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Assembly Bill 525 Offshore Wind Strategic Plan

Volume II: Main Report

Gavin Newsom, Governor

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ABSTRACT

Assembly Bill 525 (AB 525, Chiu, Chapter 231, Statutes of 2021) directs the California Energy Commission (CEC) to complete and submit a strategic plan for offshore wind development in federal waters off the California coast to the Natural Resources Agency and the relevant fiscal and policy committees of the Legislature.

This strategic plan is the last of four work products the CEC is directed to prepare by AB 525. The strategic plan consists of three volumes: **Volume I** is an overview report, **Volume II** is the main report, and **Volume III** contains the technical appendices.

In preparing the strategic plan, the CEC coordinated with federal, state, and local agencies and a wide variety of stakeholders. As required by AB 525, this strategic plan identifies suitable sea space to accommodate the offshore wind planning goals, includes a discussion of economic and workforce development and port space and infrastructure, and assesses transmission investments, upgrades, and associated costs. In addition, this strategic plan discusses the permitting processes for offshore wind facilities and identifies potential impacts on coastal resources, fisheries, Native American and Indigenous peoples, national defense, and underserved communities. The plan also includes a discussion of strategies that could address those potential impacts such as avoidance, minimization, monitoring, mitigation, and adaptive management.

Keywords: Offshore wind energy; floating offshore wind; offshore energy; offshore development; offshore wind planning goals; decarbonization; coastal, cultural, and environmental resources; renewable energy; reliability; transmission; infrastructure planning; ports and waterfront facilities; workforce; economic benefits; sea space; fisheries; floating; Assembly Bill 525; Senate Bill 100

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EXECUTIVE SUMMARY

California has accelerated efforts to reduce the pace, magnitude, and costs of climate change impacts by improving climate resilience and reducing greenhouse gas emissions. Senate Bill (SB) 100, the 100 Percent Clean Energy Act of 2018 (De León, Chapter 312, Statutes of 2018), requires that eligible renewable and zero-carbon resources supply 100 percent of total retail sales of electricity in California to end-use customers by 2045. California's current forecasts have identified a need for about 4,000 MW of new utility-scale zero carbon generation and 2,000 MW of new storage to be developed and interconnected every year until 2045.

Offshore wind can play an important role in diversifying the state's portfolio of electricity resources to meet the SB 100 clean energy goals. It presents an opportunity for California to continue advancing the state's clean energy and climate goals while creating economic development and workforce benefits. A challenge to offshore wind development will be ensuring that wind projects, and related infrastructure, are developed in a responsible and timely manner while protecting coastal, marine, and tribal resources.

Assembly Bill (AB) 525 (Chiu, Chapter 231, Statutes 2021) requires the California Energy Commission (CEC) to produce a strategic plan that charts a path forward for floating offshore wind energy development in federal waters off the California coast.

AB 525 directs the CEC to include chapters in the strategic plan on the following topics:

- Identification of sea space, including the findings and recommendations resulting from activities undertaken pursuant to Section 25991.2.
- Economic and workforce development and identification of port space and infrastructure, including the plan developed pursuant to Section 25991.3.
- Transmission planning, including the findings resulting from activities undertaken pursuant to Section 25991.4.
- Permitting, including the findings resulting from activities undertaken pursuant to Section 25991.5.
- Potential impacts on coastal resources, fisheries, Native American and Indigenous peoples, and national defense, and strategies for addressing those potential impacts. Although not specifically part of AB 525, impacts to underserved communities are a concern and have been discussed.

AB 525 sets specific requirements for coordination, consultation, and engagement in developing the strategic plan. The CEC conducted extensive coordination with local, state, and federal agencies; California Native American tribes; fishing representatives; and a variety of stakeholders through workshops, in-person or remote meetings, and comments on the topics covered by the offshore wind strategic plan.

Developing a strategic plan is a common exercise to set a vision, establish goals, lay out action plans, track progress, and adjust to new information and changing circumstances. As such, a strategic plan is a living document. The first two steps relating to the vision and goals for offshore wind are well underway. AB 525 establishes a clear vision for offshore wind: if developed and deployed at scale, offshore wind energy can provide economic and environmental benefits to the state and the nation while advancing California's progress toward its statutory clean energy and climate policies and mandates. As required by AB 525, in August 2022, the CEC adopted planning goals of 2 to 5 gigawatts (GW) of offshore wind energy by 2030 and 25 GW by 2045. Laying out the path forward is the next step in the strategic planning process.

California's floating offshore wind industry is in its infancy, but the technology is being deployed in other parts of the world and is rapidly evolving. A fully developed offshore wind industry and supply chain in the state will require time and considerable investment. Planning for the necessary port and transmission infrastructure must begin now so critical support systems are in place when floating offshore wind projects are ready to deploy. The state must also plan for the workforce needed to build port and transmission facilities, as well as to manufacture, assemble, operate, and maintain offshore wind turbine systems. These efforts can create thousands of jobs and billions of dollars in economic benefits and improve the quality of life for communities most impacted by energy production.

At the same time, the state must work with the scientific community to undertake robust scientific research to fill data gaps and better understand the potential impacts of offshore wind development on coastal, marine, and tribal cultural resources and environments, as well as on communities. This information, along with robust baseline and monitoring data, will be critical in siting, designing, constructing, and operating projects that avoid, minimize, and mitigate impacts. Finally, permitting processes for offshore wind projects must be timely and efficient to ensure offshore wind development can achieve the offshore wind planning goals.

To be successful, all these efforts will require substantial financial and human capital and ongoing consultations and engagement with California Native American tribes, state, federal, and local agencies, and stakeholders.

CHAPTER 1: Offshore Wind Introduction and Background

California has some of the best offshore wind resources in the world. In passing Assembly Bill (AB) 525 (Chiu, Chapter 231, Statutes of 2021), the Legislature found that if developed and deployed at scale, the advancement of offshore wind energy can provide economic and environmental benefits to the state and the nation. Offshore wind development in federal ocean waters off California's coast could advance the state's progress towards its clean energy and climate mandates, as well as diversify the state's energy portfolio and enhance the reliability of the electricity grid.[1] AB 525 requires the California Energy Commission (CEC) to develop a strategic plan intended to incorporate, but not delay, progress to advance responsible development of offshore wind.

Assembly Bill 525

On September 23, 2021, Governor Gavin Newsom signed into law AB 525, which took effect January 1, 2022. AB 525 requires the CEC, in coordination with federal, state, and local agencies, California Native American tribes, and a variety of stakeholders, to develop a strategic plan for offshore wind energy development in federal waters off the California coast. The CEC must submit a strategic plan to the California Natural Resources Agency (CNRA) and the relevant fiscal and policy committees of the Legislature. This strategic plan, the last product required by AB 525, is intended to advance responsible development of offshore wind. The strategic plan is required to include chapters on the following topics:

- Identification of sea space, including the findings and recommendations resulting from activities undertaken pursuant to Section 25991.2.
- Economic and workforce development and identification of port space and infrastructure, including the plan developed pursuant to Section 25991.3.
- Transmission planning, including the findings resulting from activities undertaken pursuant to Section 25991.4.
- Permitting, including the findings resulting from activities undertaken pursuant to Section 25991.5.
- Potential impacts on coastal resources, fisheries, Native American and Indigenous peoples, and national defense, and strategies for addressing those potential impacts.

Additional statutory directives related to each of these topics are discussed in the relevant sections or chapters of this report. The following interim activities and products developed by the CEC contribute to the strategic plan:

1 Newsom, Gavin. July 2022. *Governors Letter to CARB.* Available at www.gov.ca.gov/wp-content/uploads/2022/07/07.22.2022-Governors-Letter-to-CARB.pdf?emrc=1054d6.

- Establish megawatt (MW) offshore wind energy planning goals for the state. On August 10, 2022, the CEC adopted ambitious offshore wind planning goals of 2 to 5 gigawatts (GW) by 2030 and 25 GW by 2045.[2]
- Complete and submit a preliminary assessment of the economic benefits of offshore wind as they relate to seaport investments and workforce development needs and standards. On February 28, 2023, the CEC adopted a preliminary economic benefits assessment.[3]
- Complete and submit a permitting roadmap that describes timeframes 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. On May 10, 2023, the CEC adopted a final permitting roadmap.[4]

Advancing California's Climate and Clean Energy Policies

As California works to lessen the pace, magnitude, and costs of climate change impacts, offshore wind is poised to play a key role in reducing greenhouse gas emissions (GHGs). Senate Bill 100 (SB 100, De León, Chapter 312, Statutes of 2018) requires that eligible renewable and zero-carbon resources supply 100 percent of total retail sales of electricity to end-use customers and serve all state agencies by 2045.[5] The *2021 SB 100 Joint Agency Report* by the CEC, California Public Utilities Commission (CPUC), and the California Air Resources Board (CARB) found that California will need to roughly triple its current electricity generation capacity to meet the 2045 target.[6] The build-out of eligible renewable and zero-carbon electric generation over the next 25 years to meet the SB 100 goal will greatly exceed the state's already aggressive pace of clean energy development over the last decade.

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2 Flint, Scott, Rhetta de Mesa, Pamela Doughman, and Elizabeth Huber. August 2022. *Offshore Wind Energy Development in Federal Waters Offshore the California Coast: Maximum Feasible Capacity and Megawatt Planning Goals for 2030 and 2045.* CEC-800-2022-001-REV. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=244285.

3 Deaver, Paul and Jim Bartridge. December 2022. *Preliminary Assessment of Economic Benefits of Offshore Wind: Related to Seaport Investments and Workshop Development.* CEC-700-2022-007-CMD. Available at https://www.energy.ca.gov/publications/2022/preliminary-assessment-economic-benefits-offshore-wind-related-seaport.

4 Jones, Melissa, Kristy Chew, Eli Harland, and Jim Bartridge. 2023. *AB 525 Assembly Bill 525 Offshore Wind Energy Permitting Roadmap.* California Energy Commission. Publication Number: CEC-700-2023-004. https://www.energy.ca.gov/event/workshop/2023-06/workshop-assembly-bill-525-offshore-wind-energy-permitting-roadmap.

5 Senate Bill 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.

6 Gill, Liz, Aleecia Gutierrez, and Terra Weeks. March 2021. *2021 SB 100 Joint Agency Report Achieving 100 Percent Clean Electricity in California: An Initial Assessment.* CEC-200-2021. Available at https://efiling.energy.ca.gov/EFiling/GetFile.aspx?tn=237167&DocumentContentId=70349.

Offshore wind generation can add diversity to the resource portfolio and help improve reliability and create resilience for the state's energy system. As offshore wind development reaches scale, costs are expected to decrease. There are additional community benefits for underserved communities that can be delivered throughout the development process. Moreover, offshore wind can expand clean energy access for underserved communities.[7] This clean energy access will be especially important in communities near offshore wind energy areas with limited electricity supplies that are geographically isolated and experience reliability challenges because of climate change impacts like wildfires, such as communities in the North Coast of California.

The National Renewable Energy Laboratory (NREL), Bureau of Ocean Energy Management (BOEM), and the offshore wind industry generally consider a wind speed of 7 meters per second or greater as feasible for developing commercial offshore wind energy generation. One study found offshore wind speeds average about 10 meters per second within a large area for potential development,[8] while another study indicates that good places for wind turbines are where the annual average wind speed is at least 4 meters per second.[9] Another study found that the generation profile of offshore wind can complement that of solar as it can fill the gap when solar declines in the afternoon and evening as the sun sets. Offshore wind turbines can also generate more consistent electricity during winter months when solar production is lower.[10] Although these studies show consistent offshore wind generation profiles, they also find seasonal variation in wind profiles, which can make grid integration challenging because it is an intermittent renewable resource.[11] Studies show California has strong and consistent wind speeds off its North and Central Coasts.

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7 Throughout this report, the term *underserved communities* refers to populations that are predominantly composed of low-income residents, people of color, and indigenous communities, that have faced the brunt of environmental burdens for decades, also sometimes referred to as environmental justice communities. The term disadvantaged is used when referring to communities specifically defined under CalEnviroScreen.

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

9 More information on offshore wind project placement is available at https://www.eia.gov/energyexplained/wind/where-wind-power-is-harnessed.php.

10 Musial, Walter, Phillipp Beiter, Suzanne Tegen, and Aaron Smith (National Renewable Energy Laboratory). December 2016. *Potential Offshore Wind Energy Areas in California: An Assessment of Locations, Technology, and Costs.* NREL/TP-5000-67414. Available at https://www.nrel.gov/docs/fy17osti/67414.pdf.

11 Beiter, Phillipp, Walt Musial, Patrick Duffy, Aubryn Cooperman, Matt Shields, Donna Heimiller, and Mike Optis (National Renewable Energy Laboratory). November 2020. *The Cost of Floating Offshore Wind Energy in California Between 2019 and 2032.* NREL/TP-5000-77384. Available at https://www.nrel.gov/docs/fy21osti/77384.pdf.

The Schatz Energy Research Center estimated offshore wind generation profiles in the Humboldt and Cape Mendocino areas.[12] The study showed the Humboldt Call Area has a consistent distribution of wind speeds for each month of the year, with more consistent wind speeds between 10 and 15 meters per second in the summer months (May, June, July, and August). The Cape Mendocino area has greater variation between months, with a greater fraction of high wind speeds occurring in the summer months, which have a consistent distribution of wind speed between 0 and 17 meters per second.

However, in addition to seasonal variation, the study found that electricity generation from offshore wind can also vary by day. Schatz estimated the capacity factor for wind generation at roughly 48 percent in the Humboldt Call Area and roughly 57 percent for Cape Mendocino.[13] The high-capacity factors, along with timing of generation in summer months when the electricity system in California experiences peak demand, mean that offshore wind energy can add needed diversity to the clean energy portfolio.

An NREL study estimated offshore wind generation profiles and found the Morro Bay Wind Energy Area (WEA) has annual average wind speeds, measured at a height of 100 meters, between 9 and 10 meters per second.[14] The average wind speed in Morro Bay reaches a lower minimum than Humboldt and the difference between the minimum and maximum wind speeds is larger, producing a steeper rise to the evening peak. Comparatively, the average wind speeds in Humboldt are more consistent throughout the day than in Morro Bay. Nevertheless, the average annual wind speeds in the Morro Bay WEA are in excess of the offshore wind industry standard of 7 meters per second for feasibly developing commercial offshore wind energy generation. Winds blow primarily from the north-northwest with little difference between potential wind turbine hub heights of 100 meters and 150 meters. NREL estimated the net capacity factor for wind generation at roughly 48% in the Morro Bay Wind Energy Area.

In addition to the renewable and zero-carbon electricity policies, California has implemented a suite of policies and programs to achieve its climate goals of carbon neutrality by 2045 and reduce GHG emissions to 85 percent below 1990 levels by 2045. The state's aggressive decarbonization of buildings and transportation, as well as decarbonization of other sectors, depends on a clean electricity grid.

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12 Severy, Mark, Christina Ortega, Charles Chamberlin, and Arne Jacobson (Schatz Energy Research Center). September 2020. *Wind Speed Resource and Power Generation Profile Report.* Available at https://schatzcenter.org/pubs/2020-OSW-R2.pdf.

13 *Capacity factor* is the ratio of electrical energy output of a generating unit over a given period of time compared to its theoretical full power operation, or nameplate capacity.

14 Cooperman, Aubryn, Patrick Duffy, Matt Hall, Ericka Lozon, Matt Shields, and Walter Musial (National Renewable Energy Laboratory). April 2022. *Assessment of Offshore Wind Energy Leasing Areas for Humboldt and Morro Bay Wind Energy Areas, California.* NREL/TP-5000-82341, Contract No. DE-AC36-08GO28308. OCS Study BOEM 2022-025. Available at https://www.nrel.gov/docs/fy22osti/82341.pdf.

As Governor Newsom has stated, a vibrant offshore wind industry can help the state "reduce air pollution, increase energy independence, and provide new economic opportunities to Californians while protecting the natural legacy of our coastline."[15] In response to his call for bolder climate action, on August 10, 2022, the CEC adopted the most ambitious offshore wind planning goals in the United States, calling for offshore wind resources of between 2 and 5 GW by 2030 and 25 GW by 2045.[16] These goals are intended to spur development of a floating offshore wind industry.

Once the offshore wind turbines are built and installed in the wind energy areas, they can supply clean power and reduce the emission of greenhouse gas and other pollutants from the electricity system. Offshore wind, particularly from the North Coast, would provide reliable power during times of peak energy demand in the evening, when solar power is ramping down and fossil fuel ramping resources are required to meet demand. Clean energy resources available to provide power in the evening are therefore particularly useful in helping the state reduce reliance on fossil fuel ramping resources, which have health impacts to low-income communities of color.

Another important potential benefit is expanded clean energy access for California Native American tribes and underserved communities. This expanded access is especially important in communities near offshore wind energy areas with limited supplies that experience reliability challenges, such as the North Coast of California. Further, offshore wind energy presents an opportunity to attract investment capital and provide economic and workforce development benefits to the state, tribal, and local communities.

The successful development of commercial scale floating offshore wind development will require upgrades to ports and waterfront facilities to support a range of activities, including construction and staging of floating platform foundations, manufacturing and storage of components, final assembly, and long-term operations and maintenance. Floating offshore wind will also require development of new and upgraded transmission infrastructure to transmit the power onshore and deliver to customers. Successful development of floating offshore wind and associated infrastructure to support offshore wind development depends on avoiding and minimizing impacts on marine biodiversity and habitat, currents and upwelling, fishing, tribal cultural resources, cultural resources, navigation, aesthetics and visual appeal, and military operations, underserved communities, and other coastal users. The environmental review and permits for this infrastructure could take five years or more.

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15 Newsom, Gavin. July 2022. *Governors Letter to CARB.* Available at www.gov.ca.gov/wp-content/uploads/2022/07/07.22.2022-Governors-Letter-to-CARB.pdf?emrc=1054d6.

16 Flint, Scott, Rhetta deMesa, Pamela Doughman, and Elizabeth Huber. August 2022. *Offshore Wind Energy Development in Federal Waters Offshore the California Coast: Maximum Feasible Capacity and Megawatt Planning Goals for 2030 and 2045.* CEC-800-2022-001-REV. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=244285.

Status of Offshore Wind Development

The offshore wind energy industry is growing worldwide as more countries enter the market and more offshore wind generation capacity is being deployed in total. For global offshore wind energy deployment, 2021 was a record year, with 17,399 MW of new capacity commissioned.[17] The total global installed capacity of offshore wind exceeded 50 GW in 2021. To date, nearly all offshore wind energy projects in other parts of the world have used fixed-bottom foundations, which are more suitable for shallow waters of 60 meters (about 200 feet) or less. However, because the Pacific Outer Continental Shelf off California's coast has steep drop-offs and deep waters, offshore wind projects in federal waters off the coast of California will use floating platforms. These platforms will be attached to the seafloor using mooring cables and anchors. The turbines installed on the floating platforms will be connected by electrical cables to undersea or floating interconnection equipment, or floating substations. The power would then be delivered to onshore substations feeding into the bulk transmission grid or to higher-voltage, long-distance subsea cables that carry the electricity to major load centers.

Floating offshore wind technology at scale is expected to be large and complex but, as identified by the U.S. Department of Energy (DOE), is expected to advance rapidly.[18] Globally, the development trajectory of a floating offshore wind energy market continues at the pilot scale (10 MW to 100 MW) in Europe, Asia, and North America. This pilot and demonstration phase, which includes most projects anticipated to begin operations between 2022 and 2024, is expected to provide data and experience that inform the development of cost-effective, commercial-scale projects that may be installed as early as 2025. At the end of 2021, there were 10 floating offshore wind energy projects operating globally, totaling 123.4 MW.[19] Seven of those 10 projects (112.9 MW) are in Europe, and three (10.5 MW) are in Asia.

While not included in the total capacity of the floating projects under development above, in 2022, two other projects came on-line: the Maersk Supply Service 2 MW DemoSATH floating offshore wind demonstration project in Spain and the 88 MW Hywind Tampen project in Norway. The Tampen project is the largest floating wind project globally. DOE estimates that global floating offshore wind energy installed capacity could grow to about 10 GW by 2030 and to 264 GW by 2050.[20]

In 2019, the California State Lands Commission (CSLC) received an application for one of the first offshore wind projects in California waters. The CADEMO 60 MW project, proposed in state waters off the coast of Santa Barbara County, would include four wind turbines located

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17 Musial, Walter, Paul Spitsen, Patrick Duffy, Philipp Beiter, Melinda Marquis, Rob Hammond, and Matt Shields. August 2022. *Offshore Wind Market Report: 2022 Edition.* U.S. Department of Energy. Available at https://www.nrel.gov/wind/offshore-market-assessment.html.

18 Ibid.

19 Only projects with capacities greater than 1 MW were counted. Smaller projects are considered experimental and do not contribute to commercial market totals.

20 Ibid.

2.8 miles off Vandenberg Space Force Base on the Central Coast, covering an area of roughly 6 square miles. CADEMO's turbines would be visually similar to conventional onshore wind turbines but taller and would feature larger blades to produce higher generation capacities. Each turbine would be capable of generating 12–15 MW of renewable electricity for a maximum project capacity of up to 60 MW. The project is undergoing CEQA review. If approved and constructed, CADEMO asserts the project would assist California in assessing environmental impacts, technology options, workforce needs, supply chain options, and port facilities needed for offshore wind development in the state.[21]

California Offshore Wind Leases

At the national level, planning for offshore wind energy development on the Outer Continental Shelf began to take shape in 2009 when the U.S. Department of the Interior developed regulations for renewable energy development in the Outer Continental Shelf. In 2011, the Department of Interior's Bureau of Ocean Energy Management (BOEM) was created and vested with authority for offshore renewable energy development in federal waters. BOEM's authority generally extends from 3 to 200 nautical miles from shore, except within boundaries of any national park, national marine sanctuary, national wildlife refuge, or national monument. In January 2016, BOEM received an unsolicited request for a commercial lease from Trident Winds LLC for an area off the Central Coast of California.[22] To determine competitive interest, BOEM published a notice in the Federal Register requesting information on potential commercial interest in the area identified in Trident Winds LLC's unsolicited request.[23] Based on responses to the request, BOEM determined competitive interest existed for offshore California and initiated planning with state representatives for possible future leasing for offshore wind development.

In 2016, the BOEM California Intergovernmental Renewable Energy Task Force was formed to examine opportunities for offshore renewable energy development in federal waters offshore California.[24] The task force, a nondecisional entity, promotes coordination and communication in a partnership between BOEM; federal, state, and local governments; and federally recognized tribal governments. This partnership provides an opportunity to develop information for decision-making related to future offshore renewable energy development. The task force has developed and collected data and information relevant to the assessment of

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21 More information on CADEMO is available at https://cademo.net/.

22 BOEM. "TridentWinds, LLC Unsolicited Lease Request." Available at https://www.boem.gov/TridentWinds/.

23 BOEM. August 2016. "Potential Commercial Leasing for Wind Power on the Outer Continental Shelf (OCS) Offshore California Request for Interest." 81 Fed. Reg. 55,228. Notice. Available at https://www.boem.gov/81-FR-55228/.

24 At the request of California Governor Jerry Brown, Interior Secretary Jewell announced the formation of a California Intergovernmental Renewable Energy Task Force.

BOEM. February 2017. "California Offshore Renewable Energy: BOEM California Intergovernmental Renewable Energy Task Force." Available at https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/CA/BOEM-Offshore-Renewables-Factsheet--02-22-17.pdf.

potential offshore wind energy resources.[25] The task force created the California Offshore Wind Energy Gateway, which assembles and makes publicly available geospatial information on ocean wind resources, ecological and natural resources, commercial and recreational ocean uses, and community values.[26]

In 2018, BOEM identified areas in Humboldt, Morro Bay, and Diablo Canyon as the first three potential offshore wind *call areas* and issued a call for information and nominations, or *call*, and later designated wind energy areas (WEAs) as shown in **Figure 1-1**. Within BOEM's published Call in 2018, the Morro Bay and Diablo Canyon Call Areas were assessed as incompatible with wind energy development by the U.S. Department of Defense (DOD). On August 21, 2019, a meeting was held with senior officials from DOD, BOEM, the National Oceanic and Atmospheric Administration (NOAA), the CEC, and state and local elected representatives to discuss a path forward to accommodate a viable offshore wind industry on the Central Coast that recognizes the DOD's testing, training, and military operations mission off California's coast. The state and BOEM conducted a public process to receive input from agencies, tribal governments, stakeholders, and the public on proposed solutions in and around the 2018 Morro Bay Call Area.

Following an additional public process,[27] in May 2021, an agreement was announced to advance wind energy development off the Northern and Central Coasts of California.[28] BOEM and the state held a task force meeting in July 2021 to introduce the "Morro Bay East and West Extensions — Call for Information and Nominations."

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25 Through coordination with the task force, BOEM and the state conducted an extensive stakeholder outreach and engagement process as summarized in the *Outreach Summary Report* and *Outreach Summary Report Addendum*.

BOEM and State of California. 2018. *Outreach Summary Report: California Offshore Wind Energy Planning.* Available at https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/CA/Outreach-Summary-Report-September-2018.pdf.

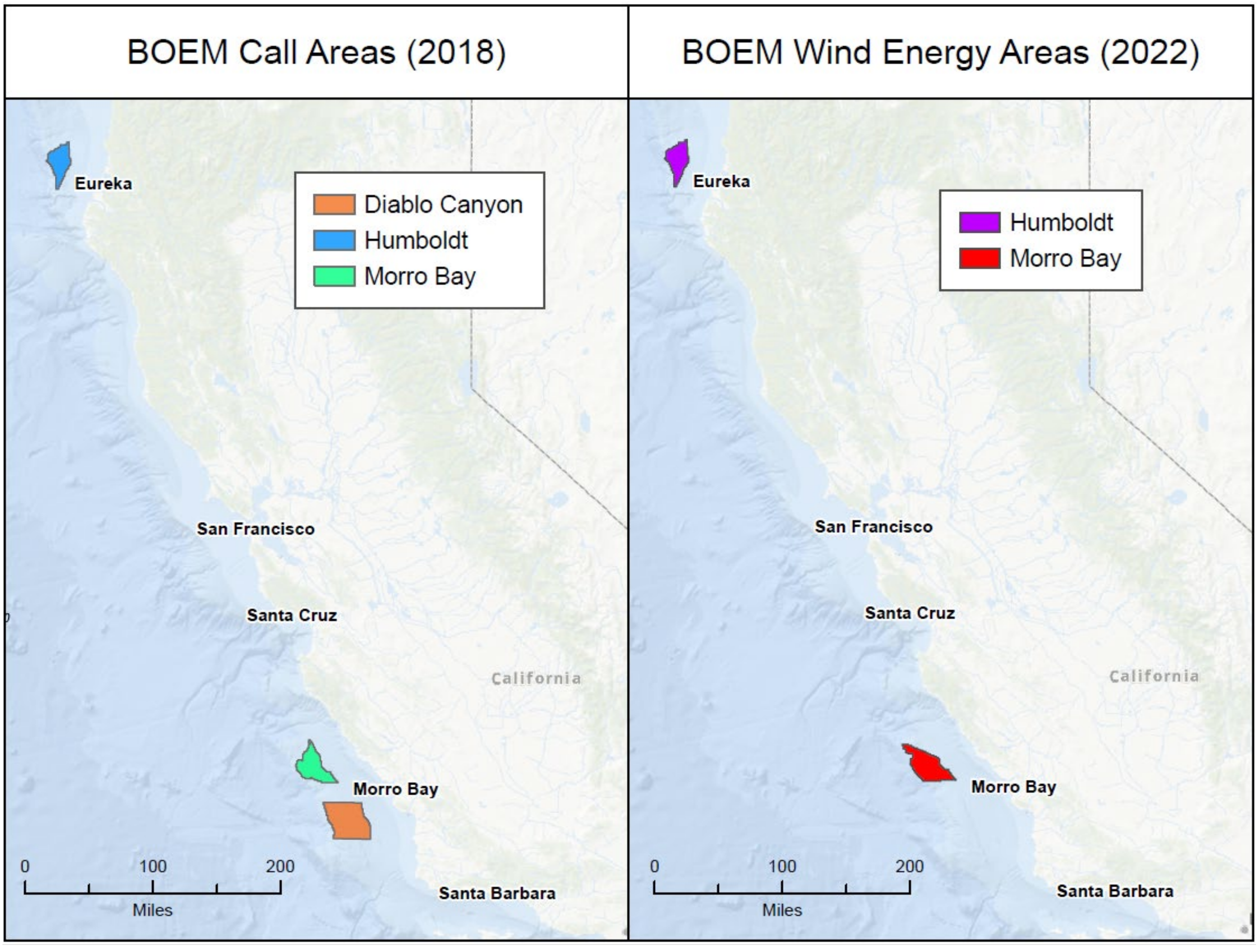
BOEM and State of California. 2021. *Outreach Summary Report Addendum: California Offshore Wind Energy Planning.* Available at https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/Offshore-Wind-Outreach-Addendum.pdf.

26 The California Offshore Wind Energy Gateway is available at https://caoffshorewind.databasin.org/.

27 At the August 21, 2019, meeting, Congressman Salud Carbajal, Congressman Jimmy Panetta, Assistant Secretary of Defense for Sustainment, BOEM, NOAA Sanctuaries, and the State of California (State) agreed to participate in a series of meetings to identify solutions off the Central Coast. A group composed of DoD, BOEM, NOAA Sanctuaries, Congressman Panetta's office and the State led by Congressman Carbajal's office met several times following the August 21, 2019, meeting.

28 The Diablo Canyon Call Area was not included in the agreement to advance areas toward leasing. The Diablo Canyon Call Area is within the area nominated by the Northern Chumash Tribal Council to become a national marine sanctuary (Chumash Heritage National Marine Sanctuary).

Figure 1-1: Offshore Wind Call Areas and Wind Energy Areas off California Coast



Source: CEC. 2022

Also in July 2021, BOEM announced the designation of the Humboldt Wind Energy Area (WEA), which is about 20 miles off the Northern California coast and comprises 206.8 square miles.[29] In November 2021, BOEM announced the designation of the Morro Bay WEA, which is about 20 miles off the Central California coastline and comprises roughly 376 square miles.[30] The Morro Bay WEA includes the 2021 Call West Extension and a portion of the 2018 Call Area but omits the 2021 Call East Extension. The Humboldt and Morro Bay WEAs are each subject to environmental review under the National Environmental Policy Act (NEPA) to consider the environmental consequences of issuing commercial wind leases and associated site characterization and site assessment activities.[31]

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29 Romero, John (BOEM). July 2021. "BOEM Advances Offshore Wind Leasing Process in California." Available at https://www.boem.gov/newsroom/press-releases/boem-advances-offshore-wind-leasing-process-california.

30 Ibid.

31 Site characterization activities include biological, archeological, geological, and geophysical surveys and core samples. site assessment activities include installation of meteorological buoys.

In addition to NEPA, BOEM's action to lease is subject to state review under the Coastal Zone Management Act (CZMA). The California Coastal Commission (CCC) implements the CZMA, which provides the CCC with the ability to review federal activities or permits outside the coastal zone, including offshore wind projects that could affect California's coastal resources. BOEM sought the CCC's concurrence that proposed leasing, site characterization, and site assessment activities within the Humboldt and Morro Bay WEAs, are consistent with California's Coastal Management Program.[32]

The scope of the CCC's review focused on affects from activities that are likely to occur during the leasing phase but also assessed reasonably foreseeable effects associated with future development on those leases. The Consistency Determination reviews describe likely coastal resource impacts and potential mitigation strategies and identify data and information needs for future environmental and federal consistency reviews of specific projects. The reviews also provide a high-level assessment of the impacts of siting offshore wind projects in both WEAs and communicate the CCC's expectations on the anticipated scope of those future reviews.[33] The CCC conditionally concurred with BOEM's Consistency Determination for the Humboldt WEA in April 2022 and the Morro Bay WEA in June 2022.

