wind

The Berkeley Labor Center (Berkeley) assessed the fixed-bottom offshore wind experiences from other countries to provide lessons learned for California.[115] While not identical to experience expected with floating offshore wind development, many of the experiences are valuable in assessing workforce issues. The report found the United Kingdom had success in developing offshore wind because of its strong apprenticeship systems and government support. However, they found that local job growth would have been stronger if the government had adopted policies that supported local supply chain and manufacturing. Applying these lessons, California could provide direct subsidies to ports for infrastructure upgrades that use local materials and encourage the use of project labor agreements and other measures to ensure labor and materials are sourced locally. Bid credits for developers

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[113] California Workforce Development Board. 2022. "California High Road Construction Careers." Accessed September 1, 2022.

[114] Zabin, Carol, Roxane Auer, J. Mijin Cha, Robert Collier, Richard France, Jenifer MacGillvary, Holly Myers, Jesse Strecker, and Steve Viscelli. June 2020. *Putting California on the High Road: A Jobs and Climate Action Plan for 2030*. UC Berkeley Labor Center. https://laborcenter.berkeley.edu/wp-content/uploads/2020/09/Putting-California-on-the-High-Road.pdf.

[115] Collier, Robert, Sanderson Hull, Oluwafemi Sawyerr, Shenshen Li, Manohar Mogadali, Dan Mullen, and Arne Olson. September 2019. *California Offshore Wind: Workforce Impacts and Grid Integration*. Center for Labor Research and Education, University of California, Berkeley. https://laborcenter.berkeley.edu/pdf/2019/CA-Offshore-Wind-Workforce-Impacts-and-Grid-Integration.pdf.

who commit to community benefits agreements, with local and targeted hiring requirements, could help incentivize developers to use local content in their projects.

Berkeley found that in Germany, government feed-in tariffs and port investments helped offshore wind remain competitive and kept manufacturing and supply chain jobs local. Denmark had success in building its offshore wind industry, with local job creation, by investing in its ports and centralizing the permitting process for offshore wind plants. From decades of experience with offshore wind, the Danish Energy Agency highlights the importance of local hiring provisions and local support for projects.[116]

A recent study of factors contributing to selection of local suppliers for offshore wind projects in Europe found that developing local industries for offshore wind farms can be advanced through local content requirements combined with "concerted system building strategies, such as investments in knowledge production, activating networking opportunities and facilitating entrepreneurial activity."[117]

For the United States East Coast, a Rhode Island study found that strong project labor agreements and adaptable apprenticeship programs helped create local jobs and economic benefits. For New York, proactive offshore wind government policy support, project labor agreements, and strengthening the exiting training infrastructure helped the growth of offshore wind and the creation of local jobs. The East Coast has been investing in workforce development to support fixed-bottom offshore wind. In 2021, the New York State Energy Research and Development Authority (NYSERDA) partnered with the State University of New York to create the New York Offshore Wind Training Institute.[118] The partnership invested $20 million in the training institute to train 2,500 workers to meet New York's goal of developing 9,000 MW of offshore wind by 2035.

Through the training institute funds ($9 million), NYSERDA is seeking proposals for training initiatives to address offshore wind training gaps and to prepare workers for high-growth jobs,

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[116] Danish Energy Agency. March 2017. *Danish Experiences from Offshore Wind Development*. https://ens.dk/sites/ens.dk/files/Globalcooperation/offshore_wind_development_0.pdf.

[117] van der Loos, A., R. Langeveld, M. Hekkert, S. Negro, and B. Truffer. January 2022. "Developing Local Industries and Global Value Chains: The Case of Offshore Wind." *Technological Forecasting and Social Change*, 174, 121248. https://doi.org/10.1016/j.techfore.2021.121248. For a comparative study highlighting the importance of local contextual factors on the successful development of local manufacturing of offshore wind components, see van der Loos, A., H. E. Normann, J. Hanson, and M. P. Hekkert. March 2021. "The Co-evolution of Innovation Systems and Context: Offshore Wind in Norway and the Netherlands." *Renewable and Sustainable Energy Reviews*, 138, 110513. https://doi.org/10.1016/j.rser.2020.110513.