In May 2022, the proposed auction details and lease terms were released for offshore wind development in the Humboldt and Morro Bay WEAs. The California Proposed Sale Notice included information about five potential areas that could be available for leasing within the two WEAs, as well as proposed lease provisions, conditions, and auction details. In June 2022, BOEM and the state held a task force meeting to discuss the proposed sale notice and other related topics. On August 1, 2022, a group of nine California state agencies submitted a comment letter to BOEM in response to the Proposed Sale Notice with recommendations that reflect the values and priorities of California.[34] In October 2022, a final sale notice was released by BOEM and on December 6, 2022, BOEM initiated an offshore wind energy lease sale. The lease sale concluded on December 7, 2022, resulting in winning bids for the five

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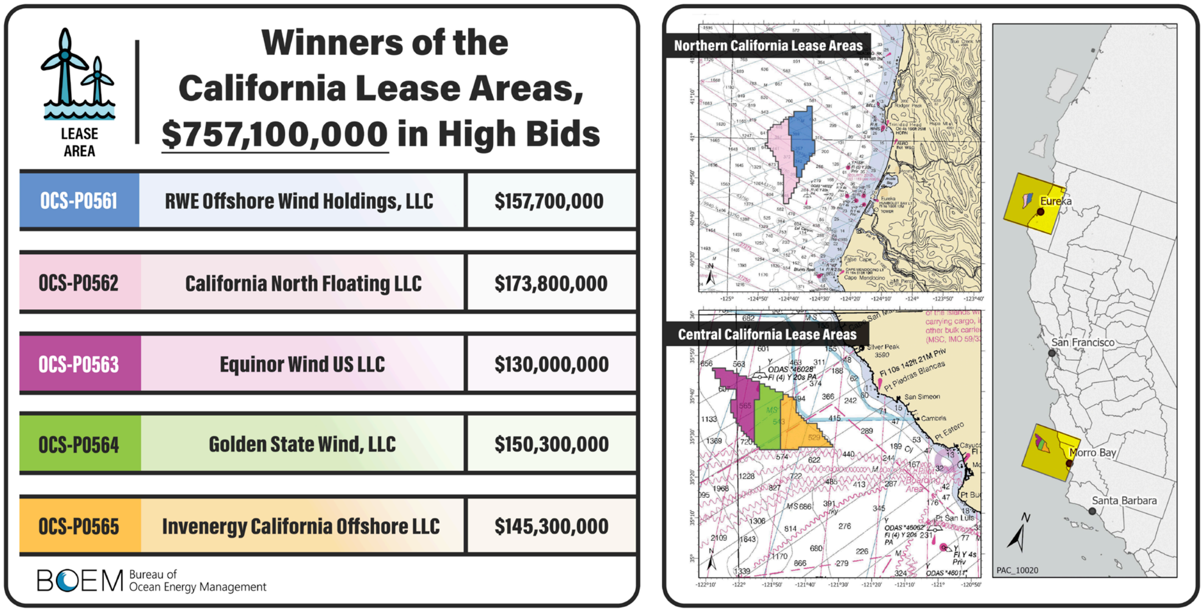
32 The California Coastal Management Program consists of the enforceable policies from "Chapter 3 Coastal Resources Planning and Management Policies" of the Coastal Act (Cal. Pub. Res. Code §§ 30200-30265.5) and is available at https://www.coastal.ca.gov/fedcd/cach3.pdf.

33 The California Coastal Commission application of CZMA to BOEM's consistency determinations and the final reviews and adopted conditions and findings for each wind energy area: Humboldt WEA Coastal Commission Consistency Determination Adopted Findings and Conditions and Morro Bay WEA Coastal Commission Consistency Determination Adopted Findings and Conditions.

34 CEC, CPUC, CCC, CDFW, CSLC, OPR, OPC, CLWDA, and GO-Biz. August 2022. "BOEM Proposed Sale Notice California state agency comment letter." Available at https://downloads.regulations.gov/BOEM-2022-0017-0043/attachment_1.pdf.

lease areas from the five companies shown in **Figure 1-2**.[35] On June 1, 2023, each of the five leases became effective.[36]

Figure 1-2: PACW-1 Lease Sale Winners



Source: BOEM. 2022

Offshore Wind Planning and Procurement

An outcome of planning for offshore wind is identifying pathways for utilities to procure offshore wind. The California Public Utilities Commission (CPUC) is authorized to order the procurement of resources with specific attributes by electrical corporations, electric service providers, and community choice aggregators as part of the Integrated Resource Planning (IRP) process and enforce any resource procurement requirements on a nondiscriminatory basis. To date, this has generally been through requirements for CPUC-jurisdictional load

35 More information about BOEM activities in California is available at https://www.boem.gov/renewable-energy/state-activities/california.

36 As described in the PACW-1 PSN BOEM was required to comply with the Inflation Reduction Act (Pub. L. 117-169) prior to issuing leases that resulted from the PACW-1 lease sale: "Section 50265(b)(2) of the IRA provides that "[d]uring the 10-year period beginning on the date of enactment of this Act . . . the Secretary may not issue a lease for offshore wind development under section 8(p)(1)(C) of the Outer Continental Shelf Lands Act (43 U.S.C. 1337(p)(1)(C)) unless— (A) an offshore lease sale has been held during the 1-year period ending on the date of the issuance of the lease for offshore wind development; and (B) the sum total of acres offered for lease in offshore lease sales during the 1-year period ending on the date of the issuance of the lease for offshore wind development is not less than 60,000,000 acres." Section 50264(d) of the IRA provides that ". . . not later than March 31, 2023, the Secretary shall conduct Lease Sale 259[.]" Conducting Lease Sale 259 is needed for BOEM to satisfy the requirements in section 50265(b)(2) of the IRA and issue the leases resulting from this lease sale."

serving entities to self-procure generation and storage resources for their share of a defined resource need. However, the use of a central procurement function can be an effective way to ensure compliance with a specific policy directive, such as reliability. For example, in 2006 the CPUC directed PG&E and SCE to secure long-term contracts for new generating capacity, with the costs and benefits shared among all load-serving entities in the investor-owned utilities (IOUs) service territory. Since then, the CPUC has directed the IOUs to serve as a central procurement entity for combined heat and power, energy storage, renewable, and demand-side resources that are intended to maintain reliability, ensure greenhouse gas reductions, and allow for the retirement of aging natural gas resources. Procurement mechanisms have also been used extensively to support the state's resource adequacy and broader IRP program requirements.

As part of the IRP process, the CPUC identifies a diverse and balanced portfolio of resources needed to ensure a reliable electricity supply that integrates renewable energy into the electricity grid cost-effectively. This process includes requiring each electrical corporation, electric service provider, or community choice aggregator to file an integrated resource plan and a schedule for periodic updates, and the CPUC must ensure that load-serving entities meet other requirements it specifies. Existing law (Chapter 367, Statutes of 2023) requires the CPUC, on or before September 1, 2024, to determine if there is a need for the procurement of diverse clean eligible energy resources. The CPUC could then specify the eligible energy resources that should be procured to meet that need and may request the California Department of Water Resources (DWR) procure those specified resources. Existing Law authorizes DWR to procure those resources, which could include offshore wind. The electrical corporations, acting as an agent of the DWR, would provide billing, collection, and other related services on terms and conditions that reasonably compensate the electrical corporation for its services and adequately secure payment to DWR.

CPUC is required to develop and adopt procedures and requirements that govern competitive procurement by, obligations on, and recovery of costs incurred by DWR should it elect to conduct competitive solicitations or enter contracts for eligible energy resources. In evaluating bids received through a solicitation, DWR must consider certain factors. Existing law requires that bids for developing eligible projects include the bidder's certification that certain labor requirements are met and that a skilled and trained workforce will be used to perform all construction. At the request of DWR, the CPUC is authorized to require an electrical corporation to act as the agent for DWR or to assist it in conducting the solicitation, bid evaluation, or contract negotiation for new eligible energy resource procurement.

DWR is also to establish a schedule and mechanism for a local publicly owned electric utility to voluntarily obtain eligible energy resources that DWR acquires through its central procurement function on a contract-by-contract basis. Electrical corporations, electric service providers, and community choice aggregators would also have a voluntary option to obtain incremental eligible energy resources from DWR.

Technical Assessments Supporting the Strategic Plan

This strategic plan discusses the results of technical studies undertaken in the last year or more to assess the status and needs for different aspects of offshore wind and provide foundational information.

Using existing data and information from accelerated investments by the Ocean Protection Council (OPC) to fill critical data gaps for species modeling, fishing grounds, and tribal cultural resource inventories, the CEC is identifying the sea space necessary to support the offshore wind planning goals. The mapping and screening of sea space are an important next step in providing information to BOEM that can be used in its process to identify additional wind energy areas in federal waters. BOEM has a well-established process for refining information developed by the CEC under AB 525. Data and information provided by the California Coastal Commission (CCC) from its review of BOEM's Consistency Determination of the WEAs were used in assessing the impacts of offshore wind. In addition, input from Aspen Environmental supported assessment of high-level impacts of offshore wind energy on fisheries, coastal and marine resources, California Native American tribes, Indigenous peoples, and national defense and identified strategies for addressing those potential impacts. More work is necessary to identify the geographically specific impacts and develop strategies to address them as specific plans for project development in the current lease areas become available. Furthermore, more coordination is needed to ensure that tribal, underserved, and impacted communities are included in the process. Investments in tribal and communities' capacity to fully participate in all aspects of the planning, permitting, constructing, maintaining, and decommissioning are also necessary.

In addition to the information outlined in the *Preliminary Assessment of Economic Benefits of Offshore Wind Related to Seaport Investments and Workforce Development* adopted by the CEC in February 2023,[37] additional studies have informed the port infrastructure and workforce development sections of this strategic plan. Moffatt & Nichol completed studies of ports and waterfront facility needs, alternative port locations, and an initial port development strategy to

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37 Deaver, Paul and Jim Bartridge. December 2022. *Preliminary Assessment of Economic Benefits of Offshore Wind: Related to Seaport Investments and Workforce Development.* CEC-700-2022-007-CMD. Available at https://www.energy.ca.gov/publications/2022/preliminary-assessment-economic-benefits-offshore-wind-related-seaport.

Fox, Brooklyn and Sarah Lehmann (Moffatt & Nichol). June 2023. *AB 525 Workforce Development Readiness Plan*. 221194/02. Available at https://slcprdwordpressstorage.blob.core.windows.net/wordpressdata/2023/07/AB525-Workforce-Readiness-Plan_acc.pdf.

support offshore wind planning goals[38] Catalyst Environmental Solutions and Moffat and Nichol also assessed workforce development for offshore wind.[39]

Transmission for offshore wind has also been studied over the last year. Some of the best wind resources are in areas with limited nearby electricity transmission capacity, making it difficult to interconnect large wind projects to customer load. The CEC has undertaken a transmission technology assessment conducted by Guidehouse Inc.,[40] which indicates that some of the critical cable, substation and other interconnection equipment needed to support offshore wind in California is still under development and not yet commercially available. The CEC, with U.S. Department of Defense (DOD) funding, has commissioned a study by the Schatz Energy Research Center to identify transmission needs and options for the North Coast region, where transmission is constrained.[41] In addition, this report discusses studies conducted by the California Independent System Operator (California ISO) on offshore wind transmission as part of its annual Transmission Planning Process, which is informed by the CPUC's IRP proceeding and the CEC's Integrated Energy Policy Report, and California ISO's 20-Year Transmission Outlook.

Over the last few months, the CEC and other state agencies engaged in offshore wind work (or "partner agencies") conducted additional tribal consultations and stakeholder outreach and discussion of permitting options to create coordinated, comprehensive, and efficient permitting processes for offshore wind energy facilities off the coast of California to follow up on the *AB 525 Offshore Wind Permitting Roadmap* adopted in May 2023.[42]

Overview of Collaborative Efforts

Collectively the CEC, state agencies, and BOEM have conducted an open and transparent process for entities to engage and understand the complex issues associated with developing a floating offshore wind industry in California. Between 2016 and 2021, five intergovernmental

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38 Lim, Jennifer and Matt Trowbridge (Moffat & Nichol). July 2023. *AB 525 Port Readiness Plan*. 221194/02. Available at https://slcprdwordpressstorage.blob.core.windows.net/wordpressdata/2023/07/AB525-Port-Readiness-Plan_acc.pdf.

39 Catalyst Environmental Solutions. April 2023. *Analytical Guidance and Benefits Assessment for AB 525 Strategic Plan: Seaport and Workforce Development for Floating Offshore Wind in California*. TN 250296. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250296.

40 Huang, Claire, Lily Busse, and Robert Baker (Guidehouse Inc.). June 2023. *Offshore Wind Transmission Technologies: Overview of Existing and Emerging Transmission Technologies*. 223437. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250520&DocumentContentId=85289.

41 Zoellick, James, Greyson Adams, Ahmed Mustafa, Aubryn Cooperman, et al. 2023. *Northern California and Southern Oregon Offshore Wind Transmission Study: Volume 1*. Schatz Energy Research Center. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=252604.

42 Jones, Melissa, Kristy Chew, Eli Harland, and Jim Bartridge. April 2023. *Assembly Bill 525 Offshore Wind Energy Permitting Roadmap.* CEC-700-2023-004. Available at https://www.energy.ca.gov/event/workshop/2023-06/workshop-assembly-bill-525-offshore-wind-energy-permitting-roadmap.

task force meetings were held, and two planning outreach reports were published.[43] As directed by AB 525, several California state agencies are collectively working to assess the potential role and opportunity offshore wind can provide for California. Led by the CEC, they include the CCC, the OPC, the California State Lands Commission (CSLC), the Governor's Office of Planning and Research (OPR), the California Department of Fish and Wildlife (CDFW), the Governor's Office of Business and Economic Development (GO-Biz), and the CPUC. These agencies play an important role in California's policy framework, including implementing climate and clean energy policies, as well as protecting and conserving coastal, ocean, and tribal cultural resources experiencing increasing impacts from climate change, infrastructure development, and commercial uses. The agencies have been working in partnership with BOEM to understand the implications of offshore wind as a potential energy resource through the collection and use of the best available science, data, and information regarding environmental considerations and existing ocean uses to guide future state and BOEM decision-making.

Throughout the development of the strategic plan, the agencies have consulted with California Native American tribes, regularly met with an intertribal working group, and engaged with stakeholders identified in AB 525, including fishermen, labor unions, industry, environmental justice organizations, environmental organizations, and other ocean users. The CEC also consulted with the California ISO and other relevant federal, state, and local agencies as needed.

On March 3, 2022, two months after AB 525 was enacted, the CEC held its first workshop providing an overview of the AB 525 requirements. Since then, the CEC has held more than a dozen workshops and an offshore wind energy symposium to engage stakeholders and interested parties in robust discussions to understand perspectives and receive technical input. In addition to the outreach described above, the CEC and state agencies have participated in numerous ad-hoc meetings with stakeholder groups, including environmental nongovernmental organizations, the offshore wind industry, environmental justice organizations, research laboratories, Pacific and Atlantic states, and European countries. Detailed outreach to specific entities is described in **Chapter 4**.

Organization of the Report

Developing a strategic plan is a common exercise undertaken by organizations to set a vision, establish goals, lay out action plans, track progress, and adjust to changing circumstances. As such, it is a living document.

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43 BOEM. September 2018. *Outreach Summary Report: California Offshore Wind Energy Planning*. Available at https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/CA/Outreach-Summary-Report-September-2018.pdf.

BOEM. June 2021. *Outreach Summary Report Addendum: California Offshore Wind Energy Planning*. Available at https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/Offshore-Wind-Outreach-Addendum.pdf.

This strategic plan is composed of three volumes: **Volume I — Overview Report**, **Volume II — Main Report**, and **Volume III – Technical Appendices.**

Volume I provides an overview of Volume II. **Volume II** details the results of the analytical tasks AB 525 directed the CEC to conduct and identifies strategies and recommendations that will move the state towards achieving its vision and goals for offshore wind. **Volume III** includes four appendices that detail floating offshore wind technologies, identifies the types of potential impacts anticipated to arise from the development and operation of offshore wind projects off the California coast, expands upon the approach, methodology, and data inputs used to identify suitable sea space, and provides offshore wind transmission schematics.

Volume II chapter summaries are:

Chapter 2 discusses the primary elements necessary to create a California offshore wind industry, including an overview of the floating technologies, ports and workforce, and transmission needed to support this new industry.

Chapter 3 discusses potential offshore wind economic and workforce benefits, many of which are expected to come from construction activities at ports and well-paying jobs created in the manufacturing and supply chain sectors.

Chapter 4 presents potential impacts from offshore wind projects on coastal (or marine) resources, fisheries, California Native American tribes and tribal communities, Indigenous peoples, national defense, and underserved communities, as well as strategies for addressing those potential impacts.

Chapter 5 identifies the suitable sea space in federal waters sufficient to accommodate the AB 525 offshore wind planning goals. The chapter discusses the process for identifying sea space to avoid or reduce (minimize) potential conflicts to help ensure the protection of coastal, marine, and tribal resources, considering existing ocean uses.

Chapter 6 outlines a plan to improve ports and waterfront facilities to support offshore wind energy development. The critical role of port and waterfront facilities is emphasized by the assessment of the port infrastructure needed to support offshore wind. This includes staging and integration or assembly sites, manufacturing and fabrication sites, and sites for operations and maintenance, as well as areas for lay down and storage of mooring lines and anchors and electrical cables. The plan presents a coordinated multiport strategy and identifies several port sites within the state that can be used for offshore wind activities.

Chapter 7 analyzes offshore wind workforce development needs, including the need for skilled and trained workers with specialized skills and adequate safety training to support the offshore wind industry.

Chapter 8 reviews transmission technology status and transmission alternatives for the North Coast and discusses transmission availability on the Central Coast. The review helps identify areas for large investment in transmission upgrades and new transmission infrastructure needed to accommodate offshore wind development to meet the state’s planning goals.

Chapter 9 outlines the complexities of transmission planning to deliver offshore wind generation to Californians. The chapter discusses necessary steps for the state to adequately plan for transmission to ensure timely investments in transmission for offshore wind, along with the large amount of transmission needed to accommodate additional procurement of clean resources.

Chapter 10 discusses permitting and review approaches and identifies the elements necessary to establish a timely, efficient, and transparent process for permitting and environmental review of offshore wind infrastructure.

Chapter 11 identifies recommendations related to addressing potential impacts, sea space, port development, workforce development, transmission planning and interconnection, and offshore wind permitting.

CHAPTER 2: Creating a California Offshore Wind Industry

Offshore wind development will create a new industry in California using emerging floating technology. Offshore wind energy can advance California's progress toward its renewable energy and climate policies and mandates and create substantial economic and environmental benefits. Creating a durable domestic floating offshore wind industry in California can provide good paying jobs and career paths, particularly to those in communities near ports and waterfront facilities.

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 anchored to the seabed. While the global floating offshore wind market is still in the early stages of development, the technology is projected to advance quickly. Continued advancements in floating offshore wind technology will be needed to achieve the state's offshore wind planning goals.

Seaports (or ports) and waterfront facilities are essential for developing a new offshore wind industry and will 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 can serve as strategic hubs to support a workforce that can assemble, fabricate, install, operate, and maintain offshore wind turbines and related components. Investing in ports and waterfront facilities is essential for a durable and thriving California floating offshore wind industry.

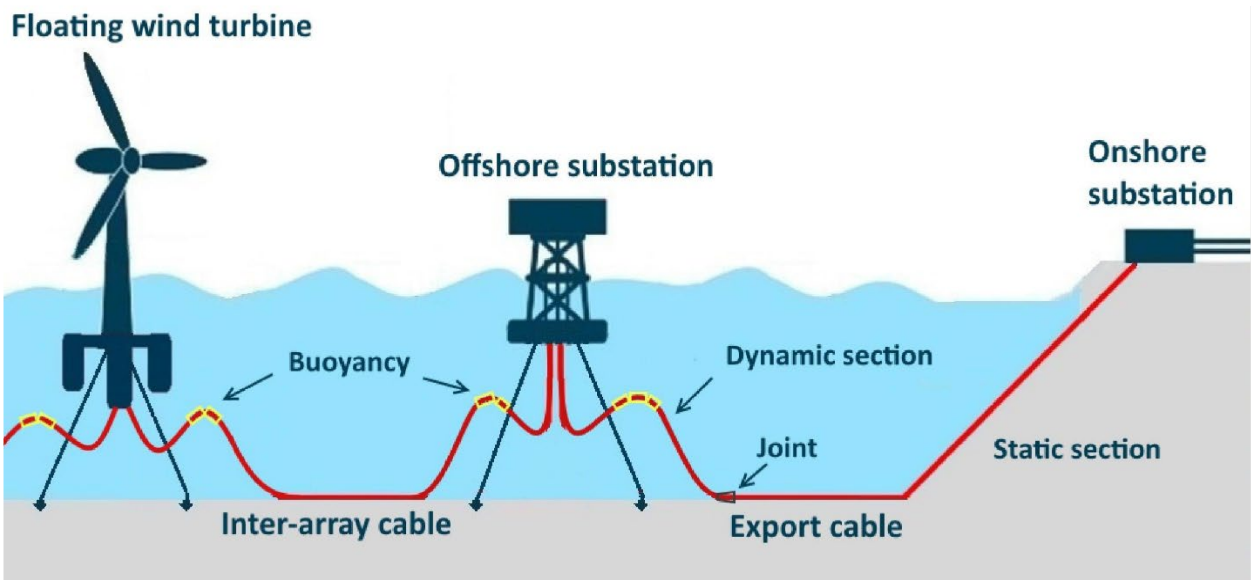
California will also need to develop a skilled and trained workforce capable of serving the offshore wind industry. A wide range of skill sets, and occupational types will be required for the offshore wind workforce. These occupational types will include jobs in construction, manufacturing, engineering, operations and maintenance, sales, science, environmental and cultural resource monitoring, and maritime services. Many other jobs will also be created, such as longshoremen and tugboat and other watercraft operators.

Transmission infrastructure is also essential to developing an offshore wind industry. The availability of existing transmission and the need to develop more transmission capacity will affect the state's achievement of the offshore wind planning goals. The electric system on the North Coast is limited and relatively isolated from the larger California grid and, where it is established, serves primarily local communities. Additional transmission will be needed to serve the region fully and deliver offshore wind energy from this region to the bulk transmission system, which provides opportunities to coordinate transmission planning for offshore wind generation from the North Coast of California with the larger Pacific Northwest. Existing transmission on the Central Coast is robust and interconnects with the grid near large load centers. However, there is still a need to do long-term planning for the offshore infrastructure and new onshore infrastructure.

Offshore Wind Technology Overview

A floating offshore wind platform is generally composed of concrete, steel, or a hybrid substructure on which a wind turbine is installed. Wind turbine generation systems are placed on these floating structures that distribute the mass and weight and are stabilized by moorings and anchors to the seafloor. As with onshore wind generation, the force of the wind turns the blades, and the wind turbine converts the kinetic energy into electricity. The electricity is then transported by underwater cables on or beneath the seafloor to an offshore substation from there to an onshore substation on the coast, and finally to homes through the transmission and distribution system, as shown in **Figure 2-1**.

Figure 2-1: Floating Offshore Wind Configuration



Source: Lerch, De-Prada-Gil, and Molins. 2020

There are several designs for floating platforms and the platform type selected can depend on various factors, including sea and seabed conditions and depth, wind speeds, turbine size, and the availability and location of manufacturing facilities, or the availability and price of imported components and equipment. There are three primary types of floating offshore wind platforms: semi-submersible, spar-buoy, and tension legs platforms, as shown in **Figure 2-2**.[44] There are many variations on the different platform types that are under development as the floating offshore wind technology advances. The industry has indicated that semi-submersible platforms made of concrete, steel, or a hybrid, are likely to be the

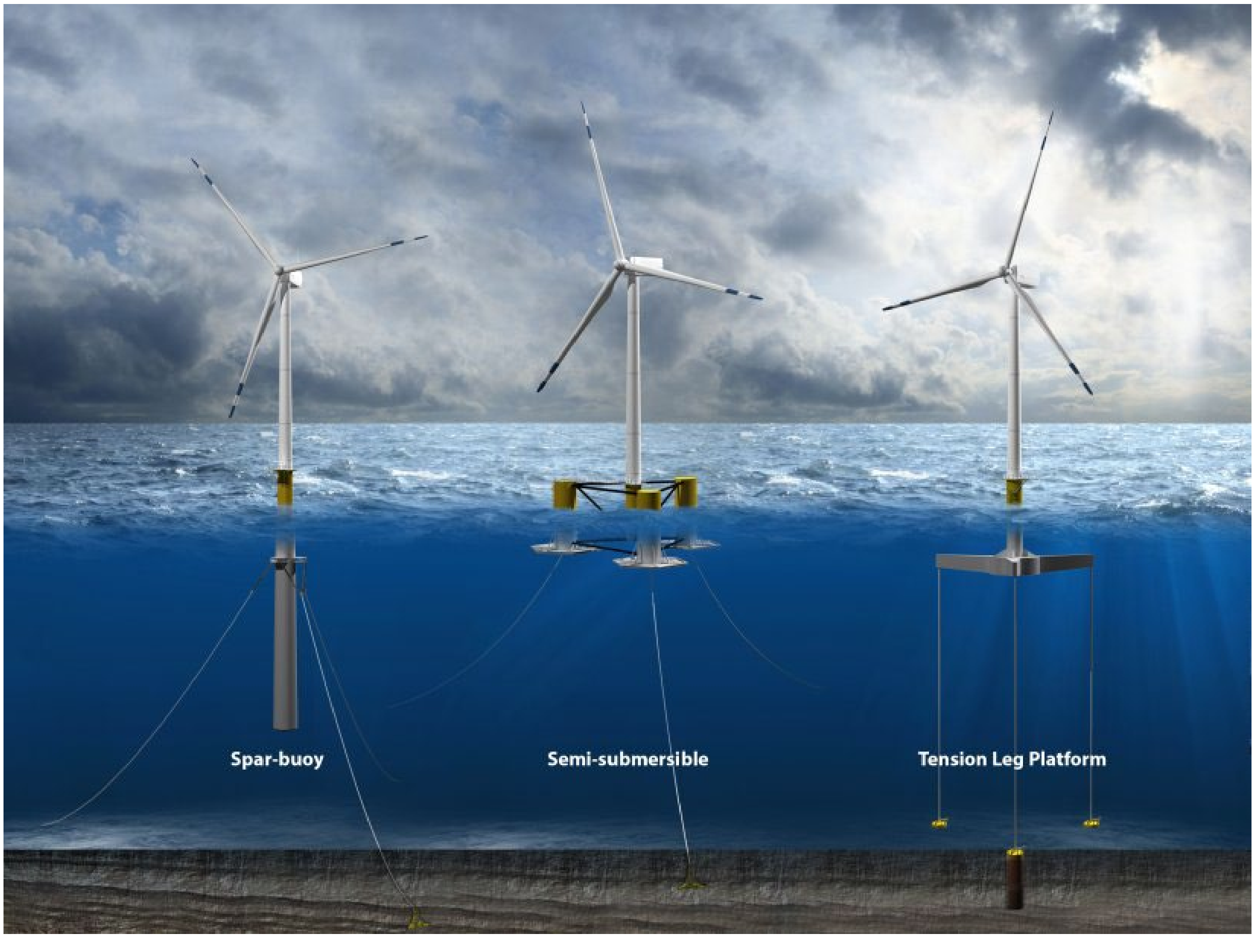
44 Iberdola. "Floating Offshore Wind Power: A Milestone to Boost Renewables Through Innovation." Available at https://www.iberdrola.com/innovation/floating-offshore-wind.

preferred technology. **Volume III, Appendix A** presents several floating offshore wind technologies under development including turbines, mooring, and anchoring and cables.

- **Semi-submersible** designs have several submerged columns or hulls underwater that are attached together with connecting braces. They support the turbine tower and seek to minimize the surface area exposed to the water while maximizing the volume to displace the mass of water and provides buoyancy.
- **Spar-buoy platforms** use a floating foundation, typically consisting of a steel or concrete cylinder filled with a ballast, or both, to keep the center of gravity well below the center of buoyancy. This floating foundation ensures the wind turbine floats in the sea and stays upright. The cylinder, which is at the opposite end from the turbine, provides mass to remain vertical.
- **Tension leg platforms** are multihull floating steel platforms held in place by vertical, tensioned steel cables or tendons connected to the seafloor to eliminate much of the vertical movement of the structure. The platform stays in place using moorings. The tension forces developed in the tendons add additional downward and stabilizing force. Reusable floats are attached to the platform and towed to the offshore anchorage site. Once there, tensioned steel cables or tendons are connected, and the temporary floats are disconnected for reuse on the next platform to be installed.

Barge platforms can also be used for mounting offshore wind turbines, but the potential deployment may be more limited than other platform types. Barge platforms are based on the concept like that of a ship; the beam and length (length and width) of the barge are significantly larger than the draught (height) to create stability. To minimize movement, the platform is usually fitted with heave plates, which are surfaces below the waterline.

Figure 2-2: Types of Floating Platforms



Source: NREL. 2022

Port and Waterfront Infrastructure Development

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. The *Preliminary Assessment of Economic Benefits of Offshore Wind Related to Seaport Investments and Workforce Development* and the *AB 525 Port Readiness Plan* define port and waterfront facilities, describe port governance, and provide an overview of California ports and harbors.[45] Existing port infrastructure on the U.S. West Coast is not adequate to

45 Deaver, Paul and Jim Bartridge. December 2022. *Preliminary Assessment of Economic Benefits of Offshore Wind: Related to Seaport Investments and Workforce Development.* CEC-700-2022-007-CMD. Available at https://www.energy.ca.gov/publications/2022/preliminary-assessment-economic-benefits-offshore-wind-related-seaport.

Lim, Jennifer and Matt Trowbridge (Moffat & Nichol). July 2023. *AB 525 Port Readiness Plan*. 221194/02. Available at https://slcprdwordpressstorage.blob.core.windows.net/wordpressdata/2023/07/AB525-Port-Readiness-Plan_acc.pdf.

support these activities, and significant investment is required to develop offshore wind energy port facilities.[46] The ideal ports to serve California's offshore wind industry will be close to lease areas to reduce transportation-related greenhouse gas emissions, risk, and cost.

Many supply chain activities are also expected to collocate at or near the ports.[47] These ports will need to construct, assemble, and service the foundations of floating offshore wind turbines. 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 where the floating foundations or integrated turbines can be safely moored until they can be towed to the WEAs where the projects will be installed. These storage areas will provide transport flexibility, reducing the risk of downtime caused by inclement weather, conflicts with vessel traffic, and delays from queueing at the port and channel entrances.

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

Commonly used terms related to floating offshore wind port and waterfront facilities include:

- **Berth:** a place in which a vessel is moored alongside a wharf within the port.
- **Draft:** the amount of water required for a vessel to float without touching the bottom.
- **Port:** a maritime facility consisting of one or more terminal sites (for example, Port of Los Angeles, Port of Long Beach, Port of Oakland, Port of San Francisco, and so forth).
- **Port terminal or port site:** a single location within a port to transfer cargo to and from a vessel.
- **Uplands:** storage area adjacent to a wharf for storing cargo.
- **Wharf or quay**: a structure for securing and then loading/unloading vessels within the port.

The following types of port sites will be required to stage, assemble or manufacture, and provide operations and maintenance for offshore wind development, and the specific port requirements for offshore wind are detailed in **Chapter 6** of this strategic plan:[48]

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46 Bureau of Ocean Energy Management. March 2022. *Port of Coos Bay Infrastructure Assessment for Offshore Wind Development.* PR-21-PRT. Available at https://www.boem.gov/PR-21-PRT.

47 Trowbridge, Matt, Jennifer Lim, and Ashley Knipe (Moffatt & Nichol). January 2023. *Alternative Port Assessment to Support Offshore Wind.* 21194/01. Available at https://slcprdwordpressstorage.blob.core.windows.net/wordpressdata/2023/02/Alternative-Port-Assessment-To-Support-Offshore-Wind-Final.pdf.

48 Lim, Jennifer and Matt Trowbridge (Moffat & Nichol). July 2023. *AB 525 Port Readiness Plan*. 221194/02. Available at https://slcprdwordpressstorage.blob.core.windows.net/wordpressdata/2023/07/AB525-Port-Readiness-Plan_acc.pdf.

- **Staging and integration site:** a site to receive, stage, and store offshore wind components and assemble the floating turbine system for towing to the offshore wind area. In addition to turbine integration activities, this facility is likely to support the following services:
    - **Turbine maintenance site:** 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.[49]
    - **End-of-life decommissioning site:** a site to decommission, disassemble, recycle, and dispose of turbine systems that are at end of life.
- **Manufacturing or fabrication site:** a port site located on a navigable waterway that receives raw materials via road, rail, or waterborne transport and creates larger components in the offshore wind supply chain. This site typically includes factory or warehouse buildings (or both) and space for storage of completed components.
- **Operation and maintenance site:** a base for wind farm operations with warehouses/offices, spare part storage, and a marine facility to support vessel provisioning and refueling/charging for the following vessels during the operational period of the offshore wind farm:
    - **Crew transfer vessel:** a vessel that transfer small crews to offshore wind turbine installations for day-trip operations and maintenance visits and inspections.
    - **Service operating vessel:** a vessel that loiters and operates as in-field accommodations for workers and platform assist for wind turbine servicing and repair work.
    - **Service accommodation transfer vessel:** intermediate between service operating and crew transfer vessels, with ability to sleep onboard for multiday trips.
- **Construction support facilities:** a base of construction operations for the fleet of construction vessels necessary for construction and commissioning of the offshore wind farm.
- **Mooring line, anchor, and electrical cable laydown site:** a site to receive and stage mooring lines, anchors, and electrical cables to support the installation of the offshore wind farm.

These facilities must be able to support the construction and transport of floating offshore wind turbines.[50] **Figure 2-3** shows an example of a staging and integration site, while **Figure 2-4** shows and example of a manufacturing and fabrication site.

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49 A *nacelle* is a cover housing for all of the generating components in a wind turbine, including the generator, gearbox, drive train, and brake assembly.

50 There is an additional offshore wind site that may be located at or near a port that is not listed in the summary of needed sites above as additional studies are underway to assess transmission needs. However, ports may also include cable landing sites, which are locations for electrical cables to transition from offshore, such as subsea cables, to a grid connection location or substation and may include electrical infrastructure onshore.

Figure 2-3: Conceptual Staging and Integration Facility Site

Source: Port of Long Beach.

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. **Figure 2-4** shows 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.[51]
- **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.[52]

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51 The pitch system adjusts the angle of the wind turbine blades with respect to the wind, controlling the rotor speed and amount of energy the blades can extract.

52 Shields, Matt, Ruth Marsh, Jeremy Stefek, Frank Oteri, Ross Gould, Noe Rouxel, Katherine Diaz, Javier Molinero, Abigayle Moser, Courtney Malvik, and Sam Tirone (National Renewable Energy Laboratory, DNV, and The Business Network for Offshore Wind). March 2022. *The Demand for a Domestic Offshore Wind Supply Chain*. NREL/TP-5000-8-81602. Available at https://www.nrel.gov/docs/fy22osti/81602.pdf.

Figure 2-4: Conceptual Manufacturing and Fabrication Facility Site

Source: Composite World.

California ports and waterfront facilities will need to be upgraded to support offshore wind development activities, and a multiport strategy will be required. The *AB 525 Port Readiness Plan Draft Report* (Port Plan) examined existing ports along the California coast and found that more than 16 large and 10 small port terminal sites may be needed to support California's offshore wind planning goal of 25 GW by 2045.[53] Further, additional economic benefits may be realized if industrial clusters are developed near ports where offshore wind related business units are geographically concentrated. This development could enable economies of scale, reduce transportation and logistics costs, and reduce supply chain costs and issues.

Chapter 3 details the economic benefits associated with port and waterfront infrastructure development, while **Chapter 4** discusses infrastructure upgrades needed to meet the state's offshore wind planning goals and create a sustainable offshore wind industry in California. **Chapter 6** provides a more detailed look at the current state of California's ports and assesses the upgrades needed to support the offshore wind planning goals.

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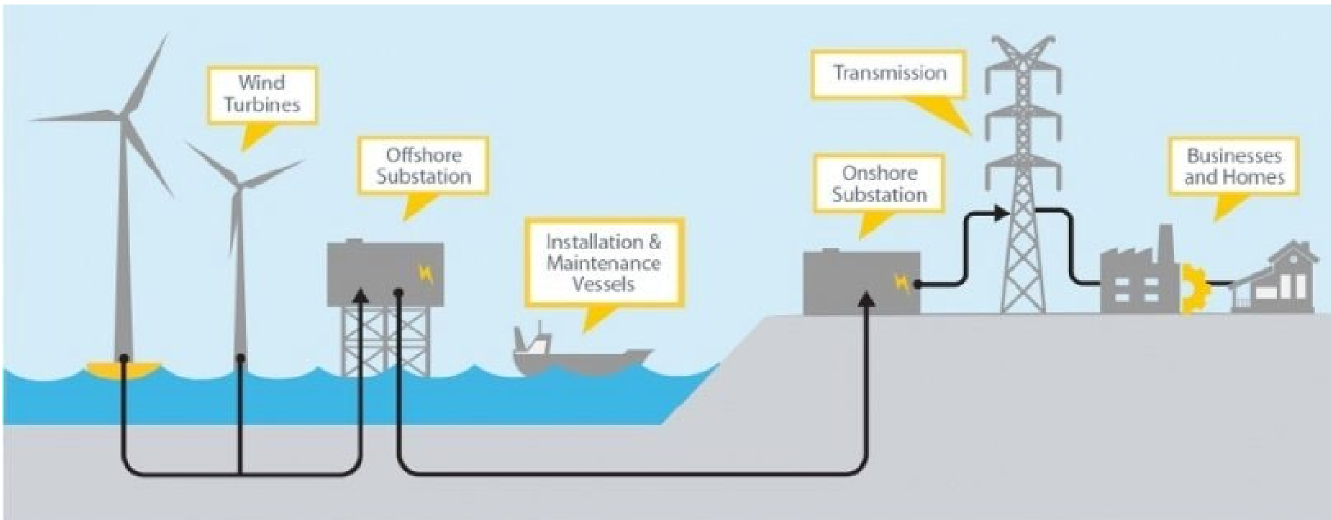
53 Lim, Jennifer and Matt Trowbridge (Moffat & Nichol). July 2023. *AB 525 Port Readiness Plan*. 221194/02. Available at https://slcprdwordpressstorage.blob.core.windows.net/wordpressdata/2023/07/AB525-Port-Readiness-Plan_acc.pdf.

Transmission

Transmission facilities to interconnect floating offshore wind generation and deliver it to the larger transmission system are essential to developing an offshore wind industry. **Figure 2-5** shows major transmission elements that connect offshore wind turbines to the larger transmission and distribution systems.

Figure 2-5: Offshore Wind Transmission Infrastructure

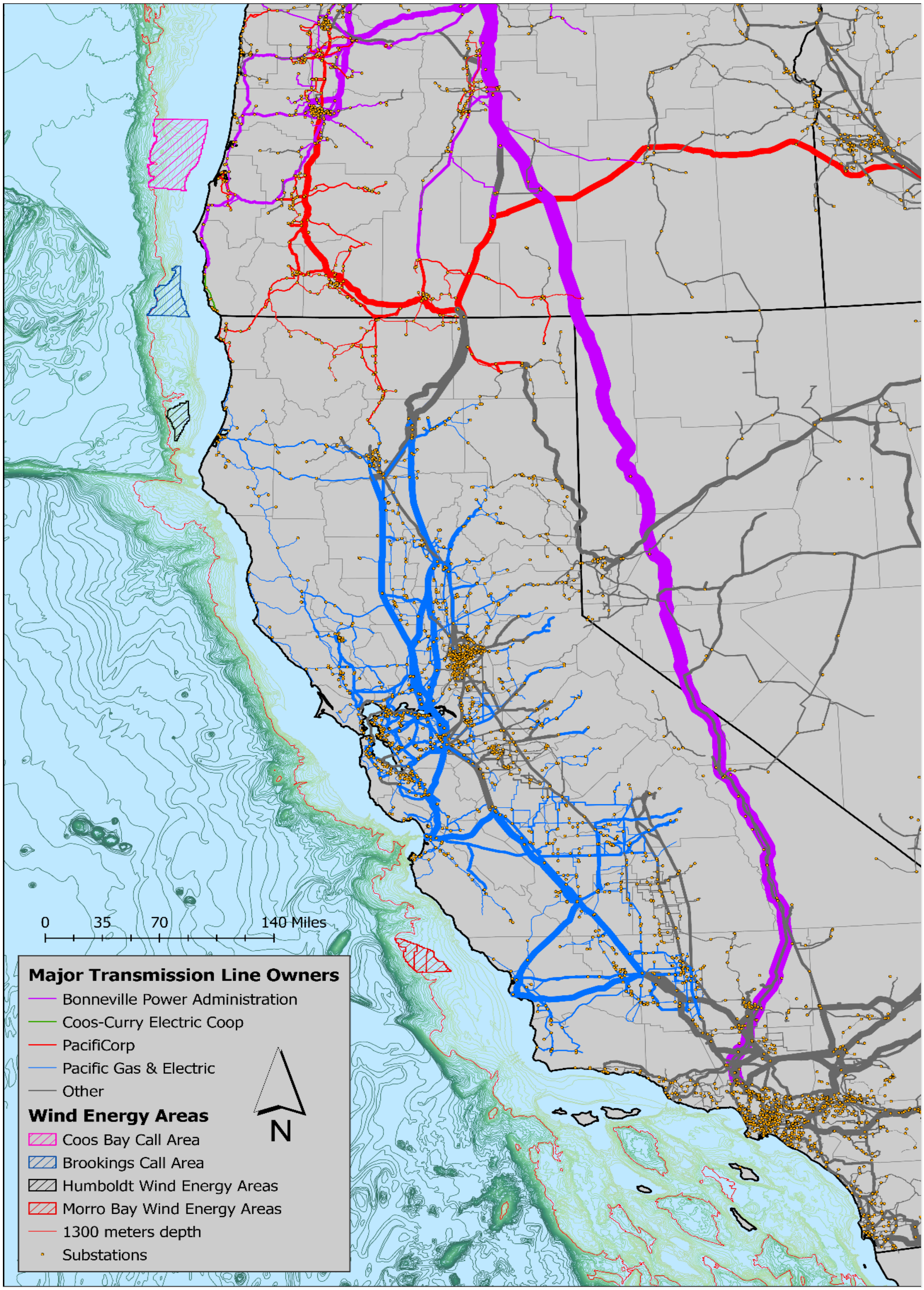


Source: EERE Offshore Wind Energy Strategies Report. 2022

Existing offshore wind deployments have primarily used high-voltage alternating-current (HVAC) systems for transmitting power to shore, although high-voltage direct-current (HVDC) systems are beginning to be deployed. HVAC systems include HVAC transformer substations, reactive power compensation, HVAC export cables, and interconnections to onshore HVAC substations. In general, offshore wind turbines generate power and deliver electricity to an offshore HVAC substation through a series of array cables. The power from the array cables is then aggregated (or collected) and transformed to high voltage on the offshore substation to transmit the electricity efficiently. Offshore substations house the electrical components necessary for high-voltage transmission of power from the wind projects to shore.

The resulting HVAC power is exported to shore via an export cable that drops down from the substation platform to the seabed. The export cable terminates on shore at a landing site, or landfall, from which it is routed to an onshore substation. Once at the onshore substation, the power can be transformed, or stepped down to lower voltages, to serve local load requirements or routed to the transmission system without transformation to serve load elsewhere. California has an extensive transmission system, as shown in **Figure 2-6.**

Figure 2-6: California's Transmission System



Source: Schatz Study. 2023

The map in **Figure 2-6** provides a qualitative overview of major transmission serving California, including the coastal areas where new transmission will be needed. The thickness of the lines is indicative of the line voltage, and, therefore, the associated transmission capacity measured in kilovolts (kV).[54] The thickest north-to-south purple line that runs nearly the length of the map is a high-voltage direct-current (DC) line called the Pacific DC Intertie, which connects large-scale hydroelectric power in the Pacific Northwest to the Los Angeles area. The next thickest group of lines represent 500 kV alternating current (AC) lines, that run primarily north to south along the Interstate 5 corridor and connect to large load centers and power plants. Connecting to the 500 kV network, the next thickest lines represent 230 kV AC lines, after which thinner 115 kV AC lines are represented. Finally, the thinnest lines shown represent 60 to 69 kV AC lines. The Northern California coast is served primarily by 115 kV and 69 kV lines.

54 Transmission line voltages typically vary in size from 69 kV to 765 kV.

CHAPTER 3: Offshore Wind Potential Economic and Workforce Benefits

In AB 525, the Legislature found that developing offshore wind resources presents an opportunity to realize economic and workforce benefits and attract investment capital to California. These benefits include developing and preserving a local skilled and trained construction workforce to carry out projects, long-term job creation, and establishment of a local offshore wind supply chain and economy. Seaports (or ports) and waterfront facilities, such as piers and wharves, will be an important driver of these potential economic benefits. The ports are essential to developing of a local supply chain that can support the scale of offshore wind development needed to meet the 2045 planning goals and maximize economic and workforce development benefits.

Offshore wind economic and workforce benefits can be realized across the state, with some of the greatest impact at the regional and local levels. Significant investments in ports and waterfront facilities will be needed to support offshore wind development and capture potential economic benefits. This chapter discusses the economic benefits of offshore wind related to ports and workforce development as required by AB 525. The importance of ensuring an equitable distribution of benefits and the need for capacity building for underserved communities to meaningfully participate in advocating for community benefits is also discussed. **Chapter 6** addresses the need for port infrastructure and identifies the upgrades and investments necessary to support the development of the offshore wind industry at scale. **Chapter 7** addresses the workforce necessary for offshore wind development.

In February 2023, the CEC adopted an interim report required by AB 525 titled *Preliminary Assessment of Economic Benefits of Offshore Wind Related to Seaport Investments and Workforce Development* (Preliminary Economic Assessment).[55] This chapter provides additional information on potential economic benefits of offshore wind from studies completed since the earlier CEC adopted report. This chapter presents the results of a study, funded by the Governor's Office of Business and Economic Development (GO-Biz) and prepared by Catalyst Environmental Solutions, titled *Analytical Guidance and Benefits Assessment for AB 525 Strategic Plan* (Catalyst Assessment).[56] In addition, this chapter discusses a recent study on the potential economic and workforce benefits associated with the proposed CADEMO

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55 Deaver, Paul and Jim Bartridge. December 2022. *Preliminary Assessment of Economic Benefits of Offshore Wind: Related to Seaport Investments and Workshop Development.* CEC-700-2022-007-CMD. Available at https://www.energy.ca.gov/publications/2022/preliminary-assessment-economic-benefits-offshore-wind-related-seaport.

56 Catalyst Environmental Solutions. April 2023. *Analytical Guidance and Benefits Assessment for AB 525 Strategic Plan: Seaport and Workforce Development for Floating Offshore Wind in California*. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250296.

offshore wind demonstration project in state waters and additional offshore wind resources off the Central Coast titled *Trial Run for California's Offshore Wind Workforce: Lessons Learned From the CADEMO High Road Training Partnership* (CADEMO Report).[57] The chapter also discusses a recent study by the National Resource Defense Council (NRDC) and Environmental Entrepreneurs (E2), titled *California's Offshore Wind Opportunity: Creating Jobs by Developing a New Clean Energy Resource, and Capitalizing on a Robust Job Creation Potential.*[58]

Potential Economic Benefits from Offshore Wind Development

Economic benefits are those benefits that can be quantified in terms of money generated, such as net income, revenue, profit, and cash flow. Economic benefits from offshore wind development may include business output or sales, increases in gross domestic product (GDP) or gross state product (GSP),[59] the number of jobs created, and increased wages.

As shown in **Figure 3-1**, there are generally three main categories of economic benefits, defined below:

- **Direct Benefits:** These benefits are the initial change in economic activity related to the development of the offshore wind industry that measures the monetary value and jobs that are injected into the local economy. Direct impacts include money spent for on-site labor, development, construction, and operations and maintenance. Enterprises that would create direct impacts from floating offshore wind activities include project developers, environmental and permitting consultants, road builders, concrete-pouring companies, construction crews, tower erection crews, crane operators, and operations and maintenance personnel.
- **Indirect Benefits:** These benefits measure the response of local industries to increased demand from interindustry transactions. Economic benefits can be created from increased direct on-site demand for components, equipment, and supply chain services, spurred by offshore wind development.[60] The indirect impacts trace the ripple effect through the local economy as local industries increase supply because of the increase in demand generated from the construction and operation of offshore wind

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57 Collier, Robert, David Vallee, Miriam Noonan, and Stephanie Tsai. July 2023. *Trial Run for California's Offshore Wind Workforce: Lessons Learned From the CADEMO High Road Training Partnership*. Available at https://offshorewindhrtp.slocoe.org/.

58 Environmental Entrepreneurs. February 2023. *California's Offshore Wind Opportunity: Creating jobs by developing a new clean energy resource, and capitalizing on a robust job creation potential*. E2R: 22-10-B. Available at https://e2.org/reports/ca-offshore-wind-opportunity-2022/.

59 *Gross domestic product* is a common measure of output and economic activity. It measures the market value of all goods and services produced by a country's economy over a specified period. It includes all final goods and services – those produced by the economic agents located in that country regardless of their ownership and that are not resold in any form. GSP is similar to GDP, but the measure is for a state rather than a country.

60 Offshore wind facilities will require turbines, construction supplies, and maintenance, which increases the demand for inputs. This increased demand creates (indirect or supply chain) economic benefits.

projects.[61] Companies that could create supply chain impacts equipment manufacturers, construction material suppliers, legal and business professionals, and financial analysts.[62]

- **Induced Benefits:** These benefits are the response of local industries to the increased expenditures resulting from new household income generated from direct and indirect effects. Induced benefits are created from increased household income, from the initial direct and indirect economic impacts, being spent back into the local economy. Examples include households spending some of their increased income (from direct and indirect economic benefits) at local businesses like grocery and retail stores, legal services, childcare, and entertainment venues.[63]

In addition to the three categories of benefits identified above, tax revenue can be generated through increased business transactions from the construction and operation of offshore wind resources. Economic benefits can also come from increased tax revenue from 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. Tax revenue benefits can be measured as increased local, state, and federal tax revenues from offshore wind activities.

Although economic benefits from offshore wind come from several activities, most are expected to come from workforce development in the form of long-lasting (more than 20 years) and 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. Some studies estimate that upward of 80 percent of the offshore wind workforce could be in the supply chain.[64] Workforce development is discussed more in **Chapter 7**.

Income generated from offshore wind activities would be spent back into local, regional, and greater state economies, bolstering economic activity throughout the state in both the short and long terms. The *multiplier effect* of income being spent into the local economy can be

61 Offshore wind facilities will require turbines, construction supplies, and maintenance, which increases the demand for inputs. This increased demand creates economic benefits.

62 A *supply chain* is the network of individuals, organizations, resources, activities, and technology involved in the creation and sale of a product. For floating offshore wind, this refers to the creation and sale of all components making up the completed offshore wind plant. Supply chain facilities include manufacturing, engineering, and construction machinery to develop blades, towers, nacelles, floating platforms, and electrical equipment and cables. Offshore wind vessels and training facilities may also be considered part of the supply chain. In this report, this definition will refer to the creation and sale of all offshore wind components making up the completed offshore wind plant.

63 This is an example of the ripple effect: economic benefits continuing to be created from an initial economic impact or benefit from money being spent back into the local economy.

64 Stefek, Jeremy, Chloe Constant, Caitlyn Clark, Heidi Tinnesand, Corrie Christol, and Ruth Baranowski (National Renewable Energy Laboratory). October 2022. *U.S. Offshore Wind Workforce Assessment*. NREL/TP-5000-81798. Available at https://www.nrel.gov/docs/fy23osti/81798.pdf.

especially strong around large supply chain facilities where many jobs could be created.[65] It will take time for this new industry to attract manufacturers, fabricators, and the facilities needed to assemble wind turbines; offshore wind projects will likely rely on materials and components from abroad while supply chain businesses develop in California. This situation suggests that economic benefits from the supply chain workforce will initially be low but increase significantly over time as the supply chain expands.

Offshore Wind Short-Term and Long-Term Benefits

Economic benefits defined above (direct, indirect, and induced), and shown in **Figure 3-1,** can be short-term or long-term. Building or upgrading a port to support offshore wind development can provide short-term economic benefits during construction, which end once construction is complete. While ports will play a critical role in offshore wind development, serving as hubs for manufacturing, logistics, training, construction, and transportation, the benefits are primarily short-term. Construction activity at ports may include dredging to make berths and navigation channels wide and deep enough to support the offshore wind industry. Other work at ports could include creating storage areas for components; increasing the weight bearing capacity of the wharves; creating breakwaters; purchasing and installing industrial equipment like heavy-lift cranes, road improvements; and building training and education facilities (such as buildings, equipment, and so forth). 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. These offshore wind activities are examples of short-term economic benefits, as they are expected to be completed in two to five years.

Once a port has been upgraded with the capabilities to support offshore wind activities, a trained and skilled workforce will be needed to manufacture and assemble offshore wind turbines. Direct benefits come from money generated through the manufacture and assembly of offshore wind turbines that include job creation, increased labor income, business transactions, and tax revenue generated from activities at the port. The need for components that will be assembled — including blades, turbines, towers, platforms, anchors, cables, mooring lines, and smaller electrical components — increases economic output and represents indirect economic benefits. These benefits can also spur growth in the local supply chain, which also includes activities such as inspecting components and turbine assemblies, manufacturing safety equipment, providing legal services, and providing science and engineering work.

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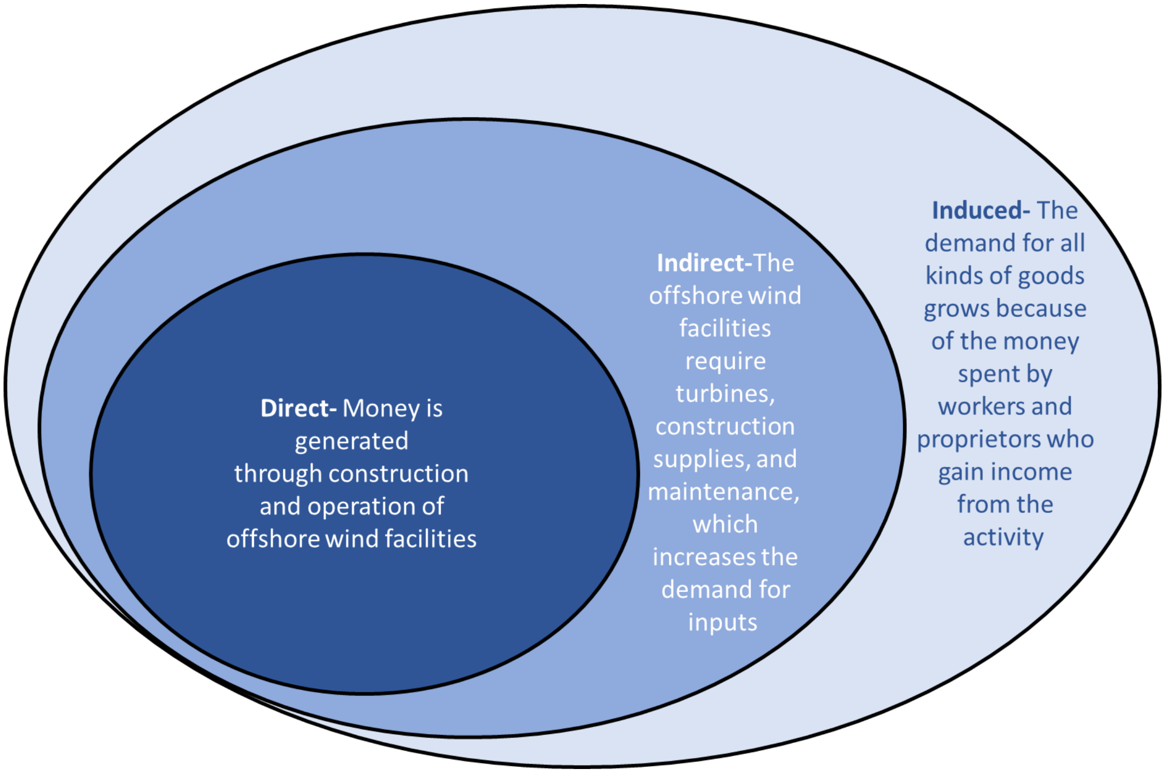
65 The *multiplier effect* indicates that an injection of new spending or investment can lead to a larger increase in final income (GSP) in a given region or economy.

Figure 3-1: Types of Beneficial Impacts



Source: Catalyst Assessment. 2023

The direct and indirect benefits from the activities discussed above can also produce long-term induced economic benefits from the multiplier effect. Increased labor and business or proprietor income recirculated in the local economy in restaurants and other local businesses can create additional economic activity.

In contrast, economic benefits realized from operating and maintaining offshore wind resources over the operational life (25 to 30 years) are considered long-term benefits. Long-term activities that generate economic benefits and jobs include general operations and maintenance such as turbine repairs, purchasing replacement parts, and other related activities. These activities can also include ongoing environmental monitoring and data collection, as well as offshore wind training at the ports.

California Statewide Economic and Workforce Benefits

The CEC's Preliminary Economic Assessment reviewed several studies on the economic benefits of offshore wind related to ports and workforce. This included studies by the University of Southern California Schwarzenegger Institute for State and Global Policy, the American Jobs Project, NREL and BOEM, Guidehouse, and the California Polytechnic State University, San Luis Obispo. As noted above, this chapter discusses additional studies completed in recent months.

The Catalyst Assessment modeled the hypothetical statewide economic benefits of offshore wind development assuming two scenarios — one with policy support and one without policy support.[66] The model estimates hypothetical total direct, indirect, and induced impacts on jobs, income, and output resulting from a dollar of spending on goods and services in the state.[67] Catalyst estimates the economic benefits associated with:

- **Workforce development:** Forecasting the number and types of jobs needed for the offshore wind workforce, by component and phase, then applying salary estimates to derive income estimates.
- **Seaport development:** Forecasting the economic impact from constructing port facilities assuming a total cost of about $125 million over three years.[68]
- **Training facility development:** Forecasting the economic impacts from constructing a new training facility at the port site assuming a total cost of $10 million over two years.

Using the IMPLAN model, the Catalyst Assessment derives estimates of economic activity (GDP), job creation, labor income, and fiscal impacts, as shown in **Table 3-1**. Estimates are provided for 2023, 2024, 2025, 2030, and 2045 to reflect the impact of the initial short-term investments required for facility development (such as port and training facilities) in the near term, and the longer-term impacts for AB 525 planning years 2030 and 2045, which represent the ongoing operation of the offshore wind projects.[69]

As shown in **Table 3-1**, the first column for each year (grey with text not bolded) presents the results for the scenario without policy support, and the second column for each year (blue with bolded text) presents the results of the scenario with policy support. These columns provide a range of possible benefits for each investment type for each modelled year. **Table 3-1** illustrates that the ripple effect of workforce development results ranging from 6,300 annual long-term jobs (without policy support in 2030) to 16,600 annual long-term jobs (with policy support in 2045). Labor income ranges from $550 million annually (without policy support in 2030) to $1.6 billion annually (with policy support in 2045). GDP ranges from $2.4 billion per year (without policy support in 2030) to $6.9 billion per year (with policy support in 2045). For the port development and the training center construction combined, between 400 and 550 short-term jobs are needed per year of construction, providing short-term labor

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66 The scenario with policy support assumes that sufficient policies are in place to result in everything for offshore wind being manufactured and assembled within California or region, to the extent possible.

67 Catalyst uses the input-output model IMPLAN (developed by the U.S. government and University of Minnesota) that simulates how the cost and investment of developing port and workforce would impact the California statewide economy. As directed in AB 525, it analyzes the potential benefits and does not consider the costs such as adverse economic impacts to existing industries or stakeholders.

68 Catalyst relied on a preliminary port construction estimate prepared by Moffatt & Nichol for the Humboldt Marine Terminal. This assessment was conducted before development of the Port Assessment discussed in Chapter 6 (Ports and Waterfront Facilities), which identifies the costs for full build-out of port facilities to support the 25 GW goal by 2045. As such, the economic benefit estimates by Catalyst are conservative.

69 For simplicity and to avoid duplication, as the annual results for 2024 and 2025 are identical, these annual values are presented one time only under the column titled *2024/2025 annual* and represent the annual values for 2024 and 2025.

income of $34 million to $45 million and $85 million to $115 million in GDP annually between 2023 and 2025, with the lows related to the scenario without policy support and the highs consistent with the policy support scenario.

The Catalyst Assessment used recent studies for information on the amount and distribution of the offshore wind workforce needed to estimate economic benefits. The studies include the American Jobs Project offshore wind report,[70] Guidehouse,[71] and NREL & BOEM.[72] As noted above, these studies are discussed in the CEC's Preliminary Economic Assessment. Supply chain workforce need is projected to be larger than other workforce categories. The report used the NREL & BOEM study for estimates of total job need from the 16 GW scenario, and the other two reports provided the type and distribution of jobs needed. For each report or study, Catalyst used the upper-bound installed capacity scenario to estimate job need. Although these previous studies did not model a scenario of up to 25 GW, they all modeled a maximum build scenario.

Table 3-1: Summary of Hypothetical Offshore Wind Statewide Beneficial Impacts

Investment	**2023**		**2024/2025 annual**		**2030**		**2045**	
Number of Jobs								
	without policy	**with policy**	without policy	**with policy**	without policy	**with policy**	without policy	**with policy**
Workforce Development					6,279	**7,306**	14,137	**16,610**
Seaport Development	406	**444**	406	**444**				
Training Center Construction			98	**98**				
Total	406	**444**	504	**542**	6,279	**7,306**	14,137	**16,610**
Labor Income (in $ millions)								
	without policy	**with policy**	without policy	**with policy**	without policy	**with policy**	without policy	**with policy**
Workforce Development					$550.5	**$671.2**	$1,266	**$1,562**
Seaport Development	$33.5	**$36.8**	$33.5	**$36.8**				

70 American Jobs Project. February 2019. *The California Offshore Wind Project: A Vision for Industry Growth*. Available at http://americanjobsproject.us/wp/wp-content/uploads/2019/02/The-California-Offshore-Wind-Project-Cited-.pdf.

71 Guidehouse Inc. May 2022. "California Supply Chain Needs Summary." California Energy Commission. TN 242928. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=242928&DocumentContentId=76513.

72 Speer, Bethany, David Keyser, and Suzanne Tegen (National Renewable Energy Laboratory). April 2016. *Floating Offshore Wind in California: Gross Potential for Jobs and Economic Impacts From Two Future Scenarios*. Bureau of Ocean Energy Management. NREL/TP-5000-65352, Contract No. DE-AC36-08GO28308, OCS Study BOEM 2016-029. Available at https://www.nrel.gov/docs/fy16osti/65352.pdf.