[118] New York State Energy Research and Development Authority. *SUNY and NYSERDA Launch Offshore Wind Training Institute to Train 2,500 Worker*. January 2021. Accessed 10/28/22. Accessed at: https://www.nyserda.ny.gov/About/Newsroom/2021-Announcements/2021-01-13-SUNY-NYSERDA-Launch-Offshore-Wind-Training-Institute

including electricians, metal workers, and construction workers. [119] High schools, colleges, labor unions, original equipment manufacturers, developers, and trade associations can provide training. The funding can be used for activities to prepare workers for offshore wind jobs, including curriculum development, training equipment, pre-apprenticeship programs, internships and mentorships, and screening and recruitment.

In 2022, NYSDERA studied the potential workforce gaps in developing fixed-bottom offshore wind in the state of New York.[120] NYSDERA found that most job growth will be in construction, manufacturing, and from induced economic benefits (induced industries); manufacturing and construction will account for more than half of total job growth. The study found that the largest workforce gaps are for plant and system operators, hoist and winch operators, continuous mining and machine operators, and wind turbine service technicians. Lastly, the study found that there may be a lack of training program offerings for wind turbine service technicians and computer numerically controlled machinists.

Environmental Entrepreneurs (E2) estimated the potential economic benefits from assembling, constructing, and doing operations and maintenance on offshore wind farms in five eastern states.[121] The study assumes each state builds a 352 MW offshore wind farm and operations will start in the early 2020s.[122] The E2 study did not mention the amount of local content for each wind farm, and, unlike other studies, this study did not estimate induced economic benefits, just direct and indirect. For assembly and construction of offshore wind plants, the study projects each state can support 4,000 to 5,000 jobs annually and create economic output in the range of $600 million to $800 million. For long-term operations and maintenance, the study estimates that each state can support between 100 and 200 jobs per year and create between $20 million and $30 million in economic output annually.

Based on the studies evaluated it is clear a comprehensive workforce will be needed to support the development of the offshore wind industry in California and will require significant investment to capture the potential economic benefits. Workforce benefits tend to scale with the deployment of offshore wind development, with more jobs associated with higher offshore wind generation goals.

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[119] New York State Energy Research and Development Authority. *New York State Offshore Wind Training Institute - Workforce Training and Skills Development*. Accessed 10/28/22. Accessed at:

Offshore-Wind-Training-Institute-Workforce-Training-and-Skills-Development.

[120] BW Research Partnership. 2022. *2022 New York Offshore Wind Workforce Gap Analysis*. New York State Energy Research and Development. https://www.nyserda.ny.gov/-/media/Project/Nyserda/Files/Programs/Offshore-Wind/2022-New-York-State-Workforce-Gap-Analysis.pdf.

[121] E2. August 2018. Offshore Wind, Generating Economic Benefits on the East Coast. Accessed at: https://www.e2.org/wp-content/uploads/2018/08/E2-OCS-Report-Final-8.30.18.pdf

[122] The E2 study estimated economic benefits for five states: New York, New Jersey, South Carolina, North Carolina, and Virginia.

Federal Funding Opportunities to Support Offshore Wind Development

California is pursuing recent Federal funding made available by the recent Inflation Reduction Act of 2022 (IRA)[123] and the Infrastructure Investment and Jobs Act (IIJA)[124], along with DOE funding, to support offshore wind development and investment in local floating offshore wind supply chains. These incentives and programs support growing the United States and California offshore wind supply chain and creating career paths and green energy jobs in local and disadvantaged communities.

The IRA can support offshore wind development and provide incentives to create economic benefits to California, including new tax credit for manufacturers of wind components and specialized offshore wind installation vessels that are produced domestically. Also, entities investing in establishing, reequipping, or expanding offshore wind manufacturing facilities, domestically, may be eligible for allocation of an advanced energy production credit. In addition, a technology-neutral production tax credit of $25/MWh is available (PTC) for renewable energy facilitates placed in service after 2024 if the renewable facility meets prevailing wage and apprenticeship requirements. The PTC increases if the renewable facility meets domestic content requirements and is in a brownfield site.[125] An investment tax credit for offshore wind up to 30% is available for projects that pay prevailing wage and meet registered apprenticeship requirements.[126] An additional $100 million was appropriated to conduct analysis related to interregional transmission development and transmission for offshore wind.