Investment	2023		2024/2025 annual		2030		2045	
Training Center Construction			$8.1	**$8.1**				
Total	$33.5	**$36.8**	$41.6	**$44.9**	$550.5	**$671.2**	$1,266	**$1,562**
Output GDP (in $ millions)								
	without policy	**with policy**	without policy	**with policy**	without policy	**with policy**	without policy	**with policy**
Workforce Development					$2,395	**$2,833**	$5,803	**$6,883**
Seaport Development	$85.2	**$96.6**	$85.2	**$96.6**				
Training Center Construction			$18.7	**$18.7**				
Total	$85.2	**$96.6**	$103.9	**$115.3**	$2,395	**$2,833**	$5,803	**$6,883**

Source: Catalyst Assessment. 2023

The NREL & BOEM study generally had the largest estimates of jobs from the three studies, which Catalyst used for estimates of total jobs needed. Because the three studies consider less than 25 GW, the Catalyst Assessment may underestimate the economic benefits of a full 25 GW build-out by 2045.

The studies and assumptions Catalyst used in its analysis are summarized in **Table 3-2** for 2030 and **Table 3-3** for 2045. The additional details on how these estimates are derived are presented in the Catalyst Assessment.

Table 3-2: Estimated Jobs Needed for Workforce Development for 2030 Goals

Source/Model	Supply Chain	Construction	Operations & Maintenance	Total Jobs
American Jobs Project	2,100	350	1,200	3,650
NREL	5,490	1,130	1,660	8,280
Guidehouse	1,936	125	314	2,375
Total Range	**1,936 – 5,490**	**125 – 1,130**	**314 – 1,660**	**2,375 – 8,280**

Source: Catalyst Assessment. 2023

Table 3-3: Estimated Jobs Needed for Workforce Development for 2045 Goals

Source/Model	Supply Chain	Construction	Operations & Maintenance	Total Jobs
American Jobs Project	9,000	1,400	2,600	13,000
NREL	11,280	2,340	4,330	17,950
Guidehouse	1,936	173	1,508	5,063
Total Range	**3,382 – 11,280**	**173 – 2,340**	**1,508 – 4,330**	**5,063 – 17,950**

Source: Catalyst Assessment. 2023

Regional Economic and Workforce Benefits

Along with the analysis of the economic impacts of offshore wind development to the state, the Catalyst Assessment included a sample analysis of a smaller four-county area around the likely port development project in Humboldt Bay. It identified the Greater Humboldt Area to encompass a four-county region that includes Humboldt, Del Norte, Trinity, and Mendocino Counties.[73] The following sections present the results of the Greater Humboldt Area model, assuming the same input data and sources as the full state model for investment in workforce, port, and training center development under the same scenario assumptions as the California model. **Table 3-4** shows the results of the analysis.

The modelling demonstrates that the ripple effect of workforce development results in a range of long-term annual jobs: 6,300 jobs (without policy support in 2030) to 18,600 jobs (with policy support in 2045). Labor income ranges annually from $465 million (without policy support in 2030) to $1.4 billion (with policy support in 2045). GDP ranges from $2.2 billion per year (without policy support in 2030) to $6.8 billion per year (with policy support in 2045). For the port development and the training center construction combined, the short-term full beneficial impact is between 360 jobs (without policy support) and 540 jobs (with policy support) for each year of construction. This impact provides short-term labor income ranging from $23 million to $35 million and GDP ranging from $62 million to $98 million annually between 2023 and 2025, with the lower estimate from the scenario without policy support and higher estimates from the scenario with policy support.

Table 3-4: Summary of Hypothetical Offshore Wind Greater Humboldt Area Beneficial Impacts

Investment	2023		2024/2025 annual		2030		2045	
Number of Jobs								
	without policy	**with policy**	without policy	**with policy**	without policy	**with policy**	without policy	**with policy**
Workforce Development					6,302	**8,448**	13,642	**18,613**
Seaport Development	362	**448**	362	**448**				
Training Center Construction			93	**93**				
Total	362	**448**	455	**541**	6,302	**8,448**	13,642	**18,613**
Labor Income (in $ millions)								
	without policy	**with policy**	without policy	**with policy**	without policy	**with policy**	without policy	**with policy**

73 The state-level and four-county-region results are not comparable due to the limitations of the IMPLAN model and the introduction of aggregation bias when the four counties are aggregated into one region. Each analysis must be assessed individually.

Investment	2023		2024/2025 annual		2030		2045	
Workforce Development					$465.7	**$616.4**	$1,028	**$1,382**
Seaport Development	$23.4	**$28.6**	$23.4	**$28.6**				
Training Center Construction			$6.4	**$6.4**				
Total	$23.4	**$28.6**	$29.8	**$35.0**	$465.7	**$616.4**	$1,028	**$1,382**
Output GDP (in $ millions)								
	without policy	**with policy**	without policy	**with policy**	without policy	**with policy**	without policy	**with policy**
Workforce Development					$2,153	**$2,862**	$5,126	**$6,820**
Seaport Development	$62.0	**$83.2**	$62.0	**$83.2**				
Training Center Construction			$14.4	**$14.4**				
Total	$62.0	**$83.2**	$76.4	**$97.6**	$2,153	**$2,862**	$5,126	**$6,820**

Source: Catalyst Assessment. 2023

CADEMO Potential Economic and Workforce Benefits

Another recent study by the California Offshore Wind High Road Training Partnership, with funding from the California Workforce Development Board, assesses the potential economic benefits associated with the proposed CADEMO demonstration offshore wind project and a larger build-out of offshore wind in state waters off the Central California coast.[74] The CADEMO Report finds that the floating offshore wind industry represents a major opportunity to provide clean energy, using nearby abundant wind resources while promoting significant job growth and economic development throughout the state. The report also finds that supply chain-related economic impacts may be small at first but will grow as California develops its offshore wind supply chain and manufactures more components locally. The report analyzes two floating offshore wind projects:

- The proposed CADEMO demonstration project in state waters off the Central California coast. This project proposes to use four 15 MW turbines totaling 60 MW and is proposed to be operational by the late 2020s. If permitted, construction of the project is expected to take three years.

74 Collier, Robert, David Vallee, Miriam Noonan, and Stephanie Tsai. July 2023. *Trial Run for California's Offshore Wind Workforce: Lessons Learned From the CADEMO High Road Training Partnership*. Available at https://offshorewindhrtp.slocoe.org/.

- A 1 GW hypothetical floating offshore wind project off the California coast, near Morro Bay that would use sixty-six 15 MW turbines and is assumed to be operational by 2030. Construction is projected to take six years.

The CADEMO Report assumes for both projects that the floating offshore wind foundations would be manufactured in California using concrete, while other components such as nacelles, towers, and blades would be imported from outside California, at least in the short term. The report authors state that staging and integration activities are expected to occur at the Port of San Francisco or the Port of Los Angeles. As a result, the economic impacts for these types of activities would occur outside the cities surrounding the proposed CADEMO project. The CADEMO Report suggests that economic and workforce estimates for these two projects could provide insights into near-term commercial offshore wind projects in the Humboldt Bay and Morro Bay Call Areas.

The CADEMO Report estimates that constructing the four offshore wind turbines of the pilot project would create more than 900 full-time jobs and more than $200 million in economic output over the three years needed to complete construction. For long-term operations and maintenance, the report estimates 23 annual jobs could be created, and more than $5 million in economic output could be produced each year. The study examines three additional scenarios that assume higher percentages of local content, all of which indicate increased economic and workforce benefits. **Table 3-5** shows the total estimated statewide construction impacts over the project construction period (three to five years). **Table 3-6** shows the total estimated statewide operations and maintenance impacts, which are estimated annual values over the life of the project (or 25 years).

The bulk of Central Coast economic impact would be generated by local construction of transmission facilities and an onshore electrical substation, as well as ongoing operations and maintenance over CADEMO's expected 25-year lifespan. The proposed CADEMO project would be expected to directly employ a total of 697 full-time-equivalent (FTE) jobs in California (onsite and supply chain) during the three- to five-year development and construction timeline of the project.[75] CADEMO's onsite jobs — those in Santa Barbara and San Luis Obispo counties — would be modest in comparison to the jobs created in the supply chain category, most of which would be for platform construction.

Table 3-5: CADEMO Project Economic and Workforce Benefits (Construction Phase)

Impact Categories	Jobs (FTE)	Earnings (Millions)	Output (Millions)	GDP (Millions)
Onsite	20	$2.0	$2.0	$2.0
Supply Chain	677	$66.1	$156.6	$84.7
Induced	225	$13.1	$44.7	$27.0
Total	922	$81.2	$203.4	$113.7

Source: CADEMO Report. 2023

75 This is an annualized figure. One full-time (40 hours per week) job for three years would equate to three FTE. One half-time job (20 hours per week) for two years would equate to one full-time job.

Table 3-6: CADEMO Project Economic and Workforce Benefits (Operations Phase)

Impact Categories	Jobs (FTE)	Earnings (Millions)	Output (Millions)	GDP (Millions)
Onsite	4	$0.4	$0.4	$0.4
Supply Chain	12	$1.1	$3.9	$1.8
Induced	7	$0.4	$1.3	$0.8
Total	23	$2.0	$5.6	$3.1

Source: CADEMO Report. 2023

The construction calculations are based on CADEMO's expected total capital expenditure budget of $338 million. The operations estimates assume $3 million for in-state annual operating expenses. These figures do not include development expenditures, engineering and management costs, or major repairs and replacement.

The CADEMO Report also included estimates of economic impacts for a potential hypothetical Morro Bay project that represents one of the three 1 GW projects in the federal Morro Bay lease area, comprising 66 floating turbines. At the time the CADEMO Report was written, none of the three auction winners had yet finalized its BOEM lease, so the modeling uses generic assumptions and inputs. **Table 3-7** shows the estimated economic and workforce development benefits of the Morro Bay project during construction. For construction, the estimated benefits would be 13,202 full-time equivalent jobs, $1.097 billion in earnings, $3.251 billion in output, and $1.573 billion in GDP. **Table 3-8** shows the estimated annual economic and workforce benefits during Morro Bay project operations. During operations, the estimated benefits would be 684 full-time equivalent annual jobs, $54.6 million annual earnings, $173.1 million annual output, and $89.8 million in annual GDP.

Table 3-7: Hypothetical Morro Bay Project Economic and Workforce Benefits (Construction Phase)

Impact Categories	Jobs (FTE)	Earnings (Millions)	Output (Millions)	GDP (Millions)
Onsite	20	$272	$27	$27
Supply Chain	677	$9,753	$885.2	$2,593
Induced	225	$3,177	$185.7	$631.3
Total	922	$13,202	$1,097.2	$3,251.2

Source: CADEMO Report. 2023

Table 3-8: Hypothetical Morro Bay Project Annual Economic and Workforce Benefits (Operations Phase)

Impact Categories	Jobs (FTE)	Earnings (Millions)	Output (Millions)	GDP (Millions)
Onsite	100	$9	$9	$9
Supply Chain	394	$33.6	$126.2	$57.9
Induced	190	$12	$37.9	$22.9
Total	684	$54.6	$173.1	$89.8

Source: CADEMO Report. 2023

Natural Resources Defense Council and E2 Offshore Wind Opportunity

Another recent study on regional economic benefits from offshore wind development on the Central Coast of California was conducted by the National Resource Defense Council (NRDC) and Environmental Entrepreneurs (E2). This study estimates the economic benefits from developing 10 GW of offshore wind in the Morro Bay and Humboldt offshore wind areas by 2040.[76] The study includes direct, indirect, and induced economic benefits and assumes by 2040 that most labor and materials are locally sourced. For the construction phase of the offshore wind turbines (short-term), the study estimates that more than 169,000 jobs are created and more than $45 billion in economic benefits accrue to the state. For both phases combined (3 GW by 2030 and 7 additional GW by 2040), fiscal benefits from the construction phase are estimated to be more than $5 billion by 2040 (one-time benefit). For the operations and maintenance phase, the study estimates more than 5,000 annual, long-term jobs are created, and more than $1.6 billion in total economic benefits accrue to the state. Lastly, the study estimates more than $200 million per year in local, state, and federal tax revenues are generated from the project, by 2040.[77]

Table 3-9 shows the total estimated economic benefit of the first phase of construction for 3 GW of offshore wind development in 2030. The total estimated short-term impact in California will be more than $11 billion in economic benefits, $3.7 billion in local wages, and $5 billion in GSP. A total estimate of 42,574 jobs will be added as a result of the first phase of offshore wind projects.

Table 3-9: Total Estimated Economic Benefits for 3 GW Offshore Wind (2030)

Project	Employment	Wages	Value Added	Economic Benefits
Morro Bay	25,651	$2,233,249,944	$3,021,754,900	$6,638,609,704
Humboldt Bay	16,922	$1,478,135,337	$2,001,487,449	$4,362,456,181
California Total	**42,574**	**$3,711,385,281**	**$5,023,242,348**	**$11,001,065,885**

Source: E2. 2022

Table 3-10 shows the total estimated short-term economic benefits of the second phase of construction for 7 GW of offshore wind development in 2040. The total estimated impact in California will be more than $34 billion in economic benefits, $11.3 billion in local wages, and $15.3 billion in GSP. A total estimate of 126,187 jobs will be added for the construction of Phase Two of the project.

76 Environmental Entrepreneurs. February 2023. *California's Offshore Wind Opportunity: Creating jobs by developing a new clean energy resource, and capitalizing on a robust job creation potential*. E2R: 22-10-B. Available at https://e2.org/reports/ca-offshore-wind-opportunity-2022/.

77 These estimates include the first phase (3 GW) and the second phase (7 GW), for a total of 10 GW. For example, for the $200 million in expected tax revenues, more than $60 million comes from the first phase and more than $140 million from the second phase.

Table 3-10: Total Estimated Economic Benefits for 7 GW Offshore Wind (2040)

Project	Employment	Wages	Value Added	Economic Benefits
Morro Bay	75,580	$6,790,883,233	$9,124,989,675	$20,401,683,429
Humboldt Bay	50,607	$4,556,608,697	$6,130,171,041	$13,361,102,455
California Total	**126,187**	**$11,347,491,930**	**$15,255,160,176**	**$34,032,785,884**

Source: E2. 2022

The Importance of Developing a Supply Chain

A *supply chain* is defined as the network of all the individuals, organizations, resources, activities, and technology involved in the creation, delivery, and sale of a product. A supply chain encompasses everything from the delivery of source materials from the supplier to the manufacturer through to the eventual delivery to the end user. For floating offshore wind, the supply chain is a network between project developers, ports, training facilities, manufacturing facilities, suppliers, vessels, skilled labor, and others. The supply chain starts at raw material extraction and ends when the offshore wind turbine is fully constructed and ready for operation; it also includes all the steps between these endpoints.[78] First, companies will extract raw materials from the earth and sell them to manufactures or fabricators to create offshore wind components.[79] Most of the offshore wind components will be manufactured at port facilities as they are too large for road or rail transport.

Once the offshore wind components are created from the raw materials, they are delivered to staging and integration areas at port facilities to be assembled into complete offshore wind turbines or larger components. Vessels are needed to transport the offshore wind components to staging and integration facilities and tow the offshore wind area to its destination at sea. The main steps and activities in the offshore wind supply chain include:

- Raw material extraction and transport.
- Manufacturing raw material into offshore wind components.
- Transporting and delivering components to port for construction.
- Constructing the components into a finished offshore wind turbine.
- Towing the finished offshore wind turbine out to sea.

Supply chain activities that require infrastructure to support offshore wind include:

- Manufacturing facilities to create offshore wind components.

78 These steps include sourcing raw materials, refining raw materials into parts, making offshore wind components from those parts, and delivering the components to the project developer to build the offshore wind turbine.

79 Offshore wind components include blades, turbines, towers, platforms, anchors, mooring lines, cables, offshore substations, and other electrical equipment.

- Port facilities for staging and integration of offshore wind turbines and to perform maintenance.
- Suppliers and businesses that supply offshore wind components to developers.
- Vessels and vessel operators to transport offshore wind components to sea.
- Training facilities and curriculum to train a skilled workforce for manufacturing, fabrication, and vessel operation.
- The skilled labor to manufacture and transport offshore wind components, transport the components, and construct them into a completed wind turbine.

A supply chain is instrumental for developing offshore wind and growing the industry. All these activities, facilities, infrastructure, and skilled human capital make up the offshore wind supply chain that creates completed offshore wind turbines ready to generate electricity. Although an offshore wind supply chain that imports goods and services from Europe and China may provide lower costs in the short term, reliance on other countries or regions for critical components of the offshore wind turbines may result in project delays and could expose California markets to supply bottlenecks and price shocks from imported content. Developing a local supply chain can insulate California from these global shocks and reduce risk for investors and ensure sustainable economic and workforce benefits from offshore wind remain in California and benefit local communities throughout the state.

A robust California and West Coast supply chain may provide opportunities for California to export offshore wind components to other states and regions, creating additional economic benefits for the state and supporting other West Coast states' floating offshore wind goals. Moreover, if the supply chain is developed with consideration of underserved communities, it can improve economic benefits for the local economies and the state. Economic benefits directed toward lower-income individuals often have a more significant stimulative effect on the local economy compared to benefits going to high-income individuals. This is because lower-income individuals are more likely to spend a larger proportion of their income on immediate needs and necessities. When they receive additional income or benefits, they tend to spend it on goods and services within their community.[80]

Benefits for Communities

AB 525 highlights the potential for a multitude of benefits from offshore wind, some of which can extend beyond workforce development. Offshore wind benefits can improve public health, services, resiliency, and positively benefit those most impacted by the historical inequities of the energy and other industries, as well as those most affected by climate change impacts. As discussed in Chapter 4, some impacts could be significant to local and underserved communities. The communities that should receive benefits can include, but are not limited to, California Native American and underserved communities, the fishing industry, subsistence and

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80 Duran-Franch, Joana and Ira Regmi (Roosevelt Institute). April 2022. "Increasing Wages for Low-Income Workers Is Key for a Full Economic Recovery." Available at https://rooseveltinstitute.org/2022/04/04/increasing-wages-for-low-income-workers-is-key-for-a-full-economic-recovery/.

cultural fishing, dock workers, coastal visitors, nearby communities, and those historically impacted by the energy industry and those potentially impacted by the offshore wind industry.

Port development and mitigation needs may provide additional opportunities for clean-up of existing environmental pollution from superfund sites and fossil fuel-based industrial development, as well as remove infrastructure no longer in use. There should be targeted engagement and allocation of benefits for California Native American tribes and underserved communities in the region. Tribal consultations and engagement with California Native American tribes and underserved communities should be prioritized to ensure benefits designed to meet the specific needs of these communities and support existing low-income families and individuals equitably.

There are several ways to ensure that community benefits agreements (CBAs) and tribal community benefits agreements (TCBAs) are utilized for energy-related projects to establish community development funds, promote training and/or hiring of local residents, establish percentage goals to use local suppliers, encourage the construction of new facilities, stimulate the use of green building techniques, and establish job training centers.

Future development of the offshore wind industry could become an asset to underserved and tribal communities in the identified offshore wind development areas and near communities where port development may occur.

It is imperative to recognize not only the potential of offshore wind as a clean and sustainable energy source, but also the critical importance of building capacity for communities. Community capacity building is the continuous process required to foster the pride and appropriate local leadership that allows communities, through their members, to take responsibility for their own development.[81] Capacity building is especially important for California Native American tribes and underserved communities that are affected by offshore wind development but may face hardships that prevent them from advocating for themselves in CBA and TCBA processes and meaningfully participating in ongoing tribal consultations and community engagement. Historically, these communities have borne the disproportionate burdens of the energy industry, facing environmental and social challenges that often went unaddressed. However, the emerging offshore wind industry presents an opportunity to correct historical wrongs and serve as an example of equitable energy development. By building the capacity of these communities to actively engage in negotiations, participate in workforce training, create or expand their businesses, and advocate for local solutions, California can mitigate the historical injustices that have plagued the energy sector and pave the way for a more inclusive and sustainable future.

There are several ways capacity building can occur in historically marginalized communities. Some examples include increasing community education and outreach programs, holding public and accessible workshops, and offering technical assistance and training for displaced

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81 Stuart, Graeme (Sustaining Community). March 2014. "What is community capacity building?" Available at https://sustainingcommunity.wordpress.com/2014/03/10/ccb/.

fishing industry workers, students, and local, small businesses. It can also include providing grants to support capacity building and partnerships between community colleges, universities, and industry to create pathways from schools to jobs in the offshore wind industry, and continued outreach. By incorporating these strategies and monitoring these investments in communities, all Californians can benefit from the potential economic benefits from offshore wind development.

CHAPTER 4:
Potential Impacts of Offshore Wind and Avoidance, Minimization, and Mitigation Strategies

AB 525 requires the strategic plan to identify and develop strategies to address the potential impacts of offshore wind on coastal resources, fisheries, Native American and Indigenous peoples, and national defense. AB 525 specifies that:

- Offshore wind should be developed in a manner that protects coastal and marine ecosystems. Significant impacts should be avoided, minimized, monitored, and managed.
- The strategic plan shall make recommendations regarding potential significant adverse environmental impacts consistent with California's long-term renewable energy, greenhouse gas emission reduction, and biodiversity goals.

Though not required by AB 525, potential impacts to underserved communities and strategies to address them are also included in this chapter.

Beginning in early 2022, the CEC and partner agencies consulted with California Native American tribes and engaged with offshore wind stakeholders to solicit additional input on potential impacts from offshore wind development. Numerous confidential tribal consultations, weekly and biweekly meetings, working group calls, workshops, consultations and in-person meetings were held to solicit input on potential impacts and the strategies to address them.

The tribal consultations and engagement built on previous work by state agencies to consult with tribes and engage with affected ocean users and communities to assess potential impacts associated with offshore wind development. Much of this earlier work was captured under the California Coastal Commission's (CCC's) federal consistency review of BOEM's designation of wind energy areas, which included a high-level assessment of impacts to California's coastal resources from future offshore wind development in the proposed wind energy areas.

The following sections summarize the anticipated impacts of offshore wind development and strategies that could mitigate or minimize the potential impacts. A more comprehensive discussion of impacts to coastal resources and communities is contained in the CCC's Consistency Determination and **Volume III, Appendix B.**

Potential Impacts from Offshore Wind Projects

Defining potential impacts for a new floating offshore wind industry is challenging, as no commercially deployed floating offshore wind projects exist in the U.S and the technology is rapidly evolving. In addition, the industry will require major improvements to port and waterfront facilities to support offshore wind development at a scale that could have potentially significant impacts. As a result, the impacts defined here are those that are anticipated, or that have been observed for other major offshore infrastructure projects, including wind facilities, oil and gas platforms, pipelines, and sub-sea power and fiber optic cables that can serve as proxies to understand impacts. Specific offshore wind impacts can be further identified and assessed once specific locations for projects are identified.

Development and operation of offshore wind projects will affect natural, cultural, and tribal cultural resources and existing uses found in offshore, coastal, and onshore environments. Coastal resources and uses include terrestrial and marine ecosystems (habitats and species), air and water quality, visual resources, sacred and culturally significant places and items, religious and cultural practices, commercial, subsistence, and recreational fishing, public access to and along the shoreline, recreation, and industrial infrastructure. While permitting agencies and developers have extensive experience with development and operation of various types of onshore and nearshore facilities, including deepwater oil and gas platforms, less is known about the impacts of floating offshore wind facilities anchored to the seabed and cables transporting electricity to shore.

Floating offshore wind technology is in its infancy and has never been deployed off the coast of California.[82] Therefore, the specific effects of these installations on the marine environment are not fully understood and uncertain. In addition, the characteristics, resources, and existing uses of both the land and sea vary spatially and over time. Consequently, the impacts anticipated to occur from a particular offshore wind project can be defined in detail only when the design of the project and related facilities is known, specific approaches to construction and operation have been determined, and actual locations for all onshore and offshore facilities are identified.

Nevertheless, reasonable inferences can be drawn regarding the types of impacts that may occur from the development and operation of an offshore wind project. Based on the experience of projects elsewhere and other marine-based activities it is possible to anticipate a range of potential impacts that reasonably can be expected to occur. Potential impacts can be identified geographically to include those that occur offshore in the lease area, linear impacts from the export cable to shore, and nearshore impacts from port development and cable landings.

Types of Offshore Wind Activities

As presented in **Chapter 2**, construction, and operation of offshore wind projects within California will require activities in the ocean, at ports and harbors, and onshore. Each of these areas has different geographic, social, and environmental conditions and resources that could

82 A few prototype turbines and floating systems are currently deployed in relatively shallow European waters including Scotland's Hywind (2017) and Kincardine (2021) offshore wind farms.

Haberlin, Damien, Alfonso Cohuo, and Thomas Doyle. 2022. *Ecosystem Benefits of Floating Offshore Wind.* University College Cork. Available at https://hdl.handle.net/10468/13967.

be affected by the construction, operation, and maintenance activities associated with a project. In addition, multiple local, state, and federal agencies will have jurisdiction over various resources and uses in these areas. The agencies involved will vary, depending on the locations of project-related activities and facilities, and the resources and populations affected. Offshore wind project impacts will vary by type, duration, and intensity within each area.

For purposes of identifying potential adverse environmental impacts, offshore wind development activities are broadly defined as occurring in the following three areas:

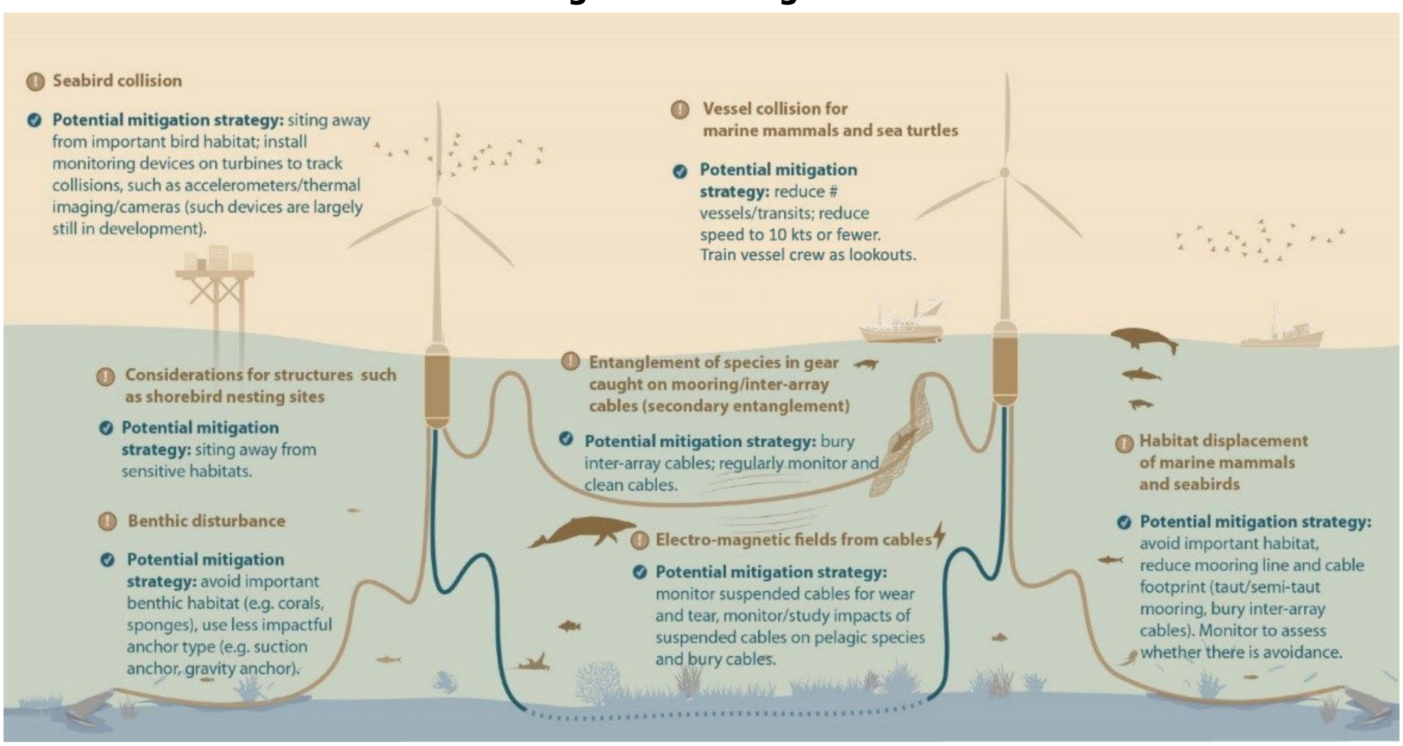
- **Offshore and Nearshore**. This area is the marine environment; it includes both shallow, near-shore areas and more distant deepwater (between 20 and 40 miles offshore) areas of the ocean. These waters and submerged lands fall under federal and state jurisdiction, depending on the distance from shore.
- **Ports and Harbors**. These are areas where there is a confluence of marine- and shore-related activity. In the case of offshore wind projects, ports and harbors will host intense construction and operational support activities, with large land areas dedicated to the storage or warehousing of parts and materials and the assembly of the large turbines and other components such as towers and floating platforms. Extensive warehousing, berthing and anchorage facilities, turning basins, dredged channels, breakwaters, and slips, wharfs, and piers in the tidal areas of ports and harbors are expected.
- **Onshore**. These areas include all lands not within dedicated ports and harbors. Impacts are expected from the development of transmission infrastructure and other activities, such as traffic congestion, the need for new housing, and construction of roadways and infrastructure to support the influx of people into the coastal areas.

Table 4-1 presents the offshore wind activities that are expected to occur within each of the three areas, focusing on activities that could result in potential adverse or beneficial impacts. As described in **Table 4-1** and illustrated in **Figure 4-1**, offshore wind facilities require installation and maintenance of floating turbines, as well as their mooring cables, anchors, electricity cables between turbines and to shore, and marine vessel operations supporting both construction and operation. New and expanded ports and coastal construction yards would be required.

Table 4-1: Potential Sources of Impacts of Offshore Wind Activities

Offshore and Nearshore	Ports and Harbors	Onshore
• Construction and operation and maintenance (O&M) of floating wind turbines, including mooring cables and anchors • Construction and O&M of floating substations and cables to shore • Construction and O&M of inter-array electric cables between turbines • Marine vessel operation to support construction of turbines and associated facilities	• Construction and O&M of new or expanded ports, coastal construction yards and laydown areas, wet and dry storage areas, warehouses, parking areas, and service facilities • New dredging projects to deepen existing channels to accommodate larger vessels • Marine vessel and helicopter operation and services at port facilities	• Construction and O&M of onshore transmission lines, substations, manufacturing facilities, and energy storage facilities, including vehicle, equipment, and helicopter use • Horizontal drilling for bringing electrical cables onshore from turbines or offshore substations • Development of housing and parking for long-term construction and permanent O&M workforce • Construction of new or upgraded infrastructure, including roadways or railways providing access for equipment and project workforce

Figure 4-1: Impacts of Floating Offshore Wind Components and Potential Mitigation Strategies



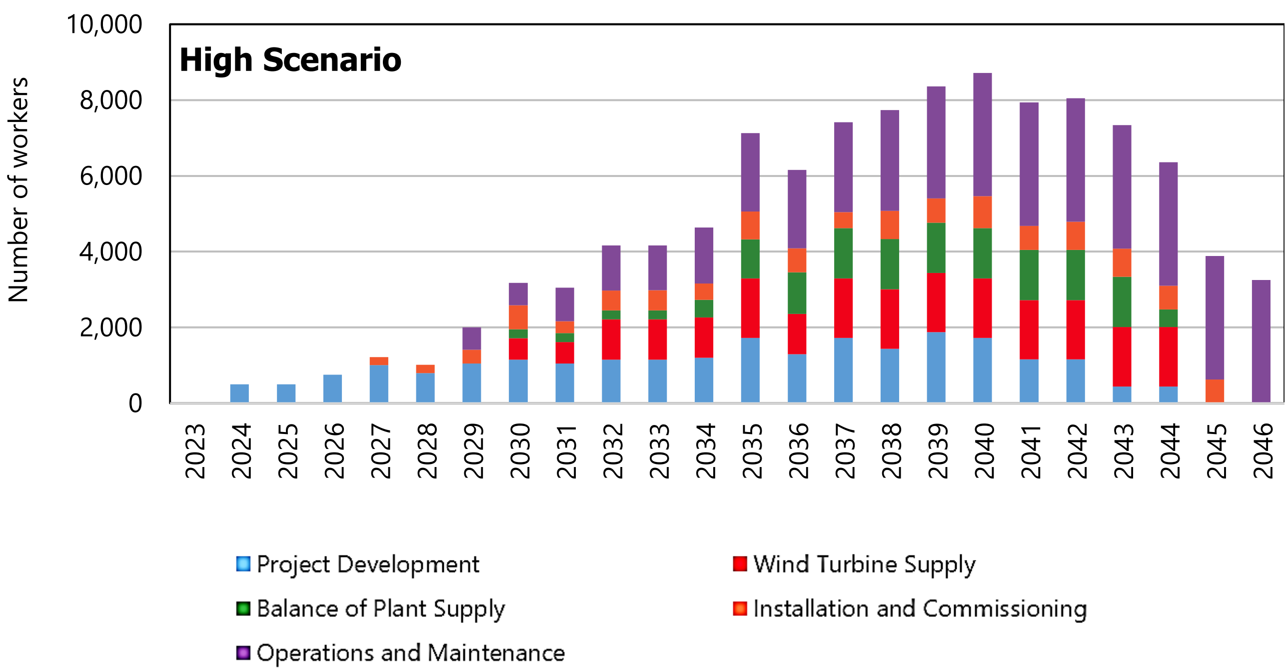
Source: Maxwell et al. 2023

Construction Scheduling and Workforce Assumptions

The impacts associated with offshore construction and operation will vary based on the location, intensity, and duration of activity. The AB 525 Workforce Development Readiness Plan (Workforce Plan) presents a variety of scenarios for the workforce that may be required.[83] The workforce includes people employed at both nearby and distant locations (for example, for project planning, parts manufacturing, and component assembly) as well as at port locations from which offshore facility sites would be accessed.

The most intense expected level of these activities is illustrated in **Figure 4-2** (Offshore Wind Workforce Estimate by Year). Because some impacts vary by the level of employment, this graphic is useful in understanding the number of workers that could be needed each year. Over the life of each project, the workforce would be involved in planning and environmental data collection, manufacturing, construction, and operations. **Figure 4-2** illustrates the potential size of these workforce teams (such as through the project development, manufacturing, construction, and operational phases) through 2046. In the High Scenario (during peak offshore wind employment years) the workforce related to offshore wind is estimated to exceed 8,000 people.

Figure 4-2: Offshore Wind Workforce Estimate by Year



Source: Workforce Plan. 2023

83 Lim, Jennifer and Matt Trowbridge (Moffat & Nichol). July 2023. *AB 525 Port Readiness Plan*. 221194/02. Available at https://slcprdwordpressstorage.blob.core.windows.net/wordpressdata/2023/07/AB525-Port-Readiness-Plan_acc.pdf.

The Workforce Plan did not consider the location of these workers. It is currently expected that offshore wind development will be focused in potential wind energy areas located off the coasts of Mendocino, Humboldt, and Del Norte counties. These areas have very low, largely dispersed populations. For example, the City of Eureka currently has a population of less than 30,000, with other Humboldt County towns and cities having even smaller populations. Therefore, the potential addition through employment of thousands of people to the region could create adverse impacts on natural resources in the affected region and challenges in providing adequate housing, public services, and infrastructure.

Impacts and Mitigation Strategies

Construction and operation of offshore wind facilities have the potential to affect a wide array of resources across a range of environmental topic areas. As previously described, the CCC's Consistency Determinations for the Humboldt and Morro Bay WEAs present a more detailed description of potential impacts associated with offshore wind and associated development.[84] **Volume III, Appendix B** presents a more detailed description of potential impacts by location (offshore, ports and harbors, and onshore).

Specific resources that may be affected depend on the actual location of activities and the nature of a particular project's components and construction methods. In addition, these areas will be affected by ongoing climate change, including sea level rise, as well as a variety of climate impacts of varying magnitude. For these reasons, there is a great deal of uncertainty as to the specific impacts expected as the result of specific offshore wind development. However, there is information available from existing offshore wind projects in other parts of the world, as well as for existing major offshore infrastructure projects in California, including oil and gas platforms, pipelines, and sub-sea power and fiber cables, that likely have similar impacts and were used to inform this assessment of potential impacts from offshore wind. As comprehensive environmental monitoring is advanced and site-specific data is collected, adaptative management strategies will be critical at all stages of offshore wind planning, construction, and operation to properly avoid, minimize, and mitigate adverse impacts and ensure marine resources are protected.

As noted, each of the three geographic areas (offshore and nearshore, ports and harbors, and onshore) where project-related activities would occur has different environmental conditions and resources that could be affected. The nature and severity of project impacts would vary based on where and when specific activities take place. Examples of activities with different timelines include pre-construction surveys and data collection, site preparation and

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84 The California Coastal Commission application of CZMA to BOEM's consistency determinations and the final reviews and adopted conditions and findings for each Wind Energy Area: Humboldt WEA Coastal Commission Consistency Determination Adopted Findings and Conditions and Morro Bay WEA Coastal Commission Consistency Determination Adopted Findings and Conditions.

construction, component assembly and construction, offshore facility installation, operations and maintenance, and decommissioning.[85]

Potential impacts and mitigation strategies for the resource categories highlighted in AB 525 are described in more detail below: marine biological resources, Native American and Indigenous peoples, fisheries, and national defense. While AB 525 did not specifically require the strategic plan to address impacts to underserved communities, a discussion is also included below. Additional impacts to resource categories not included in AB 525, such as terrestrial biological resources, public access and recreation, scenic views, and coastal hazards are described in the CCC's Consistency Determinations.[86]

Marine Biological Resources: Overview of Impacts, Strategies and Recommendations

Overview of Impacts

The site-specific effects of floating offshore wind facilities and ports are discussed in this section and further described in **Volume III, Appendix B**.

The marine biological resources that could be affected include marine mammals (including cetaceans [whales, dolphins, porpoises]; pinnipeds [sea lions, seals]; one species of fissiped [sea otter]); sea turtles; marine invertebrate species, for example, abalone; hundreds of species of fish; seabirds, shorebirds, and bats; and marine and coastal primary producers, for example, kelp, eelgrass, and phytoplankton. Many of these resources are listed as federal or state threatened or endangered species. Many species are migratory and currently pass through areas of planned future turbine operation and near operating ports on a recurring seasonal basis.

Impacts of Offshore Wind Development

As shown in **Table 4-1**, marine biological resource impacts from offshore wind development are spread across space: offshore and nearshore impacts in the lease area (approximately 20 miles from shore) and along export cable routes; impacts to biological resources in ports, harbors, and estuarine environments from port development and possibly cable landings; onshore impacts from port development and transmission buildout and cable landings. Many of the impacts highlighted below will differ depending on climate variability (for example, seasonal upwelling, El Niño and La Niña events) and life history (for example, migration and spawning).

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85 As part of the BOEM permitting process, BOEM requires financial assurances from lessees (such as bond, escrow account, etc.) for the future decommissioning of offshore wind projects.

86 The California Coastal Commission application of CZMA to BOEM's Consistency Determinations, the final reviews, and adopted conditions and findings for each Wind Energy Area are available. More information is available on the Humboldt WEA Coastal Commission Consistency Determination Adopted Findings and Conditions and Morro Bay WEA Coastal Commission Consistency Determination Adopted Findings and Conditions.

Offshore and Nearshore Impacts

The offshore and nearshore impacts discussed below include habitat disturbance, bird and bat strikes, entanglement, underwater noise, displacement, avoidance, and attraction, ship strike risk, oil spills, invasive species, changes to upwelling, and electromagnetic fields (EMF).

Habitat Disturbance

Development of offshore wind leases is expected to result in seafloor disturbance from anchoring and mooring of turbines, meteorological data buoys, support vessels, and potentially from siting substations. Installation of transmission or export cables from the offshore leases to shore also has the potential to result in impacts to the seafloor along the length of the cable route. The deep-sea environment off the coast of California includes a variety of substrates and sensitive habitats, such as seamounts, hydrothermal vents, and deep-sea coral and sponges. Anchors and mooring lines may drag on the seafloor and destroy or damage these sensitive habitats.

Generally, soft-bottom habitats are more resilient to siting these types of structures and are preferred for offshore wind turbine anchoring and installation of cables. Prior review by the CCC has required that offshore wind development avoid placing any anchors or allowing mooring line sweep on hard bottom habitat or sensitive habitats such as hydrothermal vents or deep-sea corals and sponges. For cable laid on the seafloor, such as fiber optic cables, projects have been required to avoid impacts to hard bottom habitat to the extent feasible and to provide mitigation for any unavoidable impacts.

Nearshore impacts to coastal habitat may occur through landing the export cables onshore and bringing them to the grid. State regulatory agencies expect that cables will be buried. The preferred method of bringing these cables to the shore is through horizontal directional drilling which brings the cables to shore below the seafloor and helps minimize impacts to nearshore environments.

Strategies for addressing impacts to habitats include conducting additional research to guide project design in a manner that avoids or mitigates for impacts to sensitive habitats, requiring habitat buffers to protect sensitive habitat areas, and requiring mooring and cable designs that minimize impacts on the seafloor.

Bird and Bat Strikes

Turbines have the potential to impact seabirds and bats through collision with blades. Major factors that influence the potential for collision include whether seabird or bat colonies are nearby, the abundance of seabirds and bats, flight heights of seabirds and bats, environmental factors such as fog or low light conditions, and turbine rotation speeds. Because turbines and their infrastructure will be going in the water in relatively dense arrays, higher resolution seabird and bat surveys and data are necessary to understand the probability and frequency of turbine strikes. Additionally, more detailed information is needed on bird and bat flight heights at various wind speeds, and design options for turbines that may minimize bird and bat strikes are needed.

Strategies for addressing impacts to birds and bats include identifying measures to protect and preserve bird and bat species, or to mitigate for impacts to those species. If effects on migratory birds are determined to be substantial, relevant state and federal agencies should be consulted to consider seasonal restrictions on operations and activities.

Entanglement

Offshore wind lease development will require the use of mooring cables and inter-array electrical cables to transfer electricity from the turbines to shore. Each turbine is expected to need a minimum of three anchors and mooring lines. These mooring lines and cables may increase entanglement risk for marine mammals. However, the size of both the mooring and inter-array cables is likely too large to directly cause primary entanglements. Marine mammal species are likely to detect large diameter mooring lines either through echolocation for toothed whales, whiskers for pinnipeds, or hearing for baleen whales, since ropes produce noise in relation to current flow.[87]

In contrast, secondary entanglement may create greater risk for a larger range of marine species. Secondary entanglement occurs when marine life becomes caught in lost fishing gear or other debris that has snagged on mooring lines or inter-array cables. Lines associated with fishing gear typically have a smaller diameter than the structures associated with offshore wind, and marine mammals are less able to detect and avoid it.

Strategies to address this issue include considering use of best available mooring systems and inter-array cables that include sensors to detect when debris gets snagged on them and requiring developers to perform regular maintenance to remove and recover the debris.

Underwater Noise

Site assessment and characterization prior to offshore wind construction requires the use of high-resolution geophysical surveys. Noise associated with these surveys may alter bird, marine mammal, and fish behavior within the wind energy areas, but the effect will be temporary, and is not expected to affect viability of regional populations. The use of sound in geophysical surveys may affect the behavior of marine mammals by masking their ability to hear important environmental sounds and requiring more intense vocalizations; intense sounds may damage their ability to hear. Geophysical surveys off California will likely be conducted with low-energy equipment, which would significantly reduce potential impact to marine mammals and sea turtles.

Strategies to prevent impacts to marine mammals and sea turtles from geophysical surveys include consulting with relevant state and federal agencies on seasonal restrictions on in-water construction, ramp-ups to maximum decibels used during surveys, and protected species

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87 Maxwell, Sara, Francine Kershaw, Cameron Locke, Melinda Conners, Cyndi Dawson, Sandy Aylesworth, et al. April 2022. Potential impacts of floating wind turbine technology for marine species and habitats. Journal of Environmental Management. #307, 114577. Available at https://doi.org/10.1016/j.jenvman.2022.114577.

observers on the vessels who would stop survey work if a marine mammal or sea turtle is observed within an area where they could be harassed by sound around the survey equipment.

In addition, installation and operation of offshore wind infrastructure has the potential to result in elevated levels of underwater sound that could impact marine species. Underwater sound affects for some types of activities, such as pile driving and vessel traffic, are well understood. Similarly, the suite of mitigation strategies needed to minimize impacts to marine life, such as bubble curtains and other quieting technology for pile driving and limits on vessel speeds and robust monitoring for vessel traffic, are also well established. However, the range and severity of impacts associated with the operation of floating offshore wind turbines is less well known and will require further study.

Displacement, Avoidance, and Attraction

Installation of offshore wind infrastructure will alter benthic and pelagic habitats which can potentially change animal behavior. Some species may be attracted to the infrastructure causing an artificial reef effect while other open water species may avoid the developed area. Fish, mammals, invertebrates, and seabirds can potentially be impacted through avoidance and attraction to offshore wind infrastructure. The impacts will likely be species specific and depend on turbine design. For example, minimizing perch area, altering lighting design and installing perch deterrent features may reduce the attraction of birds to the wind turbines. Very few floating turbine offshore wind projects have been built at this time, thus the extent of avoidance and attraction to offshore wind infrastructure is not currently known. However recent modeling efforts can provide some insight into which species might be the most vulnerable to habitat displacement or avoidance.

The state, through OPC, has funded two modeling studies to examine geographic areas that would potentially experience greater impacts from development: the first study by the Conservation Biology Institute (CBI) performed least-conflict modeling for California offshore wind energy planning.[88] The CBI modeling was used to identify relevant marine mammals and seabird density maps for the current wind lease areas. More information about the species and habitats in the Morro Bay and Humboldt lease areas can be found in the CCC's Adopted Findings.[89] The second ongoing study by Point Blue Conservation Science is assessing and analyzing the existing body of information on the marine environment, using key data sets to

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88 Degagne, R., Gough, M., Joseph, G., Pizzino, D., Smith, C. and Strittholt, J. 2022. *Spatial Modeling to Support Sustainable Offshore Wind Energy Development for California.* CBI Technical Report Updated Oct. 2022. Available at https://consbio.org/wp-content/uploads/2022/05/CA-OSW-EEMS-Modeling-Report-October-2022.pdf.

89 The California Coastal Commission Consistency Determination for Morro Bay is available at https://documents.coastal.ca.gov/assets/upcoming-projects/offshore-wind/W7a-6-2022-AdoptedFindings.pdf.

The California Coastal Commission Consistency Determination for Humboldt is available at https://documents.coastal.ca.gov/reports/2022/4/Th8a/Th8a-4-2022 staffreport.pdf.

examine existing wind energy areas and identify additional candidate areas for potential offshore wind development.

Monitoring of baseline and post-project conditions, and implementation of adaptive design measures, will be important for accurately assessing future impacts related to habitat displacement and species avoidance or attraction that could occur with installation and operation of offshore wind facilities.

Ship Strike Risk

Collison with large vessels (or ship strikes) is one of the highest causes of whale death on the U.S. West Coast.[90] The site assessment, construction, and operations phases will require an increase in vessel traffic for surveys, deploying buoys, installing turbines, and operations and maintenance. This increase in vessel traffic increases the potential for whale and sea turtle injury or mortality from ship strikes. Strategies for reducing potential ship strikes include reducing ship speeds to 10 knots and below and the use of protected species observers have been shown to help prevent ship strikes and reduce the likelihood of mortality if a ship strike occurs.

Oil Spills

Increased vessel traffic for operations and maintenance in the lease area may increase chances of a spill of petroleum products (fuel or lubricants) which could occur from accidents during operations and maintenance activities or natural events (such as strong waves or storms damaging equipment). Known strategies, such as requiring vessel and project-specific spill prevention, control, and countermeasures plans, and requiring critical operations and control plans can reduce the risks and extent of oil spills. Strategies to address impacts from oil spills include identifying prevention and response actions with developers and their contractors.

Invasive Species

Mooring lines, anchors, chains, and ship ballast and hull fouling can potentially be vectors for the introduction of invasive species to new locations. Additionally, floating foundations, mooring lines, and anchors provide three-dimensional structures that could be colonized by invasive species such as algae and attached invertebrates like sea squirts, bryozoans, and mussels. Invasive species may also be introduced in bays and nearshore environments due to increased cross-ocean transportation of materials and turbine parts for final assembly in

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90 Carretta, James, Justin Greenman, Kristin Wilkinson, James Free, Lauren Saez, Dan Lawson, Justin Viezbicke, and Jason Jannot. June 2021. *Sources of Human-related Injury and Mortality for U.S. Pacific West Coast Marine Mammal Stock Assessments*. NOAA-TM-NMFS-SWFSC-643. Available at https://swfsc-publications.fisheries.noaa.gov/publications/CR/2021/2021Carretta.pdf.

Rockwood, R. Cotton, John Calambokidis, and Jaime Jahncke. August 2017. "High mortality of blue, humpback, and fin whales from modeling of vessel collisions on the U.S. West Coast suggests population impacts and insufficient protection." PLOS ONE 13(7): e0201080. Available at https://doi.org/10.1371/journal.pone.0183052.

California ports. Invasive species can lead to the extinction of native species and change the ecology of coastal environments by out-competing native species for food and resources and permanently altering habitats. Known practices, such as requiring antifouling coatings on wetted vessel surfaces and appropriate management of vessel ballast water reduce the risk of introducing invasive species to the lease areas or nearshore environments.

Changes to Upwelling

Wind-driven upwelling fuels much of the primary production in the California current which sustains rich coastal ecosystems. The installation and operation of wind turbines could affect wind-driven upwelling by decreasing wind speeds at the sea surface from drag on the turbines. Changes in upwelling may affect nutrient delivery and ecosystem function. Recent modeling studies suggest that full buildout (maximum turbine density) of the current BOEM lease areas will tend to shift upwelling offshore by reducing upwelling on the onshore side of the windfarms and increasing upwelling on the offshore side.[91]

The modeling done thus far indicates that the size of wind development will determine the extent to which upwelling impacts are observed. Modest decreases in upwelling were modeled when considering buildout of the current lease areas, but more significant changes may occur if additional development is approved for future call areas. Importantly, these model results rely on assumptions about the decrease in wind in the lee of the turbines and the density of turbines within a wind farm.[92] Monitoring and on-site measurements will be needed to understand the real-world impacts from the windfarms. Further research is also needed to understand how potential changes in upwelling will affect primary production and ecosystem dynamics.

Electromagnetic Fields

The transmission of electricity through inter-array and export cables will produce electromagnetic fields (EMF) via the flow of electricity through the cable. The cable itself would be shielded, so what would extend into the surrounding environment is a magnetic field. Some fish and crustaceans use magnetic fields for orientation. As such, EMF fields can potentially impact animal navigation. Additionally, sharks, rays, and skates have an ability to sense electrical fields, which they use for hunting, and they may change their behavior in response to EMF as well. However, studies that examine the impacts from undersea cables have found mixed results. For example, some studies found crab density increased near cables and others

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91 Raghukumar, Kaustubha, Timothy Nelson, Michael Jacox, Christopher Chartrand, Jerome Fiechter, Grace Chang, Lawrence Cheung, and Jesse Roberts. April 2023. "Projected cross-shore changes in upwelling induced by offshore wind farm development along the California coast." Communications earth & environment. Available at https://doi.org/10.1038/s43247-023-00780-y.

92 The lee is a nautical term referring to a sheltered part or side away from the direction from which the wind is blowing.

found no change in behavior around energized cables.[93] Most studies have focused on buried undersea cables, so there is limited understanding of the effect of EMF from cables suspended in the water column. Strategies to minimize impacts from export cables include requiring export cables from the WEAs to use consolidated routes to shore, requiring burial of the cables, and requiring verification surveys to confirm that the cable remains buried or is in its expected location.

Port and Harbor Impacts

The extent of port development projects depends on how the port will serve the offshore wind industry. Staging and integration port sites will require more space and upgrades than operations and maintenance port sites. Port development may require the construction and expansion of wharf or dock space and dredging to deepen the federal navigation channel and surrounding areas. Additional overwater infrastructure and dredging may displace and destroy important nearshore habitats, such as eelgrass. Eelgrass responds poorly to shading from over-water structures and would likely die back if shaded by port facilities. Additionally, port development would likely require pile driving and other sources of underwater noise, which may impact nearby fish and marine mammals, though existing mitigation strategies, such as bubble curtains, would reduce these impacts. Port development may also result in the removal of existing marine infrastructure (for example piles or docks) that serve as nesting habitat for seabirds and addition of water intake systems that could entrain larval fish and invertebrates.

Finally, port development would increase vessel traffic in and out of the estuaries where ports are located. This vessel traffic may introduce invasive species to new estuaries, increase the risk of oil spills, increase air emissions of harmful pollutants, and increase overall underwater noise. Many of these potential impacts are manageable with regulatory strategies including requiring that vessels adhere to ballast water and biofouling management requirements, requirements for vessel and site-specific spill prevention and response plans and concentrating vessel traffic into existing industrial areas rather than less disturbed environments. The potential air emissions and water quality effects would also affect nearby California Native American tribes and underserved communities. Port development should be planned in partnership with the community and with the expectation that development will reduce air pollutants and improve water quality and other environmental conditions in those communities, rather than making them worse.

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93 Bull, A., M. Nishimoto, M. Love, and D. Schroeder. February 2016. “Does EMF Emitted from In Situ Subsea Power Cables Affect the Composition of Deep Benthic Fish and Invertebrate Communities?” American Geophysical Union. Available at https://ui.adsabs.harvard.edu/abs/2016AGUOSHI53A.06B/abstract.

Love, Milton et al. December 2017. "Assessing potential impacts of energized submarine power cables on crab harvests." Continental Shelf Research, Volume 151. Available at https://ui.adsabs.harvard.edu/abs/2017CSR...151...23L/abstract

Monitoring and Adaptive Management

Comprehensive monitoring plans and adaptive management strategies for offshore wind projects will be key in ensuring that marine resources are protected given the high degree of uncertainty surrounding the scope and scale of impacts associated with construction and operation of offshore wind development as described in the CCC's Consistency Determinations. Knowledge gained from monitoring throughout the buildout, operation, and decommissioning of offshore wind projects will require flexibility and adaptation in project designs that may also impact the economic calculations for projects. Significant research has been and continues to be conducted on the potential impacts from offshore wind. In letters to the CCC during the Consistency Determination review of the Humboldt and Morro Bay wind areas, several environmental nongovernment organizations provided research-based recommendations for potential future monitoring and adaptive management plans related to the protection of marine species and habitats.[94] These recommendations provide a good starting point for discussions on what elements should be addressed in future monitoring and adaptive management plans that will be a critical component of future construction and operations plan review. These recommendations include:

- Underwater noise: Collection of baseline data and survey, construction and operation noise data on the underwater soundscape to better understand the impacts of additional noise from construction and operation, and to inform turbine micro-siting.
- Secondary entanglement: Continuous monitoring of mooring lines and inter-array cables for strains resulting from ensnarement or entanglement of an animal or marine debris. Also, design features to minimize the potential for and maximize the detection of entanglement, and protocols to address entanglements that do occur.
- Benthic habitat: Detailed benthic survey of sensitive benthic habitat, including Habitat Areas of Particular Concern to inform buoy placement and siting of future turbines and other development to avoid and minimize impacts to biogenic and sensitive habitat.
- Bird and bat impacts: Inclusion of design features to reduce effects from lighting. Also, development of a comprehensive collision avoidance strategy that includes monitoring of collisions and inclusion of collision minimization measures.

The state, through OPC, has also committed to develop comprehensive environmental monitoring guidance to ensure that environmental impacts of offshore wind development are properly monitored, evaluated, and mitigated throughout a project's lifecycle. OPC will also leverage this effort to inform the development and implementation of a comprehensive

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94 W7a-6-2022-Correspondence (ca.gov) Th8a-4-2022-correspondence.pdf (ca.gov) available at: https://documents.coastal.ca.gov/reports/2022/6/W7a/W7a-6-2022-Correspondence.pdf and https://documents.coastal.ca.gov/reports/2022/4/Th8a/Th8a-4-2022-correspondence.pdf

environmental research and monitoring program and identify potential adaptive management strategies.

Recommendations to Address Marine Impacts

The following recommendations will support increased understanding of potential environmental impacts to coastal and ocean ecosystems, leverage resources and expertise, and inform actions to avoid, minimize, and mitigate impacts and adaptively manage offshore wind development and ongoing operation.

- Support comprehensive environmental research and monitoring that uses best available science and monitoring technologies, traditional ecological knowledge, and baseline and long-term monitoring to guide project siting, assess project-level and cumulative impacts during construction and ongoing operations, inform adaptative management strategies throughout the project lifecycle and future sea space planning and lease sales. This effort should incorporate scientific advice from academia, governments, tribes, nongovernmental organizations, the offshore wind industry, and other interested entities.
- Continue promoting coordination and collaboration among lessees on surveys, comprehensive monitoring plans, and project implementation to minimize environmental impacts, leverage resources, and increase efficiency.
- Develop a comprehensive mitigation framework that prioritizes avoidance and identifies strategies to minimize and offset impacts to marine life and habitats from offshore wind development and ongoing operations, including impacts from port development. Adaptive management strategies should also be identified to facilitate rapid response to unanticipated impacts.

Native American Tribes and Peoples: Overview of Impacts, Strategies, and Recommendations

AB 525 requires the CEC to prepare a strategic plan that identifies and proposes strategies for potential impacts to Native American and Indigenous peoples. For the purposes of this report, the CEC has interpreted indigenous people to mean people indigenous to the state of California. AB 525 directed the CEC to consult with California Native American tribes on the impacts of the potential development of offshore wind. As discussed in Chapter 10, because the state has permitting authority related to offshore wind projects, the CEC and coordinating agencies-initiated consultations with California Native American tribes and will continue to collaborate with them on offshore wind going forward.

Throughout 2022 and 2023, the CEC has engaged in tribal consultations with California Native American tribes to discuss the potential impacts from future offshore wind projects and the development of the AB 525 strategic plan. Request for consultation letters were sent on May 12, 2022, and April 4, 2023, to all California Native American tribes across California. Additional emails and phone calls were made to California Native American tribes with ancestral boundaries in and near the proposed call areas for offshore wind. Lastly, the CEC and partnering state and federal agencies meet twice a month with an inter-tribal working group to continue conversations regarding the impacts of offshore wind and developing recommendations and strategies to avoid or mitigate those impacts. The CEC and agencies involved in preparing the strategic plan are thankful for the time and information shared by tribal leaders, staff, and tribal members in the development of the AB 525 strategic plan and future offshore wind projects.

Each California Native American tribe has its own perspective, concerns, and priorities regarding offshore wind. This strategic plan attempts to summarize by topic what has been shared with the CEC and other federal and state agencies to help inform recommendations and strategies for future offshore wind. Relying on the summaries included in this report does not replace the requirement of state, federal, and offshore wind lessee obligations to consult and collaboratively work with California Native American tribes throughout the planning, permitting, operation, and decommissioning of offshore wind operations and associated infrastructure.

Further, this strategic plan relies on the following definitions: California Native American tribes include federally and nonfederally recognized Native American tribes located within California. Native American tribes include federally and nonfederally recognized Native American tribes within the United States of America. Coastal Native American tribes include federally and nonfederally recognized Native American tribes with ancestral territories in the coastal zone and direct connection with the Pacific Ocean.

This section covers the following topics: tribal historical and social considerations; location considerations; offshore wind permitting and co-management considerations; tribal cultural resources considerations; tribal natural cultural resources considerations; tribal economic and energy reliability considerations; and strategies for addressing tribal impacts.

Tribal Historical and Social Considerations

Understanding and Addressing Historical Wrongs

The State of California was created through war, violence, forced removal, slavery, and attempts of genocide of Native American people and destruction of their governments, societies, religions, and ways of life. The history of the atrocities committed against California Native American people is long and complicated and not fully discussed in this strategic plan.[95] On June 18, 2019, Governor Gavin Newsom issued through Executive Order N-15-19, an apology on behalf of the State of California to California Native Americans for the "many instances of violence, maltreatment and neglect California inflicted on tribes." Through this executive order, Governor Newsom also reaffirmed the "principles of government-to-government consultations with California Native American tribes regarding policies that may affect tribal communities" and established the Truth & Healing Council "to bear witness to,

95 Akins, Damon and William Bauer. 2021. *We are the Land: A History of Native California*. University of California Press. Available at https://doi.org/10.2307/j.ctv1h9djzk.

record, examine existing documentation of, and receive California Native American narratives regarding the historical relationship between the State of California and California Native Americans in order to clarify the historical record of this relationship in the spirit of truth and healing."

In consultations with the CEC and other state and federal agencies, California Native American tribes have highlighted the past historical wrongs still impacting tribal communities today. Specifically, in the past, the lucrative incentives to quickly build out industries to support resource extraction led to state-sponsored forced removal of tribes from their ancestral territories and theft of those lands for private benefit. These industries led to increased pollution of the air and water and drained economic opportunities of tribes and their communities in their territories. Through these actions, tribes have been limited in their access to lands, have had minimal economic opportunities, and their tribal cultural resources and natural cultural resources were put at risk of impacts due to the siting of industry and the associated pollutants.

An example of current operations of resource extractive industries cited by Central Coast tribes includes offshore oil and gas platforms and pipelines. In consultation, tribes shared concerns about recent spills impacting marine habitats and species and tribal cultural resources tribes rely on. Tribal representatives further connected the advancement of offshore wind in the same area as recent spills as creating cumulative impacts on the same resources.

Overall, tribes are concerned the development of offshore wind is a continuation of resource extraction that will not have meaningful benefits to their governments and communities. Many of the comments received from tribal representatives follow similar themes and provide an overarching lens to understanding the specific recommendations tribes have requested for inclusion in the strategic plan.

Location Considerations

Many California Native American tribes and people have a significant connection with the Pacific Ocean and the marine habitats and species that rely on a healthy coast and ocean. These connections vary from active stewardship, subsistence, cultural, and commercial relations with the coast and ocean to indirect relations through trade, trails, seasonal ceremonies, and kinship with coastal Native American tribes.

While most California Native American tribes agree that many tribes have connection to the Pacific Ocean, the coast, and marine habitats and species, some tribes have expressed in consultation that coastal tribes with ancestral territories, sacred sites, and direct connection and reliance on marine habitats and species should have deference from the state and federal agencies in determining appropriate recommendations and strategies to avoid or mitigate impacts of offshore wind.

California Native American tribes have expressed concerns with the analysis of new sea space identification for future offshore leases. Opening additional sea space for future offshore leases will increase the impacts to all the considerations discussed in this section. Specifically, tribes have requested that the first leases should serve as demonstration projects to test out the new floating offshore wind technology, analyze the impacts on marine resources, and conduct further studies and monitoring to inform the decision to opening new sea space for additional offshore wind leases. In consultation, tribes have expressed the concern that the technology is too new, and the impacts are too unknown to support the increase of the lease areas and additional sea space currently being discussed by state and federal agencies.