The IIJA makes available funds that can support floating offshore wind deployment. The Wind Energy Technology Program provides $60 million in funding for research, development, demonstration, and commercialization activities to improve wind energy technologies. The Wind Energy Technology Recycling Research & Development Program provides $40 million in funding for developing alternative materials, designs, manufacturing processes. It can also fund disassembly and resource recovery processes for wind energy technologies. The Port Infrastructure Development Program provides $2.25 billion in competitive grants for modernization and expansion of United States ports. These funds can be used for projects that improve the resiliency of ports to address sea-level rise, flooding, extreme weather events,

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123 Inflation Reduction Act of 2022. HR 5376. 117th Congress (2021-2022). https://www.congress.gov/bill/117th-congress/house-bill/5376/text.

124 Government Finance Officers Association. *Infrastructure Investment and Jobs Act (IIJA) Implantation Resources*. https://www.gfoa.org/the-infrastructure-investment-and-jobs-act-iija-was

125 The PTC also increases for certain metropolitan statistical areas, or areas with high unemployment, where a percentage of the employment previously came from natural gas extraction, processing, or storage.

126 Additionally, projects meeting certain domestic content requirements may be eligible for a bonus 10% credit if they meet wage and workforce requirements. Finally, projects may be eligible for a 10% credit if located in a brownfield site or fossil fuel community.

earthquakes, and tsunami inundation, as well as projects that reduce or eliminate port-related criteria pollutant or greenhouse gas emissions.

Finally, the United States Department of Energy announced the FLOWIN prize investment opportunity on September 12, 2022, to grow a domestic manufacturing and supply chain capability to support the floating offshore wind energy. The total prize funding amount is $6.85 million and will be invested in three phases: commercialization and development of a domestic supply chain for floating platform technologies; planning for mass production and assembly of floating offshore wind energy platforms; and completing location-specific implementation pathways for the United States manufacture and deployment of floating offshore wind energy technologies.

Appendix A: List of Acronyms

AB — Assembly Bill

ATB — Annual Technology Baseline

BOEM — Bureau of Ocean Energy Management

CEC — California Energy Commission

CLV — cable laying vessel

CNRA — California Natural Resources Agency

CTV — crew transfer vessel

CBA — community benefits agreements

CPUC — California Public Utilities Commission

CZMA — Coastal Zone Management Act

DOE — U.S. Department of Energy

DOI — U.S. Department of the Interior

EPIC — Electric Program Investment Charge

GDP — gross domestic product

GSP — gross state product

GW — gigawatt

HLV — heavy lift vessel

IRP — integrated resource planning

ISO — Independent System Operator

ITC — Investment Tax Credit

LCOE — levelized cost of energy

LSE — load-serving entities

MW — megawatt

nm — nautical miles

NREL — National Renewable Energy Laboratory

OCS — outer continental shelf

PSP — Preferred System Plan

PLA — Project labor agreement

SB — Senate Bill

SOV — Service operations vessel

SPV — Scour protection vessel

TPP — transmission planning process

USC — University of Southern California

WEA — Wind Energy Area

APPENDIX B: Glossary of Terms

Barge: A large, flat-bottomed boat used to carry cargo that is typically navigated and powered by a tug or towboat

Berth: The space at a terminal at which a ship docks. A terminal may have multiple berths, depending on the length of incoming ships.

Breakwater: a barrier built into a body of water to protect a coast or harbor from the ocean wave conditions

Cargo: The freight (goods, products) carried by a ship, barge, train, truck, or plane.

Dock: A dock is a structure built along, or at an angle from, a navigable waterway so that vessels may lie alongside to receive or discharge cargo.