Tribes have also expressed concern on the amount of sea space being considered for offshore wind development as it relates to shipping lanes, marine protected areas, fishing areas, and other location-based considerations. The larger the dedicated sea space for offshore wind, the more "cramped" the other uses will be, which will have ripple effect on the impacts to the marine species and tribal subsistence, cultural resources, and commercial fishing.

Offshore Wind Permitting and Co-management Considerations

California Native American tribes have provided comments in consultations and through written comment letters on the permitting processes for offshore wind and port infrastructure development. Overall, tribal comments requested a direct role in the decision-making process throughout all permitting steps for offshore wind development. To work towards government-to-government decision-making, tribes have requested early, often, and meaningful tribal consultations with BOEM and all the state agencies with permitting authority over offshore wind. Further, tribes have requested early access to draft documents, opportunities to co-create strategies and recommendations, and build their priorities into permit and mitigation requirements.

Due to the size, scope, and number of federal and state agencies involved in regulating offshore wind development, California Native American tribes have been inundated with requests for consultation. The time and energy to respond to each request for consultation has a fiscal impact and burden for tribes to participate in ongoing and regular meetings about offshore wind development, permitting processes, and other activities. For many tribes with limited capacity, tribal councilmembers are not compensated for their service and maintain other employment to cover their living expenses. For those leaders in this situation, they must take off time from work to attend each meeting or consultation. This puts considerable strain and stress on tribal leaders to participate in the many consultations and meetings associated with offshore wind. Further, most tribes are reliant on grant funding and do not have funds to pay for staff or consultants' time participating in tribal consultations and other offshore wind meetings. In nearly all consultations, CEC has learned of the need to financially compensate tribes for their time and expertise they are being asked to provide. Further, tribes request resources to build their internal capacity and technical assistance to support their review of permitting and environmental documents, data, and materials related to offshore wind.

One tribe, through its written comments, requested the development of intergovernmental cooperative agreements. The tribe shared the Bears Ears National Monument Intergovernmental Cooperative Agreement utilizing Section 307(b) of the Federal Land Policy and Management Act of 1976, as amended, 43 U.S.C. §§ 1701 et seq. legal authority as an example of a successful model.[96] The tribe notes that the Federal Land Policy and Management Act allows the Department of the Interior and its departments, including the Bureau of Ocean Energy Management (BOEM) and Bureau of Safety and Environmental Enforcement (BSEE), legal authority to enter into intergovernmental cooperative agreements. These agreements would allow for a co-management or co-stewardship relationship between the federal government and federally recognized Native American tribes in the permitting and management of offshore wind operations. The tribe requested the permitting process build in opportunities for co-management and use this law to establish intergovernmental cooperative agreements to facilitate a formal relationship.

Discussed in greater detail within the Permitting Chapter, one tribe, in its public comment letter, also supported the use of the Programmatic Environmental Impact Reports (PEIRs) to better account for the cumulative effects of individual offshore wind projects on tribal cultural resources and the environment. The tribe described how the PEIRs could facilitate large-scale marine spatial planning but requested the PEIRs not be used as a substitute for project-level environmental reviews.[97] The tribe shared that analyzing offshore wind projects at a programmatic level can support broader geospatial analysis of various uses and environmental needs at a planning stage to help identify these uses, needs, and resources to be protected. The tribe explained that environmental review at the individual project stage would not provide the landscape analysis necessary to fully understand the impacts of offshore wind. The tribe also shared with the CEC that a PEIR could provide a baseline understanding of pre-offshore wind environmental conditions and support future individual project environmental reviews and monitoring efforts to fully understand all the impacts of offshore wind.[98]

California Native American tribes continue to request early, often, and meaningful tribal consultations over all aspects of the permitting, development, and implementation processes of offshore wind and associated infrastructure. One tribe also expressed additional agreements and processes that need to be in place to support shared decision-making and co-management of the ocean and coast between the federal government and tribes. Strategies for addressing impacts on California tribes include developing avoidance and mitigation strategies for tribal cultural resources alongside tribes, identifying opportunities for tribes to access technical assistance to support their participation in offshore wind planning and permitting efforts, and considering contracting with California Native American tribes for

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96 The Bears Ears Inter-Governmental Cooperative Agreement is an agreement between multiple Tribal Nations (whose representatives comprise the Bears Ears Commission- the Hopi Tribe, Navajo Nation, Ute Mountain Ute Tribe, Ute Indian Tribe of the Uintah and Ouray Reservation, and the Pueblo of Zuni) and the United Stated Department of the Interior, Bureau of Land Management and the United States Department of Agriculture, Forest Service for the Cooperative Management of the Federal Lands and Resources of the Bears Ears National Monument.

97 Joseph, James (Yurok Tribe). May 2023. "Comment on April 28 Permitting Roadmap." TN 250082. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250082&DocumentContentId=84800.

98 Ibid.

cultural and environmental monitoring before, during, and after construction of offshore wind projects, port improvements, and expansion of transmission infrastructure.

Tribal Cultural Resources Considerations

California Native American tribes have consistently expressed deep concerns about the impacts of offshore wind and associated infrastructure on tribal cultural resources. While state and federal law provide definitions of tribal cultural resources for the purposes of the California Environmental Quality Act, the National Environmental Policy Act, and the National Historic Preservation Act, for many California Native American tribes those definitions do not fully identify all aspects and the importance of tribal cultural resources. Many tribes have expressed that tribal cultural resources are not limited to archeological resources, but encompass full landscapes, plant and animal species, water, air, and the interconnection of tribal lifeways with the environment. Western laws and the English language typically cannot capture the full understanding of the importance of tribal cultural resources to Native American tribes.

Understanding these limitations, the strategic plan does not fully rely on the legal definitions of tribal cultural resources but provides these definitions as a starting place for conversation and appreciates tribal leaders' guidance and expertise in providing a fuller understanding of tribal cultural resources.

California Environmental Quality Act, Section 21074 defines Tribal Cultural Resources as:

> (1) Sites, features, places, cultural landscapes, sacred places, and objects with cultural value to a California Native American tribe that are either of the following:
>
> (A) Included or determined to be eligible for inclusion in the California Register of Historical Resources.
>
> (B) Included in a local register of historical resources as defined in subdivision (k) of Section 5020.1.
>
> (2) A resource determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in subdivision (c) of Section 5024.1. In applying the criteria set forth in subdivision (c) of Section 5024.1 for the purposes of this paragraph, the lead agency shall consider the significance of the resource to a California Native American tribe.
>
> (b) A cultural landscape that meets the criteria of subdivision (a) is a tribal cultural resource to the extent that the landscape is geographically defined in terms of the size and scope of the landscape.
>
> (c) A historical resource described in Section 21084.1, a unique archaeological resource as defined in subdivision (g) of Section 21083.2, or a "nonunique archaeological resource" as defined in subdivision (h) of Section 21083.2 may also be a tribal cultural resource if it conforms with the criteria of subdivision (a).

Historic properties, for Section 106 of the National Historic Preservation Act purposes, include districts, sites, buildings, structures, and objects included in or eligible for the National Register of Historic Places.

Many Native American tribes also have their own laws, resolutions, oral histories, cultural practices, or other regulatory measures defining tribal cultural resources. This strategic plan strives to include tribally informed definitions throughout this section.

Sites, Features, Places, Sacred Places, and Objects Considerations

In consultations and public meetings, California Native American tribes have expressed concerns with the impacts of offshore wind and associated infrastructure on sacred and culturally significant sites, features, places, and objects in the ocean, on the coast, and inland. Ocean tribal cultural resources include submerged sites and objects resting on top of the seafloor and underground. The concerns include damage to these tribal cultural resources from the anchors of the floating turbines and the cables from the turbines transporting electricity onshore.

Coastal and inland tribal cultural resources include a wide variety of sites, features, places, and objects that contain deep cultural and sacred significance to California Native American tribes. State agencies heard in consultations that the coastline and areas inland contain many villages, sacred and ceremonial sites, and features that are still used today. These areas also contain burial sites, shell mounds, and historical objects used and cared for by the ancestors. Tribes expressed concerns that increasing port infrastructure and transmission lines will disturb and destroy these tribal cultural resources throughout the construction and operation of the new infrastructure.

Tribes have requested specific recommendations and strategies to avoid and, when avoidance is unavailable, mitigate harms to the sites, features, places, and objects historically, culturally, and religiously important to tribes in the ocean, on the coast, and inland.

Cultural Landscapes Considerations

California Native American tribes have clearly articulated in consultation that tribal cultural resources are not limited to historical items found underground but are interconnected in a holistic way with the environment and tribal religious and cultural lifeways. This interconnected nature of tribal cultural resources can be described as cultural landscapes, where important features viewed together map out a full landscape of cultural significance for tribes.

A component of cultural landscapes includes viewsheds. Tribes have expressed concerns with offshore wind having a significant impact to tribal viewsheds of the horizon over the Pacific Ocean, including potentially seeing the turbines and red lights on top of the turbines at night. Many of the coastal tribes have stated parts of their ceremonies and connection to the ocean rely on viewing the ocean’s horizon. Some tribes have ceremonies that include prayer, songs, and movement on the coast with eyes directed at the ocean’s horizon. Concerns have been expressed that having the offshore wind turbines dotting the horizon will disrupt and negatively impact these ceremonies.

Cultural landscapes also include interconnection of multiple village sites, burial grounds, and other sacred places with each other. Tribes have expressed concerns that with additional port infrastructure and transmission lines, these sacred and important sites will be separated, impacting the ability of tribal members to travel between sites or block the ability to view one site from the other. Further, cultural landscapes include access to and interconnection with culturally significant species. As discussed more in the next section and in the biological resource section of this strategic plan, concerns of the impacts to species and their habitats are an important consideration to impacts to tribal cultural landscapes. Tribes have requested that the state develop recommendations and strategies to avoid impacts to cultural landscapes.

Strategies for addressing impacts on tribal cultural resources include completing land and ocean surveys in partnership with California Native American tribes to identify areas of importance, investigating opportunities to list Tribal Cultural Resources in the National Register of Historic Places or the California Register of Historic Resources, and working with tribes to develop appropriate mitigation measures for inadvertent discovery of human remains and Tribal Cultural Resources.

Tribal Natural Cultural Resources Considerations

Native American tribes have shared in many different circumstances that biological resources – plants, animals, and their habitats – are also tribal cultural resources and have an integral role in tribal lifeways. This is true in the context of marine species and habitats for California Native American tribes and other Native American tribes with ancestral lands on the U.S. West Coast.

Some of these marine species identified by tribes as having cultural significance include, but are not limited to, salmon, whales, orcas, abalone, condors, seaweeds, and sea grasses. Tribes have expressed concerns that the impacts of offshore wind on culturally significant species are still unknown, which causes anxiety and stress especially given that many culturally significant species are currently threatened by pollution, climate change, and other factors. Many cultural practices incorporate marine species into ceremonies, regalia, and meals. Tribes have expressed concerns that impacts to these species will reduce tribal access to these culturally important species, thus impacting their cultural practices and way of life.

In intergovernmental roundtables, tribal representatives raised concerns with news of increased numbers of ships striking whales around East Coast- and European-based offshore wind projects. Many members of Native American tribes have questioned if offshore wind projects may be driving marine life into high traffic shipping lanes causing these strikes. Tribes do not want to see overcrowding of human uses in the Pacific Ocean that will drive whales and other marine species into harm’s way.

California Native American tribes expressed concerns related to unknown weather impacts on and from operating offshore wind turbines and the impacts to species and habitats. Tribes expressed questions on the durability of offshore wind turbines to withstand varying weather patterns, citing oral histories of tsunamis and extreme weather on the coast. Tribal representatives have also noted that there may be unknown weather impacts from operating turbines that may also alter microclimatic conditions such as surface temperature, wind speed, and fog dispersion.

California Native American tribes' concerns echo the impacts and considerations to biological resources as further detailed in this chapter. Tribes have requested recommendations and strategies to avoid and limit impacts to culturally significant species and their habitats.

Cumulative Impacts on Tribal Cultural Resources

The California Environmental Quality Act defines cumulative impacts as "two or more effects that when considered together are considerable or which compound or increase other environmental impacts." Tribes have identified in consultations and meetings with the CEC that offshore wind and port infrastructure improvements are not the only projects impacting tribal cultural resources and have requested the strategic plan consider and provide recommendations and strategies for avoidance and mitigation of the cumulative impacts on tribal cultural resources. Some strategies for addressing cumulative impacts include developing appropriate mitigation measures to prevent cumulative impacts to Tribal Cultural Resources, including the purchase and return of ancestral lands, cultural easements, co-management agreements, joint powers agreements, and other legal mechanisms.

Tribal Economic and Energy Reliability Considerations

California Native American tribes have shared concerns about climate change and expressed the importance of developing renewable electrical generation to move away from fossil fuels as one of many solutions to address the climate crisis. Tribes have further expressed that to successfully transition the grid to renewable energy equitably, new power generation must be done in an appropriate manner that provides local community benefits, reliable electricity, and supports California Native American tribes' energy priorities and community needs. Tribes have shared in consultation a variety of economic and energy needs of their communities.

Local Reliability and Transmission Considerations

Many California Native American tribes in the North Coast region have expressed concerns that their communities are currently not connected to the grid and rely on personal generators for their electricity needs. Further, the members who are connected to the grid continue to experience black and brown outs due to emergency shut offs or failing grid infrastructure. During a CEC visit to the North Coast in 2023, a winter storm caused a major power outage impacting many tribes and their communities. Specifically, tribal elders and community members didn't have electricity to heat their homes, didn't have access to phones or internet to contact emergencies services when in need, and, due to snow, were trapped in their homes without access to food and medical services. Tribes had to deploy emergency services to check in with elders, bring food and water, firewood, and other supplies for warmth. These types of power outages are frequent and disrupt the lives and wellbeing of tribal members as well as the governmental and business operations of tribes.

In consultation, tribes have expressed the desire to have offshore wind and updated transmission infrastructure provide a direct benefit to their communities by connecting tribal homes to the grid and providing energy reliability to their communities. There is a concern that offshore wind will be located in tribes' ancestral lands, impacting their tribal cultural resources, but all the power generated would be exported out of the local area, thus tribes and the local community would be burdened by the impacts of offshore wind, but not receive any benefits. Tribes would like to see offshore wind activities result in improved energization, with clean power, for their communities.

Further, California Native American tribes are interested in the increased availability of distributed energy resources and microgrids to provide local power and improve their local reliability. Tribes have asked if federal and state agencies have fully evaluated and compared other alternative clean energy generation, such as biofuel utilizing forest waste, rooftop solar, or other technologies. Lastly, some tribal representatives also expressed that Californians should take personal responsibility to reduce electricity consumption and the state should develop and encourage increased efficiency measures of current power sources before building more generation resources.

California Native American tribes have expressed that they want to be part of the decision-making process on the build out of transmission to ensure benefits for their communities. Tribes have requested close coordination with the CPUC, as the permitting agency for transmission infrastructure, on the preparation of the planning, CEQA environmental impact reports, and permitting of transmission projects. While the California ISO and CPUC processes can take several years, tribes have requested being included early in the decision-making process.

Subsistence and Commercial Tribal Fishery Considerations

As also discussed in the fisheries section of this chapter, the implementation of offshore wind and port infrastructure will impact the fishing community. For many tribes, their members depend on local fishing and harvesting of sea life for cultural, subsistence, and commercial needs.

Native American tribes are actively working towards addressing food scarcity and poor nutrition in their communities by building food sovereignty programs. While each tribe defines food sovereignty differently based on their cultures and community needs, generally food sovereignty is defined as tribally led food and agriculture systems that provide culturally appropriate food produced through ecologically sound and sustainable methods for their communities. Most coastal tribes rely on marine species as part of their food sovereignty programs and many tribal members rely on subsistence fishing to feed their families and commercial fishing for financial income. Tribes have expressed concerns that the offshore wind lease areas will no longer be open for their members to access for cultural, subsistence, and commercial fishing.

In consultations, tribes expressed significant concern about the impacts of offshore wind on the already endangered salmon population and migration patterns. For North Coast tribes, the salmon are important species for tribal members subsistence and economic prosperity. Bad run years have devastating impacts to the health, wellbeing, and economic stability of tribal members. Tribes have reported that when the tribal fishery is closed and tribal members do not have access to salmon, there is an increase of suicide in their communities. Lastly, federally recognized tribes have fishing rights to in-river salmon and have expressed concerns of offshore wind impacting salmon ability to migrate from the ocean to the rivers, thus having an impact on tribes legal fishing rights. Many North Coast tribes have been advocating for decades for the removal of the Klamath River dams due to the impact on the salmon and health of the river. Tribes expressed frustration that new energy production facilities are being pursued on the eve of the Klamath River dams being removed, thus replacing one harm to the salmon with another.

In Oregon and Washington, several federally recognized Native American tribes with treaties with the U.S. have undisputed offshore fishing rights. There is concern among the Northwest Native American tribes that offshore wind may affect oceanographic conditions off the coast of California and will negatively affect upwelling and larval transport on the West Coast, thereby reducing fish stocks. Since the whiting and sardine fisheries can be affected by diminished oceanographic conditions, there is deep concern that significant economic losses from loss of subsistence and commercial fishing will also occur along the West Coast. Native American tribes have requested recommendations and strategies to avoid or mitigate impacts to tribal subsistence and commercial fishing.

Employment and Job Training Opportunities

In many rural and tribal communities, there are high numbers of unemployment due to limited employment opportunities in the area. Tribes have expressed interest in securing job opportunities for their members from offshore wind development. Tribes want to ensure the new jobs created by offshore wind, port infrastructure improvements, and transmission line build-out and maintenance are filled by tribal and local community members first. Specifically, tribes have requested that skilled training and educational opportunities are made easily accessible for their members, with an option of wrap around services such as housing, childcare, and transportation to and from training locations.

Some tribes noted that their locations and facilities could house training centers or programs for the region and would like to explore partnerships with local unions to co-create training and workforce development opportunities. Many tribes are also developing tribal utilities and other energy related businesses and want to explore opportunities to expand their tribe's expertise in clean energy resources deployment both on and off tribal lands.

Tribes have identified that offshore wind projects will need tribal cultural resource and environmental monitors during construction and throughout offshore wind operations. Project budgets should reflect the contracting and subcontracting needs for these positions and agreements should be negotiated early in the process to ensure cultural monitors can be in place before any ground disturbance activities start.

Tribes have requested the strategic plan include recommendations and strategies that provide their members well-paying jobs and cultural monitoring contracts. In addition, California Native American tribes have requested the development of tribal community benefit agreements with lease holders and the permitting agencies to ensure benefits are provided to tribes and tribal communities, including the requests detailed in this section of the strategic plan.

Understanding and Preventing the Increase of the Missing and Murdered Indigenous Peoples Crisis

A majority of the federally recognized Native American tribes within California have declared a missing and murdered Indigenous peoples (MMIP) crisis due to the disproportionately high rates of violence experienced by Native Americans, and relatedly, high rates of Native Americans reported missing. Across gender, sexuality, and sexual orientation identities, Native American people have experience disproportionately high rates of sexual and gender-based violence. This violence includes intimate partner violence as well as strangers specifically targeting Native American people as victims.

Consultation with tribes and review of relevant research indicates a sharp increase of violence and missing Native American people during an influx of nonlocal workforce supporting the development of a new industry. Typically, the nonlocal workers are housed in areas called "man-camps," which can overburden local communities' public safety personnel and put Native American people at risk for sexual and gender-based violence. Additional research is necessary to fully understand if the increase of offshore wind workforce in local communities will increase the MMIP crisis.

Tribes have requested more effort be made to fully understand the impacts of nonlocal workers supporting offshore wind and port development coming into their communities and what safety measures will be in place to protect vulnerable populations from violent crime and sexual and gender-based violence, including a request to study and develop public safety measures to reduce violent crime and sexual and gender-based violence.

Recommendations to Address Impacts to Native American Tribes

The following recommendations will support increased understanding of potential impacts to California Native American tribes and inform actions to avoid, minimize, and mitigate impacts and adaptively manage offshore wind development and ongoing operation. Additional strategies for addressing impacts identified by Native American Tribes are included in **Volume III, Appendix B**.

- The study, development, and operation of offshore wind related projects should include early, often, and meaningful consultations with California Native American tribes and collaborative development of appropriate avoidance, minimization, and mitigation strategies for impacts to tribal cultural resources, natural resources, cultural, social, economic, and other interests.
- Continue to study and develop public safety measures to reduce violent crime and sexual and gender-based violence, particularly against Native American and other vulnerable populations.

- Encourage project proponents to contract with California Native American tribes for cultural and environmental monitoring before, during, and after construction of offshore wind projects, port improvements, and expansion of transmission infrastructure.
- State and federal agencies should explore opportunities for increased tribal access and stewardship in state and federal waters.

Fisheries: Overview of Impacts, Strategies, and Recommendations

Overview of Impacts

Fishing and fishing-related industries often have multi-generational businesses that are deeply rooted in their local community. California's commercial fishermen landed 184 million pounds of seafood in-state, with an ex-vessel value of $198 million.[99] As referred to in the CCC's Consistency Determination for the Humboldt Wind Energy Area, and CDFW commercial and fisheries landings data, the 2009 to 2018 average value of California north coast fish landings (ex-vessel value, which excludes downstream economic impacts from seafood) is nearly $40,000,000 dollars annually.[100] These landings constitute 26 percent of the state's entire seafood harvest.[101] The commercial and fisheries landings data for the Morro Bay Wind Energy Area is nearly $9,286,000.[102] The industry includes salmon and albacore trolling, pole caught albacore, Dungeness crab, groundfish (caught via longline), bottom trawl fisheries, pink shrimp trawling, and other fisheries. Live bait (typically anchovies) is caught in the Humboldt Bay.

Pre-construction activities, construction, and ongoing operation of offshore wind development all have the potential to impact commercial, recreational, subsistence, and cultural fisheries in California, with consequences to marine ecosystems, local economies, livelihoods, and access. These impacts may include loss or reduction of current or future fishing grounds, impacts to marine life and habitats, economic losses, navigational hazards, damage or loss of fishing gear, increased vessel traffic, displacement from and/or use conflicts at ports and harbors,

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99 CDFW. 2023. *Marine Region: 2022 by the Numbers*. Available at https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=210781&inline.

100 California Coastal Commission Staff. April 2022. *Th8a Consistency Determination*. California Coastal Commission. CD-0001-22. Available at https://documents.coastal.ca.gov/reports/2022/4/Th8a/Th8a-4-2022%20staffreport.pdf.

101 Bates, Ken and Linda Hildebrand (California Fishermen's Resiliency Association). January 2023. *Value of Fishing Grounds California North Coast*. Available at https://www.californiafishermensresiliencyassociation.com/_files/ugd/6c8e83_e518976e80a74935b037b7a18feb943f.pdf.

102 BOEM. October 2022. *Morro Bay WEA Final Environmental Assessment*. OCS EIS/EA BOEM 2022-024. Available at https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/2022-MorroBay-FinalEA.pdf.

increased risk to fishermen’s health and safety, and disruption to ongoing scientific surveys critical for fisheries management. These impacts, and strategies and recommendations to address them, are described in more detail below.

In addition, the fishing industry could be affected by port activities and development to support construction and operation of offshore wind facilities. These activities could create competition with fisheries industries for berths, vessel and gear storage, and marine services. Fish processing plants and wholesale or retail facilities could also be disrupted or displaced by construction. Moreover, those ports that support the staging and integration of turbines may have additional impacts on fisheries as fully constructed turbines are towed out to sea. Turbines will need to be towed under ideal ocean conditions and ports may implement rolling closures of the navigation channels to allow turbines to be safely towed out to sea. These rolling closures may prevent fishing vessels from taking advantage of good ocean conditions and could prevent fishing vessels from returning to port with their fresh products or under emergency situations.

The placement of offshore wind projects may also disrupt or displace National Marine Fisheries Service scientific surveys and long-term monitoring efforts. Data from these surveys are used to inform state and federally managed fisheries stock assessments that are then used to set catch limits in many commercial and recreational fisheries. If mitigation for the loss of these surveys within offshore wind projects does not occur, fish population estimates would become more uncertain. Fisheries management agencies may then respond to the increasing uncertainty by reducing the allowable catch for the fisheries. This has a direct impact on the continued economic viability of fisheries.

Fishing opportunities could be constrained by filling, dredging and deepening of ports or harbors, and channel or shoreline reconfiguration needed to support port and offshore wind facilities. These activities could affect bedforms and hydrology that support fisheries. See **Volume III, Appendix B** for additional detail on impacts to fisheries.

Impacts Identified by Fishermen and the Fishing Industry

The CEC and partner agencies met with fishermen and fishing industry stakeholders remotely and in-person. Fishing industry representatives also participated in staff workshops and provided numerous comments. In addition to concerns about unknown environmental impacts from offshore wind, representatives from the recreational and commercial fishing community are fearful about the potential negative economic impacts to their industry and associated supporting businesses. Fishing industry representatives have actively participated in federal and state offshore wind meetings and processes since 2016. They have expressed frustration and uncertainty about offshore wind overall, often commenting about lack of data, information, and engagement from the lessees.

Fishing representatives voiced concerns that the state’s offshore wind ambitions will result in a massive loss of historically important fishing grounds. They believe that fishing families, and tribal and underserved fishing communities face new losses of fishing grounds and the resources harvested from these grounds.[103] Although the direct economic losses are difficult to quantify, the looming threat of offshore wind development adds to an already unsteady footing of coastal communities. In addition to direct impacts to fishermen, concerns about indirect impacts to associated businesses (e.g., seafood processors, dock hands, gear manufacturers, vessel crewmembers), resulting in loss of jobs, closures, and further economic hardship, have also been raised.

Given the amount of time required (volunteer hours which result in lost work and income), fishing representatives are concerned about their ongoing ability to advocate for their interests as offshore wind development moves forward. Other concerns raised include the loss of community identity, dilution of the fishing and tourism industry, increased personal and family stress due to increased economic pressure.

Further, local fishermen's organizations and tribal and underserved fishing communities need to engage legal counsel at the beginning and throughout the duration of any proposed nonfishing coastal development to ensure that fishermen and their communities have meaningful participation in negotiations with developers and interaction with state permitting agencies.

Vessel Safety Concerns

Offshore wind development and ongoing operations have the potential to increase navigational hazards and vessel collisions. Fishing industry representatives shared concerns about vessel safety caused by collision with significant infrastructure in the water and increased boat traffic caused by offshore wind activities and/or associated vessel compaction. They also shared concerns about the potential for offshore wind turbines to distort radar contacts, which could increase the risk of collisions and impair USCG's ability to perform rescue operations. Fishermen also shared concerns about vessel safety caused by displacement from offshore wind development into dangerous or less favorable conditions during transit to and from port.

For example, in late 2022, the National Academy of Science and Medicine published a report that found offshore wind turbines create distorted radar contacts, which increases the risk of collision or allision, and will likely impact the ability of the U.S. Coast Guard to perform rescue operations for injured or sick crewmembers, as aircraft may not be able to operate near turbines. Furthermore, vessels drifting at night for sleep periods with only a captain aboard or vessels in distress will have to be located far away from offshore wind projects as they could drift into structures or other offshore wind infrastructure. Otherwise, the vessels can drift through the large vessel shipping lanes, creating additional hazards.

Fishermen also indicated that they have repeatedly asked BOEM to accommodate security and safety zones interior to the existing and potential future lease areas identified for offshore wind development, but to date, BOEM has not responded. Therefore, any such zones will be

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103 California Fisherman's Resiliency Association. June 2022. "California Fishermen's Resiliency Association Minimization and Mitigation Plan for Offshore Non-fishing Development in Northern California." TN 250492. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250492&DocumentContentId=85256.

placed outside of the lease area boundary, resulting in the loss of additional fishing areas. They note that on the East Coast, temporary 500-yard security zones are being proposed around each turbine during construction. It is reasonable to assume that similar safety zones may also be contemplated once a facility is operational. Additional experience on the East Coast indicates that insurers are reassessing fishing premiums, based on a perceived increased risk of losses due to safety concerns, conflicts, and impacts to radar system with offshore wind turbines.

Additionally, West Coast lease areas and any future areas identified upwind of ports will force much of the fishing effort downwind or in locations that puts vessels in the trough, or lowest part of a wave, for extended periods of time. This will make returning to port more difficult and less safe when facing prevailing headwinds or returning at an angle that puts the loaded vessel in the trough for much of the trip back to the dock.[104] Discussions with fishermen in Del Norte identified safety concerns with potential wind area development in Del Norte and Oregon. They indicated that designating corridor passage back to port could pose significant safety risks, such as the potential for capsizing, given the prevailing winds and dangerous swell that can occur in the waters off the Del Norte and Brookings areas.

Lost or Reduced Access to Fishing Areas

Offshore wind development and ongoing operation of port infrastructure, floating turbines and substations, undersea electric cables, anchors, and mooring cables may result in loss or reduction of current or future fishing grounds. Pre-construction surveys and deployment of turbines to their offshore locations may require temporary fishing closures, eliminating access and potentially requiring fishermen to fish in poor oceanic or weather conditions to compensate for economic losses. The long-term operation of offshore wind turbines and associated infrastructure may also result in permanent restricted access to certain areas for fishing and other activities.

Fishermen expressed concerns that this restricted access could displace fishing activities into other areas, resulting in competition and/or compaction, and causing increased gear entanglement, localized fishery depletion and associated adverse ecosystem effects, and negative impacts to food security and livelihoods for fishermen and associated industries.

Gear Loss or Damage

The presence of infrastructure on the surface, in the water column and on the seafloor has the potential to interact with fishing gear, resulting in gear entanglement, damage or loss. Increased vessel activity, navigational hazards and compaction of boat traffic may also result in damage or loss to fishing gear. These impacts would result in lost time on the water and the need to repair or replace gear, with economic consequences for fishermen.

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104 Helvey, Mark, Caroline Pomeroy, Naresh Pradhan, Dale Squires, and Stephen Stohs. January 2017. "Can the United States have its fish and eat it too?" Marine Policy, Volume 75, Pages 62-67. Available at https://doi.org/10.1016/j.marpol.2016.10.013.

Commenters noted concern that electrical cables to shore on the East Coast and in Europe have become un-buried, potentially entangling their gear. Impacted gear includes bottom trawls, seines, and traps and pots used for groundfish, squid, and crabs. Shifting of shipping lanes and tug and tow lanes will also impact fishing gear as coastal tug and barge traffic is moved closer to shore to avoid the wind farms. This places vessel traffic into Dungeness crab and other fixed-gear fishing grounds.

Uncertainty with Survey Work

All phases of offshore wind development may significantly impact marine life, starting with survey work that will utilize sonar and other technologies to determine the characteristics of the seafloor. During outreach to fishermen, they indicated that surveys will displace them for periods of time, as well as drive fish off the bite. Fishermen and fishing industry commenters understand this from past experiences with similar site characterization work done by the oil, gas, and telecommunications industries. Fishermen are concerned that sonar levels necessary to characterize the seafloor for anchor locations and trenching routes may kill a variety of fish and crustacean larvae, resulting in additional fishing losses. According to CDFW, the high energy surveys that pose a risk to fish and crustacean larvae, are not being considered for site characterization activities at this time.