Gigawatt (GW): One thousand megawatts (1,000 MW) or, one million kilowatts (1,000,000 kW) or one billion watts (1,000,000,000 watts) of electricity. One GW is enough to supply the electric demand of about one million average California homes.

Harbor: A sheltered location where ships may anchor.

Levelized Cost of Energy (LCOE): The average total cost of an energy generation project per unit of total electricity generated. Also referred to as the levelized cost of electricity or the levelized energy cost (LEC), LCOE is a measurement to assess and compare alternative methods of energy production. The LCOE of an energy-generating asset can be thought of as the average total cost of building and operating the asset per unit of total electricity generated over an assumed lifetime.

Marina: A protected harbor for mooring of small craft vessels for fishing and recreational purposes.

Maximum Feasible Capacity (AB 525/CEC definition): California Code of Regulations, Title 20, section 1201(h), defines "feasible" as "capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, legal, social, and technological factors." Maximum feasible capacity is the amount of offshore wind that California can expect to generate with realistic projections of what could be achieved by 2030 and 2045, considering the broad range of specified factors identified in AB 525.

Megawatt (MW): One thousand kilowatts (1,000 kW) or 1 million (1,000,000) watts. One MW is enough electrical capacity to power 1,000 average California homes. (Assuming a loading factor of 0.5 and an average California home having a 2 kilowatt peak capacity.)

Nameplate Capacity, Rated Capacity: The total manufacturer-rated capacities (or full-load sustained output) of equipment such as turbines, generators, condensers, transformers, and other system components.

Outer Continental Shelf (OCS): Includes the area between state jurisdiction to 200 nautical miles from shore.

Pier: A type of marine structure, typically perpendicular to the shoreline, for mooring vessels and cargo handling.

Port: This term is used both for the harbor area where ships are docked and for the agency (port authority), which administers use of public wharves and port properties.

Renewables Portfolio Standard: One of California's key programs for advancing renewable energy. The program sets continuously escalating renewable energy procurement requirements for the state's load-serving entities.

Technical Potential (for floating offshore wind): Areas offshore that can generate electricity using offshore wind and meet certain technical requirements for the deployment of floating offshore wind technology. Technical requirements include waters that are greater than 60 meters and less than 1,300 meters in depth, have an annual average windspeed of seven meters per second or greater, and can be commercially developed using available technology.

Terminal: A single location within a port to transfer cargo to and from a vessel. Depending on the type of terminal, connections to land transportation such as road, rail, pipelines, etc. are provided.

Terminal Equipment: Various vehicles and specialized equipment that is used to operate a terminal and move cargo around the terminal such as cranes, trucks, and other specialty vehicles or equipment.

Tier 1: Finished components. Finished components are the major products that are purchased by an offshore wind energy project developer, such as the wind turbine, foundation, or cables.

Tier 2: Subassemblies. Subassemblies are the systems that have a specific function for a Tier 1 component, which may include subassemblies of a number of smaller parts, such as a pitch system for blades.

Tier 3: Subcomponents. Subcomponents are commonly available items that are combined into Tier 2 subassemblies, such as motors, bolts, and gears.

Tier 4: Raw materials. Raw materials, such as steel, copper, carbon fiber, concrete, or rare-earth metals, are directly processed into Tier 2 or 3 components

The ISO Transmission Planning Process (TPP): Annual stakeholder process that provides a comprehensive evaluation of the ISO transmission grid to identify upgrades needed to maintain reliability, successfully meet public policy goals, and identify transmission projects that can bring economic benefits to consumers.

Tug: Strong and powerful boats used for maneuvering ships into and out of port safely.

Utility-Scale Energy Generation: A utility-scale generation system involves large energy facilities that are designed to generate large amounts of electricity to be place directly onto the regional transmission grid.

Vessel: A ship or large boat used to move cargo from one port to another.

Wharf: A type of marine structure, typically parallel to the shoreline, where vessels moor to transfer cargo.

Yard: An upland area adjacent to the berth where cargo is staged and/or stored either before vessel loading or after vessel unloading.

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