Food Security Concerns

Fishermen and fishing industry commenters note the loss of fresh local products could cause increased reliance on imported or farmed seafood. They assert that local, wild-capture seafood produces the lowest carbon footprint compared with other domestic and foreign sourced forms of protein. Increased reliance on imported seafood will result in exporting fishing activities to nations with much less concern for the environmental impacts of their fisheries. Fishermen note that a recent case study estimated that partial closures of the West Coast drift gillnet swordfish fishery led to the unintended catch of 1,457 endangered leatherback sea turtles worldwide from 2001-2012, compared to 45 turtles if the U.S. fishing grounds had remained open.[105]

Impacts from Port Activities

Port development for offshore wind activities could lead to reduced dock space and increased costs for fishing vessels. Increased vessel traffic could also cause congestion and competition for port space and access. Fishing opportunities could be constrained by filling, dredging and deepening of ports or harbors, and channel or shoreline reconfiguration needed to support port and offshore wind facilities. These activities could affect bedforms and hydrology that support fisheries. California port upgrades for the offshore wind industry have the potential to interrupt fishing operations and associated businesses during construction and renovation activities. The extent of these disruptions is uncertain and will depend on the scale of the upgrades and planning activities undertaken by the local ports and harbors. Upon completion

105 Ibid.

of the upgrades, there is a possibility of displacement of fishing vessels, shoreside infrastructure, and businesses that support fishing operations. A reduction in landings could also lead to indirect job losses for vessel crewmembers, fishing gear manufacturers, and repair workers, which make up a significant portion of the seafood economy.

Fishermen noted that in 2019, 546 U.S. based commercial fishing vessels participated in the West Coast fishery for North Pacific albacore. This seasonal fishery normally operates between July and October and draws commercial and recreational fisherman from San Diego, to Bellingham, Washington. Schools of albacore can be found anywhere from California into Canada. Due to the migratory nature of the fishery, fisherman need access to multiple ports along the West Coast, which could be negatively impacted by port development and competition with the offshore wind industry. Vessels homeported a great distance from the fishing grounds, will seek temporary accommodations near the grounds where they can offload product, purchase fuel, bait, and other supplies. Not only is the albacore fishery critical to those businesses, but it also benefits the ports and harbors who collect fees for transient berthing.

Fishermen and fishing industry commenters expressed concern about cumulative impacts of offshore wind development, as many fisheries are coast-wide businesses and may bear the greatest burden from the takeover of productive fishing grounds by offshore wind development. Fishermen feel government efforts to mitigate climate change are unjustly and unequally applied to them, and that California's goals to increase environmental and economic justice are undermined by the injustice being done to the fishing community. Fishermen believe the knowledge gap for the West Coast is far greater, with many additional unknowns about floating, deep-water wind developments. At a minimum, fishermen suggest that community benefits agreements should be based on a thorough catalogue of impacts, to be amended as additional impacts and information becomes available.

Disruption of Fisheries Data Collection

In discussions with the CEC, the fisheries and fishing communities shared several strategies to address impacts to their communities. As with impacts to marine resources, adaptive management will aid in creating new knowledge and decreasing uncertainties. The fishing industry asked that the state consider developing a Fishing Community Benefit Agreement (FCBA) template.[106] This FCBA would provide a mechanism for claims to be evaluated and paid for fishing gear damaged or lost due to offshore wind structures or activities and provide a one-time compensatory mitigation to all regional fishermen and additional compensation for those directly impacted by the WEA and cable routes, as well as other needs of the fishing community.

Other mitigation strategies discussed included developing a *Fisheries and Mariners Communications Plan* required by BOEM, in which a fisheries liaison would be established to

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106 "The Need for Fisheries Community Benefit Agreements with OSW." June 2023. TN 250680. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250680&DocumentContentId=85476.

coordinate with the USCG and representatives of local fisheries groups to publicize relevant information, using modeling to design offshore wind projects to minimize impacts on fisheries and maximize access to productive fishing grounds, and designing port and harbor infrastructure improvements to serve both the local fishing community and offshore wind needs – with an eye toward coexistence of offshore wind facilities with sustainable commercial, recreational, subsistence, and cultural fishing, each of which would support communities in coastal regions of California.

Recommendations to Address Fisheries Impacts

The following recommendations will support increased understanding of potential impacts to fisheries and the fishing industry, and inform actions to avoid, minimize, mitigate impacts and adaptively manage offshore wind development and ongoing operation. Additional strategies for addressing fisheries impacts identified by fishing industry representatives, are included in **Volume III, Appendix B**.

- The latest commercial, recreational, subsistence, and cultural fishing data should be used to conduct analyses assessing spatial and temporal trends in fishing effort and value metrics in the offshore and nearshore environments, in consultation with California Native American tribes and the California Offshore Wind Fisheries Working Group. These efforts will inform deployment within existing lease areas and planning for port development and sea space for future offshore wind projects.
- Continue to support the California Offshore Wind Fisheries Working Group in developing a statewide strategy for avoidance, minimization, and mitigation of impacts to fishing and fisheries that prioritizes fisheries productivity, viability, long-term resilience, and safe navigation.
- Continue working with researchers, offshore wind leaseholders, tribes, and other state and federal agencies to develop a strategy to avoid, minimize, and mitigate impacts to ongoing fisheries surveys that inform fisheries management.

National Defense: Overview of Impacts, Strategies, and Recommendations

Overview of Impacts

Essential DOD operations in California are based inland, in coastal facilities, and in the ocean itself. Operations include high- and low-level flights, search and rescue, and marine transit, and they rely on radar and other tracking technologies. The construction and operation of floating offshore wind turbines will require a large fleet of marine vessels with frequent use of marine transit lanes. This can lead to the potential for vessel collision, conflict with DOD vessels, testing, training, and operations. The increase in marine vessel traffic may increase the number of events requiring search and rescue actions by the USCG.

In addition, the presence of the large turbines can alter radar signals and preclude large areas of the sea for use in DOD training exercises. The turbines also present additional risk of collisions between marine vessels or aircraft and floating turbines. Marine vessels may collide with or snag mooring cables, inter-array cables, and turbine anchor systems.

In ports and harbors, offshore wind construction and operations and maintenance would compete with DOD uses of port facilities and traffic lanes. Onshore transmission lines can present hazards to DOD activities, especially for low-altitude training flights.

Avoidance of conflict with DOD coastal, marine, and air operations would be ensured through coordination among DOD, BOEM and offshore wind project developers during leasing, siting, design, and operation activities. Mitigation would focus on avoidance of conflicts, considering potential interference with navigational radar, risk of collisions with infrastructure (including anchoring systems and floating turbine structures), risk of electromagnetic emissions conflict, and risk of snagging or being entangled with underwater cables. Coordination in advance of offshore facility construction and operation should also include the development of communications plans and vessel transit routes to facilitate vessel lane management, law enforcement, and search and rescue activities by the USCG.

Recommendations to Address Impacts to National Defense

The following recommendation will help eliminate or reduce potential conflicts between offshore wind development and military operations necessary for national defense:

- The state should continue to coordinate with the DOD to prevent potential offshore wind development from encroaching on military testing, training, and operations areas.

Underserved Communities: Overview of Impacts, Strategies, and Recommendations

For decades, marginalized communities that are predominantly low-income, residents of color, and indigenous communities, have experienced disproportionate impacts of environmental burdens. These inequities were fueled by historic government policies such as redlining,[107] disinvestment, and other unjust zoning practices. These led to underserved communities being burdened with power plants, refineries, and other industrial facilities, which exposed residents to higher levels of air and water pollution. At times, these practices also led to displacement, genocide, and erasure of California Native American tribes and their cultural sites for energy-producing and industrial facilities. Simultaneously, these communities have often had limited access to environmental resources like clean and affordable energy sources for housing and transportation.

Offshore wind offers a unique opportunity to increase equitable access to energy and benefits. Environmental justice and equity must be thoughtfully addressed early in the process. Achieving energy equity requires intentionally designing systems, technologies, procedures, and policies that help achieve the fair and just distribution of energy system benefits and the participation of individuals from underserved communities. An intentional approach can also avoid, mitigate, and lessen historical injustice in these processes.

The CEC and partner agencies are committed to a thoughtful approach on equity to help bring about a future where the benefits of cleaner, more efficient energy are enjoyed by all Californians, including those in underserved, tribal, and rural communities. As noted in the 2021 SB 100 Joint Agency Report by the CEC, CPUC, and CARB, prioritizing equitable outcomes will mean considering what energy policies could support underserved communities in overcoming barriers to clean energy by:

- Keeping electricity affordable, with an emphasis on vulnerable populations and households that spend a disproportionately high share of their household income on energy.
- Reducing air pollution from local power plants, particularly in communities that experience a disproportionate amount of air pollution.
- Strengthening communities' ability to function during power outages and enjoy reliable energy in a changing climate.
- Funding training for high-quality jobs and careers in the growing clean energy industry for communities historically impacted by the energy industry.

In addition to providing clean, reliable electricity for California, creating an offshore wind industry in California has the potential to deliver significant benefits to local and underserved communities through economic and workforce development. There will be opportunity to create well-paying, long-term jobs in local and underserved communities through developing local supply chain capacity and upgrading ports and waterfront facilities, investing in manufacturing of components and assembly of offshore wind turbines, operation and maintenance of offshore wind turbines, environmental and cultural resource monitoring, grid operations and maintenance, and other related jobs. In addition, offshore wind can create

[107] *Redlining* refers to the government practice of designating some neighborhoods as hazardous to investments, thus denying the predominantly minority and low-income residents' access to loans or investment.

opportunities for small businesses, tribal enterprises, and other diverse business enterprises. Through these efforts, offshore wind can create a pathway to developing local economic growth that benefits local and underserved communities, and to build a workforce that more accurately reflects the diversity of California.

Workforce partnerships that include workforce training centers, government agencies, community organizations, employers, community colleges, trainees and apprentices can foster a wider and more diverse pool of trained and available workers.

Offshore wind energy development also has the potential to provide reliability and resilience benefits to rural and remote communities with inadequate energy services that limit their ability to participate in the evolving clean energy economy. For example, because of limited access to transmission infrastructure, rural communities on the North Coast are less able to take advantage of clean and efficient technologies, such as electric vehicles. Offshore wind has the potential to bring additional clean energy benefits to local and regional areas.

The CEC and its partner agencies met with community members and environmental justice advocates in the development of this report. In these consultations, environmental justice advocates noted the importance of reducing impacts of the offshore wind industry on local and underserved communities. Some of these impacts include potential increased strains on housing availability and affordability, increased cost of living, and negative air quality impacts near port development. While offshore wind is itself a clean energy source, the production, transportation, and maintenance of these facilities could produce pollution if it is not electrified. These activities may impact port communities with potential air, water, noise and light pollution. Communities raised concerns about increased vehicle emissions and how these emissions might impact air quality. In addition, they raised concerns that the construction and operation of offshore wind turbines uses oil-based lubricants and other products that has the rare potential to result in an oil spill.

Because future development proposals have yet to be submitted, the extent of the air emissions, water pollutants, and other existing pollution impacts from industrial and hazardous waste sites, cleanup sites, traffic and how these sources of pollution may cumulatively affect underserved communities in the region is currently unknown. Future environmental studies and development plans will include impacts and identify avoidance and mitigation strategies addressing any environmental burdens.

Community groups and advocates proposed a number of strategies to address impacts, including increasing engagement with potentially impacted communities and funding to increase their capacity to engage. While there are many active port organizations, they are only just beginning to discuss offshore wind development. They want to understand how projects may be progressing and are asking questions and providing input on minimizing and avoiding potential impacts. According to advocates, best practices for engagement include creating an advisory board of community leaders, partnering with trusted community groups, advertising meetings weeks in advance, holding meetings in trusted locations at times when working families can attend, providing children’s activities and food, and creating accessibly written materials that are also translated.

A key priority advocates outlined is to support efforts to decommission aging oil and gas facilities as California moves towards a clean energy future. Community groups also expressed support for zero emission goals for ports and electrifying trucking and goods movement as much as possible. They also want to see strong legally binding community benefit agreements, investments in community resilience programs, and continuous monitoring and use of adaptive management practices throughout the development and operation of offshore wind facilities. Additional opportunities for community engagement and input will be posted via the CEC's Offshore Renewable Energy web page.[108]

Additional strategies for addressing impacts to underserved communities include prioritizing infrastructure projects that also have co-benefits for communities that have reliability issues and are most impacted during public safety power shut offs, supporting the development of community benefits agreements as required by offshore wind lease agreements with BOEM, and support training, hiring, and recruiting for employment opportunities within underserved communities and communities most impacted by offshore wind development.

Recommendations to Address Impacts to Underserved Communities

The following recommendations will increase understanding of potential impacts to underserved communities and inform actions to avoid, minimize and mitigate impacts and adaptively manage offshore wind development and ongoing operation.

- The study, development and operation of offshore wind related projects should include early regular, and meaningful community outreach and engagement with underserved communities, nongovernmental organizations, local governments and other potentially impacted underserved groups.
- Offshore wind development and operation should avoid, minimize or mitigate impacts to underserved communities, including those in and around ports.
- Evaluate and identify ways to increase capacity for stakeholders to engage on the permitting, development, and mitigation of offshore wind development.

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108 More information on CEC Offshore Renewable Energy is available at https://www.energy.ca.gov/programs-and-topics/topics/renewable-energy/offshore-renewable-energy.

Overview of Impacts to Other Resources

The following impacts and mitigation strategies are summarized only in **Volume III, Appendix B**, and not summarized in this chapter:

- Aesthetics
- Air Quality and Greenhouse Gas Emissions
- Agriculture and Forestry Resources
- Biological Resources – Terrestrial
- Economic and Environmental Justice
- Geology, Soils, and Paleontological Resources
- Hazards, Safety, and Hazardous Materials
- Hydrology and Water Quality
- Land Use and Planning
- Mineral Resources
- Public Services
- Recreation and Tourism
- Transportation, including Shipping Lanes
- Utilities and Service Systems
- Wildfire

Volume III, Appendix B presents a detailed list of the potential impacts by location and discipline, identifying the types of impacts that may occur in each of the three areas affected by offshore wind development and operation, as well as potentially applicable mitigation strategies. The impacts and mitigation strategies are presented by environmental discipline. No ranking or degree of severity is provided. The impact categories, or disciplines, include those in the CEQA Guidelines Appendix G (Environmental Checklist Form)[109] but the list has been expanded to address other impact types that may occur because of offshore wind construction and operation.

109 Association of Environmental Professionals. 2022. *2022 CEQA California Environmental Quality Act Statute & Guidelines*. Appendix G: Environmental Checklist Form, p. 391. Available at https://www.califaep.org/docs/2022_CEQA_Statue_and_Guidelines.pdf.

CHAPTER 5: Sea Space for Offshore Wind Development

AB 525 directs the CEC, in coordination with the CCC, CDFW, OPC, and CSLC, to work with stakeholders, other state, local, and federal agencies, and the offshore wind energy industry to identify suitable sea space for wind energy areas in federal waters to accommodate the offshore wind planning goals the CEC established under AB 525. AB 525 specifies a sequence of actions requiring that the CEC first identify the sea space identified by BOEM in its 2018 call for nominations for areas offshore the California coast and any other relevant information necessary to achieve the planning goals. Next, the CEC must identify suitable sea space for future development of offshore wind to accommodate the 2045 offshore wind planning goals.

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 BOEM's California Intergovernmental Renewable Energy Task Force (Task Force).
- Use the California Offshore Wind Energy Gateway, or a functionally equivalent internet website, to provide relevant information developed under this section to the public.
- Coordinate with the agencies noted above 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.

In August 2022, the CEC established offshore wind megawatt planning goals to inform the strategic plan, as required by AB 525. The planning goals to be evaluated in the AB 525 strategic planning process are 2 GW to 5 GW by 2030 and 25 GW by 2045. For AB 525, CEC has defined suitable sea space as ocean areas identified off the California coast that could support the commercial deployment of floating offshore wind generation technologies. Based on available information, the sea space should avoid or reduce (minimize) potential conflicts to help ensure the protection of cultural and biological resources and existing ocean uses. Suitable sea space must also be located in federal waters (three to 200 miles offshore) to support development activities sufficient to accommodate the AB 525 planning goals. The process for identifying sea space includes spatial mapping of locations potentially suitable for offshore wind.

In identifying sea space, the CEC established an interagency working group with representatives from the CDFW, CCC, CSLC, OPC, and CPUC. The CEC used previous work from BOEM and the Task Force as a starting point and continues to work with BOEM and others to review data, technical work, sea space areas, and screening results. This ensures that identified sea space can accommodate both national and California offshore wind goals. The CEC continues to collect and use new or updated data and information from the latest research and studies available. The sea space identification uses this new body of work developed through the collective efforts of state and federal agencies, academic institutions, environmental and conservation stakeholders, and other interested parties. This chapter summarizes a more detailed discussion of sea space identification presented in **Volume III, Appendix C**.

Identification of AB 525 Sea Space

To identify suitable sea space, CEC followed a relatively simplified process that recognizes the generalized nature and the limitations of existing data sets for identifying the potential conflicts with the diverse nature of biological organisms, ecological processes, and existing ocean values and uses. In many cases biological data was not sufficiently detailed to allow for in-depth analysis of interactions and the extent of potential impacts of the deployment of offshore wind technologies. The same limitations exist for information on evaluating conflicts for specific ocean uses, such as commercial fishing and tribal cultural resources and uses. Much of this type of information is only beginning to be gathered and applied through stakeholder discussion and tribal consultations that began with the passage of AB 525. These continued collaborative efforts will be needed to better understand and identify potential conflicts, effects, and impacts so that they can be minimized and mitigated.

Throughout the AB 525 sea space identification process, CEC used a series of geospatial overlays of existing data on existing ocean use and coastal resources that could be easily mapped to identify sea space. This process allowed CEC to map the geospatial extent of sea space, by identifying the wind generation potential and areas where biological and ocean use conflicts were avoided or minimized. The resulting sea space, with feasible wind energy potential, has been screened for potential conflicts.

The following section discusses key elements of the sea space analysis and the various factors considered in identifying suitable sea space. Factors that are important to deployment feasibility and cost of development include wind resource and technical characteristics like ocean bottom depth and ocean bottom slope. Exclusions for offshore wind development are also examined. Components of the analysis are described below, with the final characterization of AB 525 identified sea space depicted later in this chapter, in **Figure 5-12**.

Wind Resources

The wind resources considered are within federal waters off the California coast that extend from approximately three miles offshore to the 200-mile boundary of the Exclusive Economic

Zone off California, established by the National Oceanic and Atmospheric Administration.[110] These offshore winds are stronger and more consistent than any winds onshore, and generally blow more consistently in the evening.[111]

The NREL, BOEM, and the offshore wind industry generally consider a wind speed of 7 meters per second or greater as feasible for developing commercial offshore wind energy generation. Waters off the North Coast, including Del Norte, Humboldt, and Mendocino counties, have the highest wind resources and are more desirable for offshore wind development from a wind resource perspective. Waters off the Central Coast have moderate wind resources still suitable for offshore wind deployment, while waters off the South Coast have the lowest offshore wind energy generation potential.

Ocean Bottom Depth

Water depth is a major consideration for offshore wind development, with NREL and BOEM considering a water depth of 1,300 meters as a maximum depth when siting WEAs in other parts of the U.S. This is considered a conservative depth for feasible technology deployment, based on existing and emerging floating wind technologies. On the Pacific Coast, the continental shelf drops off quickly as it moves away from the shoreline. This poses technical challenges for the offshore wind industry, which must consider using the newest advances in floating offshore wind technology that have yet to be deployed at scale in the U.S. Areas closer to shore provide better access to ports and available electric grid connections and are more economically feasible to develop and maintain when considering necessary lengths of mooring and transmission cables and distance of boat trips. Because of these considerations and the need to examine a range of potential sea space that could help meet the AB 525 planning goals, ocean areas with a depth of 2,600 meters or less were included in the AB 525 sea space identification process.

Ocean Bottom Slope

A steep ocean bottom floor is less feasible for offshore wind development because it becomes increasingly difficult to anchor mooring lines to the seabed and lay transmission cables, while flat and shallow areas are preferable for development. For this analysis, an ocean bottom slope of less than 10 percent was used as a maximum suitable slope for offshore wind deployment. Seafloor substrate and seafloor habitats were not used as limiting factors due to limited data availability.

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110 An Exclusive Economic Zone is an area of coastal water and seabed within a certain distance of a country's coastline, generally 200 nautical miles, to which the country claims exclusive rights for fishing, drilling, and other economic activities.

111 The evening hours are when solar generation is declining due as the sun sets, and additional renewable resources are needed to maintain system reliability and meet California’s clean energy and climate goals.

Exclusions for Development

Exclusion areas are removed from further screening in the sea space identification process, as they are not suitable for offshore wind development. California's National Marine Sanctuaries are considered exclusions as commercial deployment of offshore wind is inconsistent with sanctuary regulations and BOEM has no legal jurisdiction to issue leases in these areas.

Considering Existing Ocean Use and Marine Resources

Throughout the spatial data analysis, CEC found that concentrations of existing ocean use and marine biological resources occur nearer to shore. Ocean use activity, including commercial and recreational fishing, vessel traffic, recreation, and cultural and historical resources, is generally highest in waters within about 20 miles from shore. Marine species presence generally occurs near the coast, with the highest concentrations occurring off the greater Bay Area coast (Mendocino to Point Sur) and the Southern Central Coast (San Luis Obispo to Lompoc). A composite index shows moderate to high concentrations of species occurring in waters less than 20 miles off the North Coast.[112] Moderate to high species concentrations occur in waters less than 40 miles off the greater Bay Area coast, Central Coast, and further south.[113]

To avoid the highest conflict areas and minimize impacts, offshore wind infrastructure should be deployed as far from the coast as feasible. The CEC used approximately 20 miles from shore for identifying AB 525 sea space to minimize potential conflicts with some ocean uses and specific marine mammal and marine bird species. Sea space located 20 miles from shore could avoid or help to reduce some potential conflicts and potential project-specific impacts, because species use, or existing ocean use activities occur less frequently.

AB 525 Sea Space Map

The Northern California Coast area is suitable for offshore wind development due to the exceptional wind resource, the availability of area for development, and the depth and slope of the ocean bottom. In addition, these areas have the highest combination of factors favorable for offshore wind development, including high wind speeds and annual daily wind consistency.

Throughout the spatial data analysis, CEC found that concentrations of existing ocean use and marine biological resources occur nearer to shore. Ocean use activity, including commercial and recreational fishing, vessel traffic, recreation, and cultural and historical resources, is generally highest in waters within about 20 miles from shore. Marine species presence generally occurs near the coast, with the highest concentrations occurring off the greater Bay Area coast (Mendocino to Point Sur) and the Southern Central Coast (San Luis Obispo to

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112 A composite index is a tool used to represent complex information from multiple indicators as a single metric, in this case the composite index consists of species occurrence, activity, density, and/or habitat.

113 Degagne, Rebecca, Mike Gough, Gladwin Joseph, Declan Pizzino, Charlotte Smith, and James Strittholt. October 2022. *Spatial Modeling to Support Sustainable Offshore Wind Energy Development for California*. Conservation Biology Institute. Available at https://consbio.org/wp-content/uploads/2022/05/CA-OSW-EEMS-Modeling-Report-October-2022.pdf.

Lompoc). A composite index shows moderate to high concentrations of species occurring in waters less than 20 miles off the North Coast.[114] Moderate to high species concentrations occur in waters less than 40 miles off the greater Bay Area coast, Central Coast, and further south.[115]

Figure 5-1 shows the map that was the starting point for identifying lower conflict areas of AB 525 suitable sea space to meet the 2030 and 2045 planning goals. The sea space areas of interest are denoted by the large, hatched ovals with the wind resource beginning at 20 miles from shore and at a maximum water depth of 2,600 meters. The areas of interest are located off Del Norte, Humboldt, Mendocino, and Monterey Counties. The area located off Monterey County is used for DOD military testing and training activities, which will be a consideration during continued suitability analysis.

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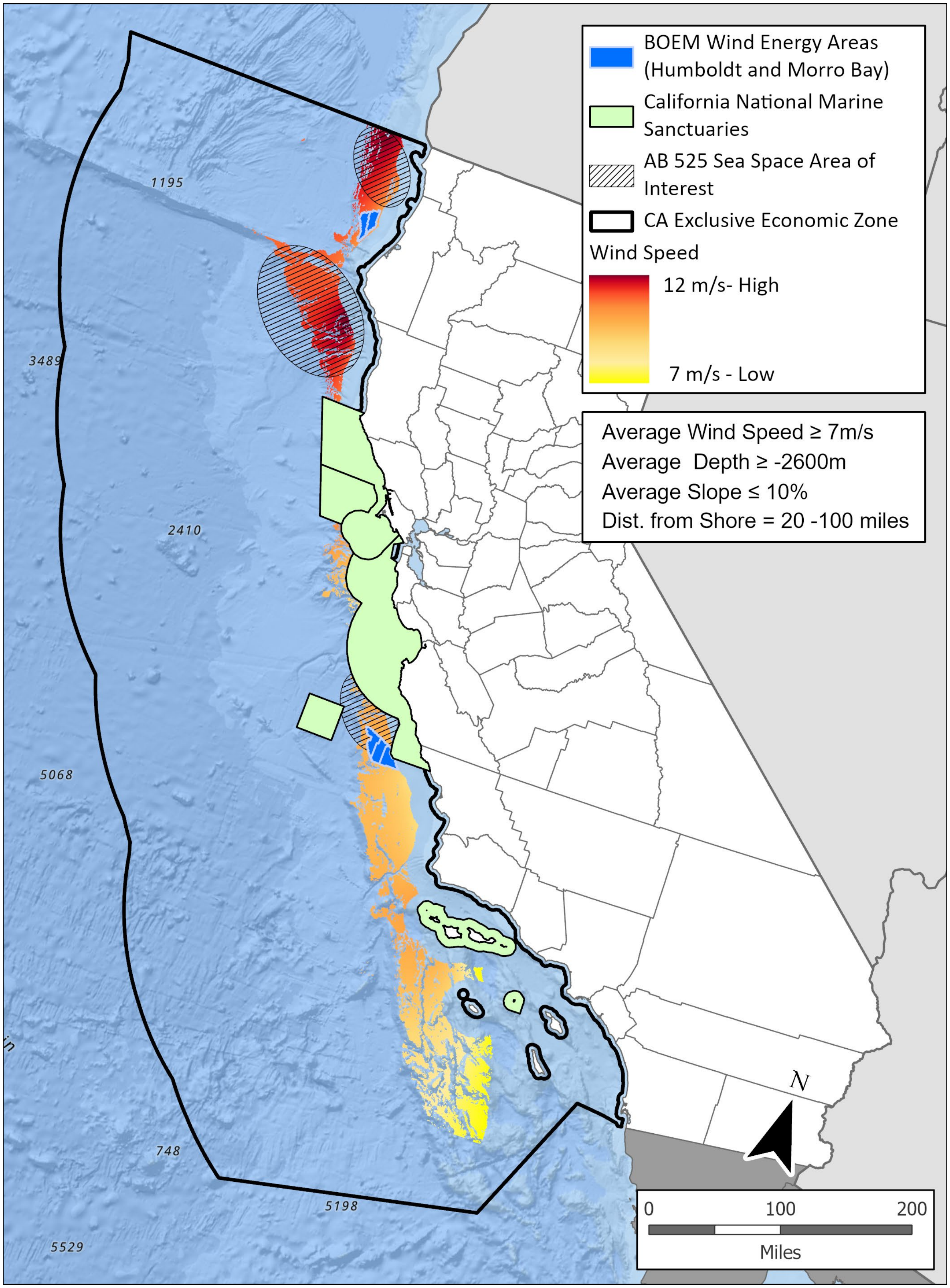
114 A composite index is a tool used to represent complex information from multiple indicators as a single metric, in this case the composite index consists of species occurrence, activity, density, and/or habitat.

115 Degagne, Rebecca, Mike Gough, Gladwin Joseph, Declan Pizzino, Charlotte Smith, and James Strittholt. October 2022. *Spatial Modeling to Support Sustainable Offshore Wind Energy Development for California*. Conservation Biology Institute. Available at https://consbio.org/wp-content/uploads/2022/05/CA-OSW-EEMS-Modeling-Report-October-2022.pdf.

Figure 5-1: AB 525 Sea Space Areas of Interest



Source: CEC. 2023

Characterization of AB 525 Suitable Sea Space

Using the results of the wind resource identification and conflict screening exercises, the CEC further refined sea space areas to identify areas with lower potential conflict. These areas are shown in **Figure 5-2** in more defined shapes within the ovals.

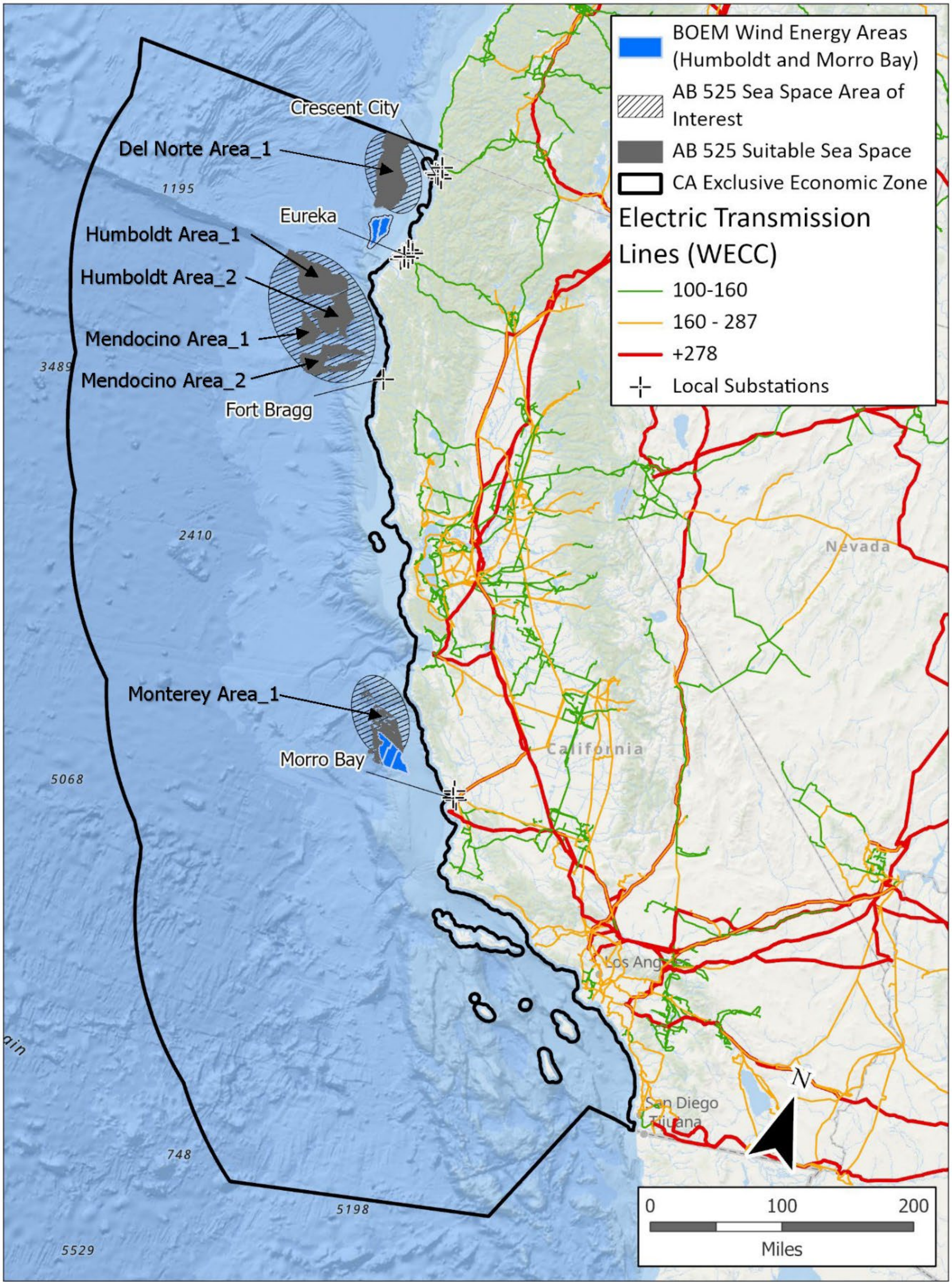
There are six sea space areas: one in the Del Norte area, two in the Humboldt area, two in the Mendocino area, and one in the Monterey area.[116] Five areas are located off the North Coast of California and one area is located off the South-Central Coast of California, just north of the current Morro Bay lease area, shown in **Figure 5-2**. All six sea space locations are characterized in detail in **Volume III, Appendix C**. The characterization tables provide location specific details regarding wind resources, existing ocean uses, environmental resources, and ocean characteristics occurring in that area.

Each sea space location is characterized by annual average wind speed greater than 7 meters per second, average water depth of 2,600 meters or less, ocean bottom slope of 10 percent or less, and a minimum distance of 20 miles from shore. These areas were identified exclusively by these constraints and were not changed in response to conflict screening, beyond siting 20 miles from shore to reflect reduced conflicts.

Potential conflicts in suitable sea space were identified as concerns. To better understand and assess these conflicts, additional focused work and data collection will be required. Because current information indicates that this sea space is potentially lower conflict for some species and ocean uses, the suitable sea space identified for AB 525 should be considered as areas where research should be focused to better understand impacts of offshore wind deployment. They should also be areas for additional data gathering, research, and feasibility analysis to lessen conflicts and help minimize the potential impacts of offshore wind development.

116 The naming convention used correlates with California counties.

Figure 5-2: AB 525 Suitable Sea Space Identified for Further Analysis



Source: CEC. 2023

Table 5-1 provides a summary of the detailed characterization tables in **Volume III, Appendix C**. The potential conflicts for each sea space area are listed based on review of existing data. Each entry in the table identifies the relative conflict within these areas as compared to areas closer to shore, with a reduction in potential conflict based on the distance from shore.

Table 5-1: Potential Conflicts Identified in AB 525 Suitable Sea Space

Sea Space Location	Benthic Habitats	Marine Birds	Marine Mammals	Marine Turtles	Fisheries	Shipping	DOD
Del Norte Area_1	High	Moderate	Low	N/A**	Reduced***	Low	Low
Humboldt Area_1	High	Low to Moderate	Moderate	N/A**	Reduced***	High	Low
Humboldt Area_2	Low	Moderate	Moderate	N/A**	Reduced***	High	Low
Mendocino Area_1	No Data*	Low to Moderate	Low to Moderate	N/A**	Reduced***	Low	Low
Mendocino Area_2	No Data*	Low to Moderate	Low to Moderate	N/A**	Reduced***	High	Low
Monterey Area_1	No Data*	Low to Moderate	High	High	Reduced***	Low	High

Notes: Refer to Figure 5-2 for map of locations.

* No Data – Spatial Modeling does not cover this area

** N/A – No significant species presence in this AB 525 Sea Space Location

*** – Reduced means that conflicts to fisheries are reduced compared to nearshore environments. Additional fisheries analyses are needed to fully understand impacts to fisheries.

Source: CEC. 2023

Screening for Conflicts

AB 525 requires the CEC to identify potential impacts on coastal resources, fisheries, Native American and Indigenous peoples, and national defense. The CEC and partner agencies identified the most relevant existing data that represent these categories.

The CEC's initial assessment identified coastal resources and existing ocean uses, comparing these data to the sea space areas to identify where coastal resources and ocean uses overlap. Identifying these overlaps informs the potential adverse impacts of floating offshore wind development.

The available data fall into the following groups that reflect the best available data and areas of concern identified by tribes, ocean users, and stakeholders:

Coastal Resources:

- Benthic habitats
- Marine birds
- Marine mammals
- Marine turtles
- Viewshed and cultural

Ocean Uses:

- Commercial fishing
- Recreational fishing
- Commercial shipping
- DOD military operations

AB 525 sea space areas are considered lower conflict, or least conflict, for potential offshore wind generation development, based on existing but limited information. However, further conflict screening is needed within these areas to fully assess suitability for offshore wind development. Available information indicates that some portions of sea space identified could be unsuitable for development. While the sea space identified 20 miles from shore is lower conflict, there are still coastal resource and ocean use conflicts to consider. Depending on the decisions made regarding ocean use conflict minimization and marine resource protection, the suitable sea space identified could be reduced in size. The following section summarizes some of the potential coastal resource conflicts and ocean use conflicts within the AB 525 sea space. **Volume III, Appendix C** provides additional details and full assessment results.

Marine Biological Resources

Benthic Habitats

Waters off the California Coast support a rich ecosystem with many species of marine life present. Benthic habitats are a major consideration for offshore wind siting. Many deep-sea corals and sponges add structural complexity to benthic habitats, provide refuge and substrate, and increase the number and availability of microhabitats for other organisms, thereby creating hotspots of biological diversity.[117] These organisms are generally long-lived, slow-growing, and fragile, making them vulnerable to human impacts. **Figure 5-3** maps the important benthic habitats in the AB 525 North Coast sea space and **Figure 5-4** maps the AB 525 South Coast sea space. Both maps display spatial data related to models predicting the distributions of deep-sea corals and sponges offshore of the U.S. West Coast to 1,200 meters.[118] These maps show that a high number of deep-sea coral taxa (species groupings)

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117 Poti, Matthew, Sarah Henkel, Joseph Bizzarro, Thomas Hourigan, M. Elizabeth Clarke, Curt Whitmire, Abigail Powell, et al. October 2020. *Cross-Shelf Habitat Suitability Modeling: Characterizing Potential Distributions of Deep-Sea Corals, Sponges, and Macrofauna Offshore of the US West Coast*. OCS Study BOEM 2020-021. p. 267. Available at https://espis.boem.gov/final%20reports/BOEM_2020-021.pdf.

118 A maximum depth of 1,200 meters (m) was chosen for the study because there was less coverage of bathymetry in deeper waters offshore California, there were fewer deep-sea coral and sponge occurrence records

have high habitat suitability within the sea space areas of interest, particularly off Del Norte County.

Essential Fish Habitat (EFH) is another category of important biological areas. EFH areas are designated by NOAA's National Marine Fisheries Service (NMFS), who work with regional fishery management councils to identify the essential habitat for every life stage of each federally managed species using the best available scientific information. For this analysis, two designations were identified as areas that should have special consideration for protection:

- Pacific Groundfish Habitat Areas of Particular Concern: Groundfish HAPC's include seagrass, canopy kelp, rocky reefs, estuaries, and specified areas of interest. HAPCs based on habitat type may vary in location and extent over time.[119] A HAPC is a designation that encompasses discrete subsets of Essential Fish Habitat, which provide extremely important ecological functions or are especially vulnerable to degradation.
- Pacific Groundfish Essential Fish Habitat Conservation Areas (EFHCA): These data represent configurations of areas closed to bottom trawl fishing to minimize the adverse effects from fishing and protect essential fish habitat (Amendment 28 of Pacific Fisheries Management Council).[120]

Figure 5-3 and **Figure 5-4** also depict the Pacific Groundfish HAPC and the Pacific Groundfish EFHCA. These areas should be taken into consideration when siting offshore wind infrastructure as they are designated habitat that are necessary to the species for spawning, breeding, feeding, or growth to maturity.

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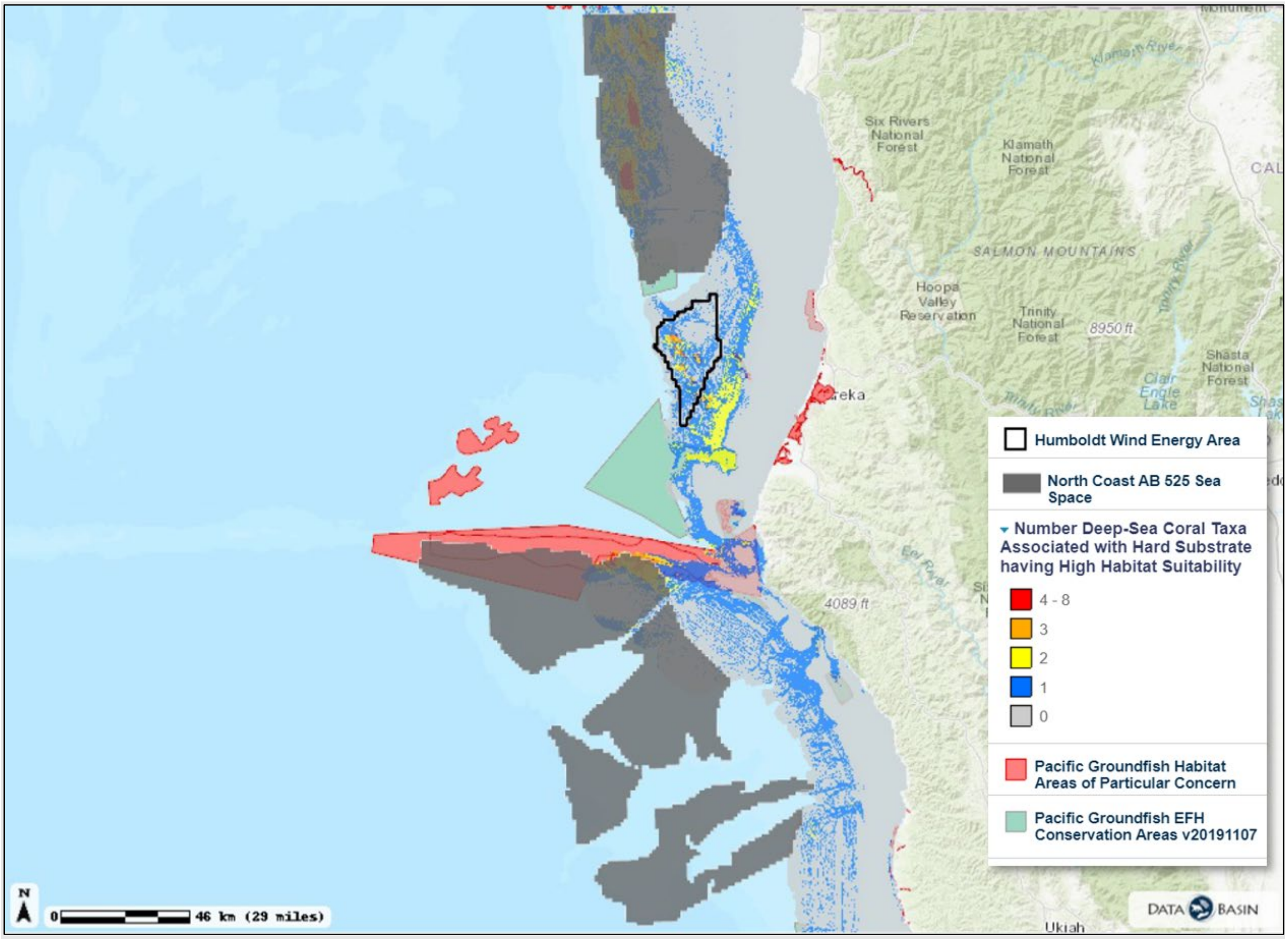
in the NOAA database, many of the records identified in deeper waters were not identified to the species level and no macrofauna sampling stations were located in water deeper than 1,200 m, and at the time of the report (2020) most human use and planning along the west coast were inshore of 1,200 m.

119 The NOAA Fisheries Essential Fish Habitat Mapper is available at https://www.habitat.noaa.gov/apps/efhmapper/.

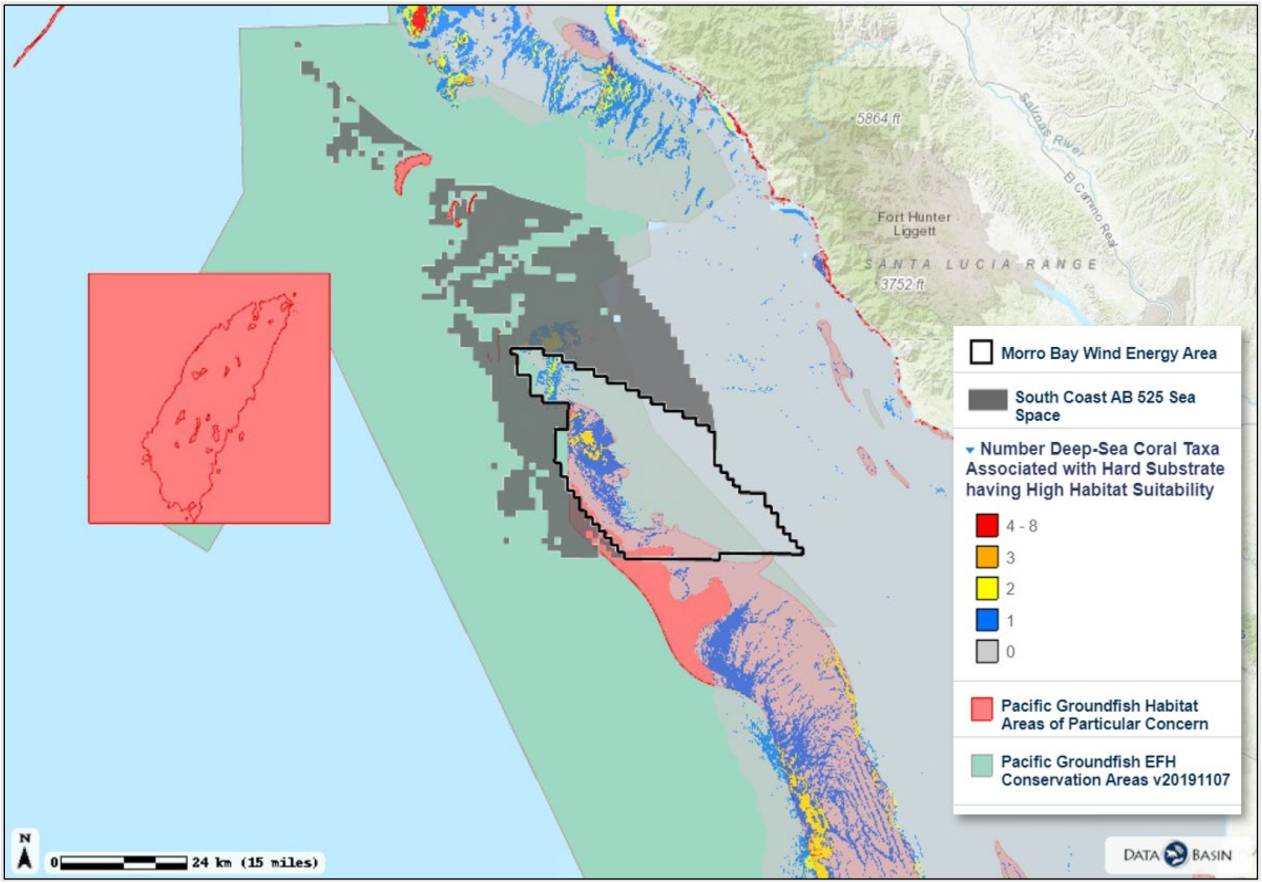
120 The NOAA Fisheries Essential Fish Habitat Mapper is available at https://www.habitat.noaa.gov/apps/efhmapper/.

Figure 5-3: Map of Important Benthic Habitats in North Coast



Source: CEC. 2023

Figure 5-4: Map of Important Benthic Habitats in South Coast



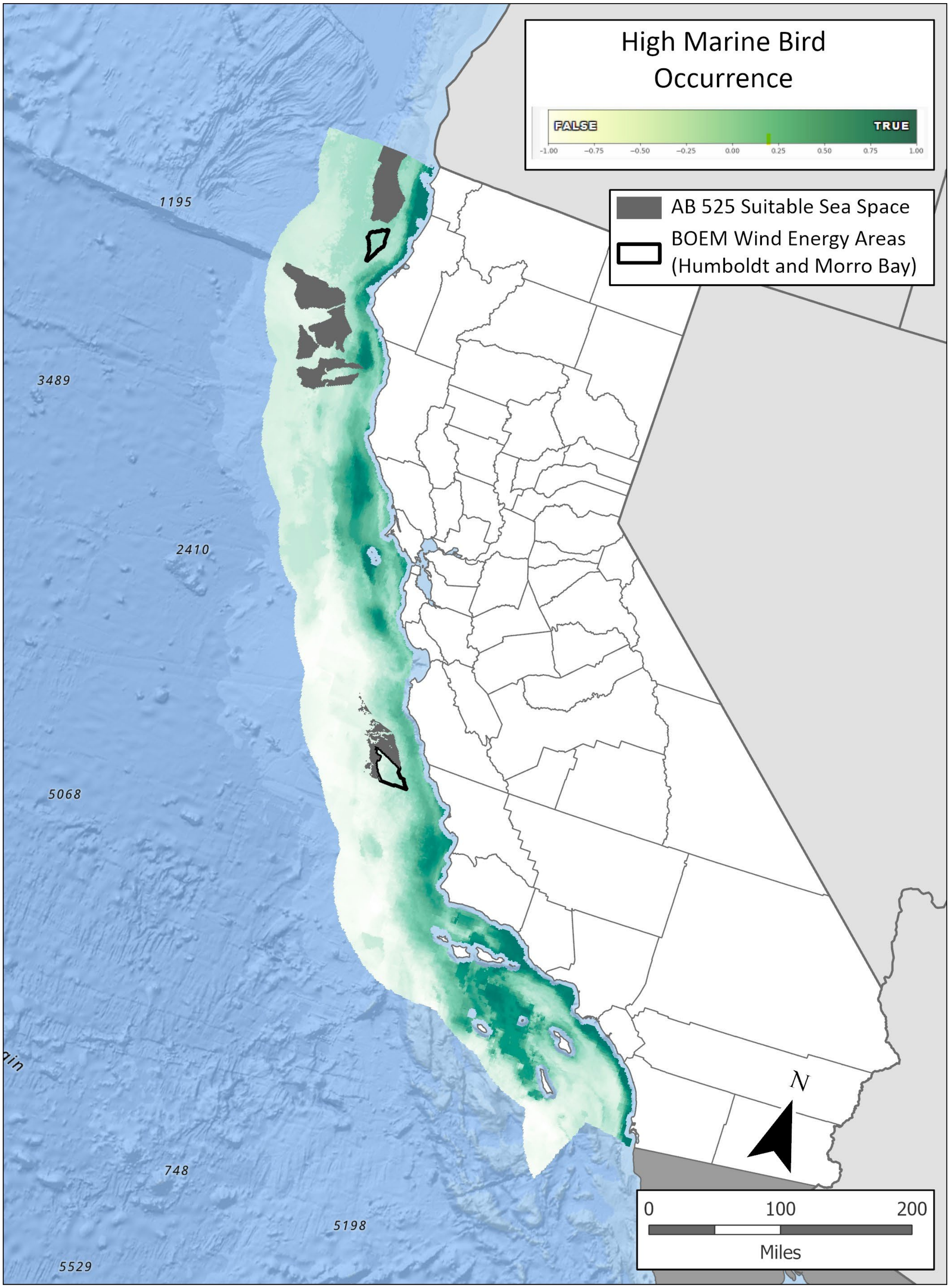
Source: CEC. 2023

Marine Birds

Marine birds have the potential to be negatively affected by offshore wind energy development. Spatial mapping of marine bird abundance, distribution, and density are important for siting offshore wind infrastructure and evaluating environmental impacts.

Figure 5-5 depicts marine bird relative density in the California Offshore Wind Energy Modeling Platform, a publicly available set of spatial models designed to synthesize information of offshore wind energy development. The model estimates an index of marine life presence by considering the occurrence, activity, density, and habitat of sensitive marine species. Species with a higher protected status (such as endangered) were weighted more heavily in the model. A description of each model is provided in **Volume III, Appendix C**.

Figure 5-5: Marine Birds Map



Source: California Offshore Wind Energy Modeling Platform. 2023

The data shows marine bird species groups across multiple seasons. Marine birds include species of alcids, cormorants, grebes, gulls and terns, jaegers and skuas, loons, brown pelican, phalaropes, scoters, and tubenoses (albatrosses, storm-petrels, and petrels and shearwaters).[121] The dark green color shows areas where there is high marine bird presence and yellow areas show less marine bird presence. Data from this study demonstrates that higher marine bird activity takes place closer to shore. Farther from shore, there is less activity for marine bird species in general, however, certain species continue to use extensive areas of the ocean surface.

Marine Mammals

Marine mammals have the potential to be affected by offshore wind energy development. The best available species distribution models were used to examine the density and distribution of marine mammals and to identify potential interaction with offshore wind energy infrastructure development. In **Figure 5-6**, data from the California Offshore Wind Energy Modeling Platform shows total marine mammals species density and distribution. Marine mammals include toothed whales (southern resident killer whale, sperm whale, beaked whale, dolphin, porpoise), baleen whales (humpback whale, fin whale, blue whale, gray whale, minke whale), and pinnipeds (California sea lion, northern elephant seal, Guadalupe fur seal).

Findings show areas closer to shore have higher marine mammal density and there is generally higher activity off the Central Coast. The distribution of whales extends into deeper waters, with higher density closer to shore. Pinnipeds distribution data shows higher density off the Central Coast in comparison to the North Coast.[122]

Marine Turtles

Similar to marine birds and mammals, marine turtles have the potential to be affected by offshore wind infrastructure. While there are numerous sea turtle species present in California waters, based on available data, the endangered leatherback sea turtle is the only species with a potentially significant presence in the identified sea space. Based on data from the California Offshore Wind Energy Modeling Platform, **Figure 5-7** shows low leatherback sea turtle density off the North Coast and considerable density off the Central Coast. The dark green shows areas where there is high leatherback sea turtle presence and should be prioritized as an area where more information is needed to understand how they will interact with offshore wind infrastructure.

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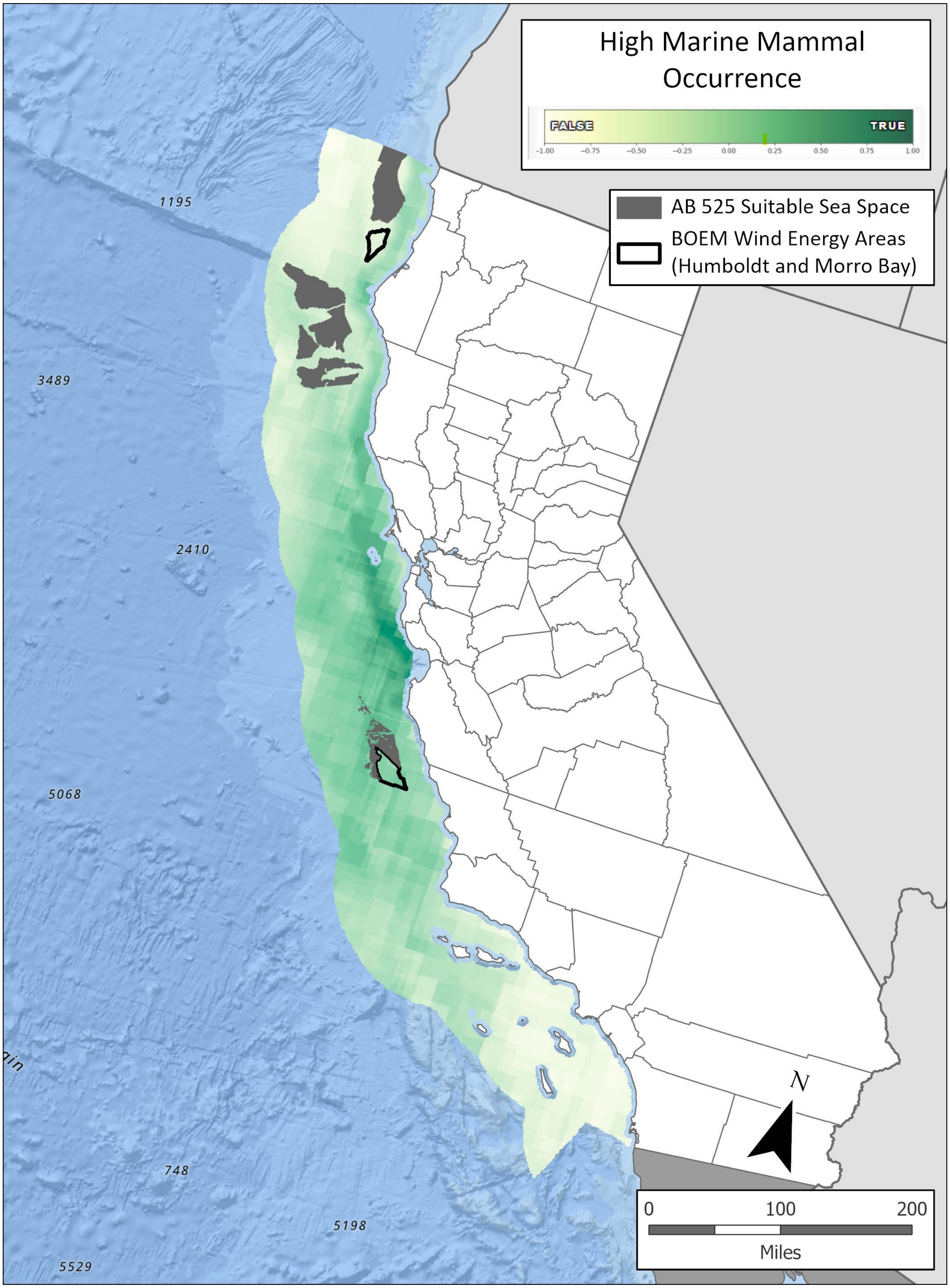
121 Degagne, Rebecca, Mike Gough, Gladwin Joseph, Declan Pizzino, Charlotte Smith, and James Strittholt. October 2022. *Spatial Modeling to Support Sustainable Offshore Wind Energy Development for California*. Conservation Biology Institute. Available at https://consbio.org/wp-content/uploads/2022/05/CA-OSW-EEMS-Modeling-Report-October-2022.pdf.

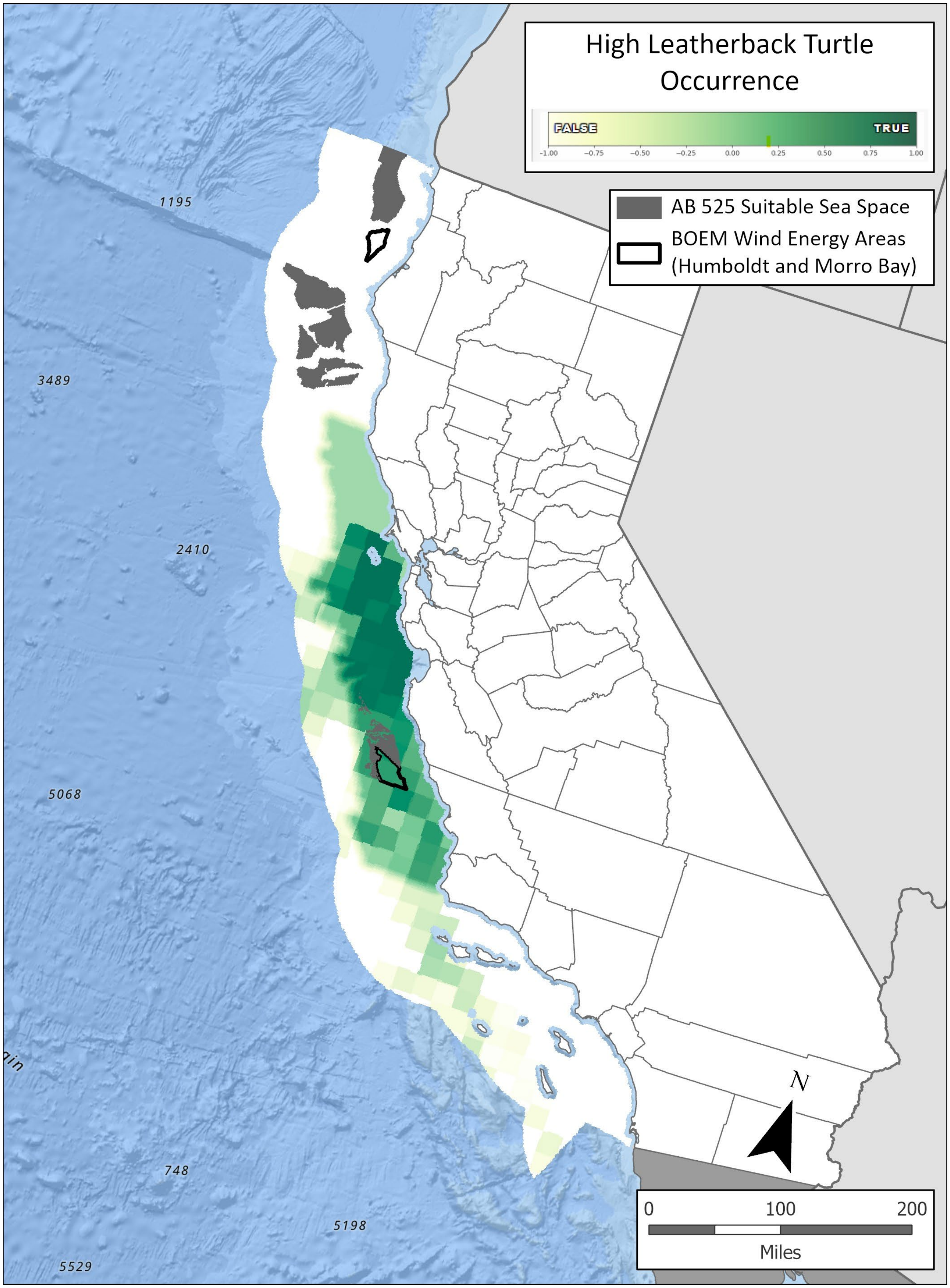
122 Ibid.

Figure 5-6: Marine Mammals Map



Source: California Offshore Wind Energy Modeling Platform. 2023

Figure 5-7: Leatherback Sea Turtle Map



Source: California Offshore Wind Energy Modeling Platform. 2023

Native American Tribes

Offshore wind development has the potential to impact Native American tribes in a number of ways, as described earlier in **Chapter 4**. Concerns they identified include access to subsistence fishing, impacts to culturally important species such as Chinook salmon, long term changes to the viewshed during construction and operation of offshore wind, and additional effects on physical resources such as prehistoric habitation sites.

Tribes have requested specific recommendations and strategies to avoid and, when avoidance is unavailable, mitigate harms to the sites, features, places, and objects historically, culturally, and religiously important to tribes in the ocean, on the coast, and inland. Northern tribes have also voiced concern of the Del Norte sea space (Del Norte Area_1 identified in **Figure 5-2**) due to its close proximity to the Humboldt WEA and the Oregon Brookings Call Area. The Del Norte sea space is located in between the WEA and the Brookings Call Area and tribes have voiced concerns about changes to the viewshed.

On August 24, 2023, NOAA published a proposal for the new Chumash Heritage National Marine Sanctuary off California's Central Coast.[123] The draft proposal designates a 5,617 square mile area offshore San Luis Obispo and Santa Barbara counties in Central California as Chumash Heritage National Marine Sanctuary. The Agency-Preferred Alternative for the proposed sanctuary differs from the initial proposed boundary. It excludes an area that could serve as a corridor for offshore wind energy infrastructure, specifically subsea electrical transmission cables and substations from the Morro Bay WEA to shore.[124] Tribes have voiced concern over the subsea transmission cables affecting the sanctuary boundaries and affecting cultural resources near shore because this infrastructure may not be compatible with a national marine sanctuary.

The CEC initiated outreach to tribal governments to discuss identified sea space and gather more information from affected tribes on potential impacts. This included funding from OPC to support tribes to conduct cultural resource inventories on the North and Central Coasts. CEC and partner agencies have established an offshore wind working group with tribes to help identify, develop, and evaluate spatial and other data regarding culturally important resources to continue to inform the sea space evaluation.

Existing Ocean Uses

Commercial Fisheries

The commercial fishing industry is an existing ocean use that may be impacted by offshore wind development. To gather fishing data, fishermen in the North and Central Coasts

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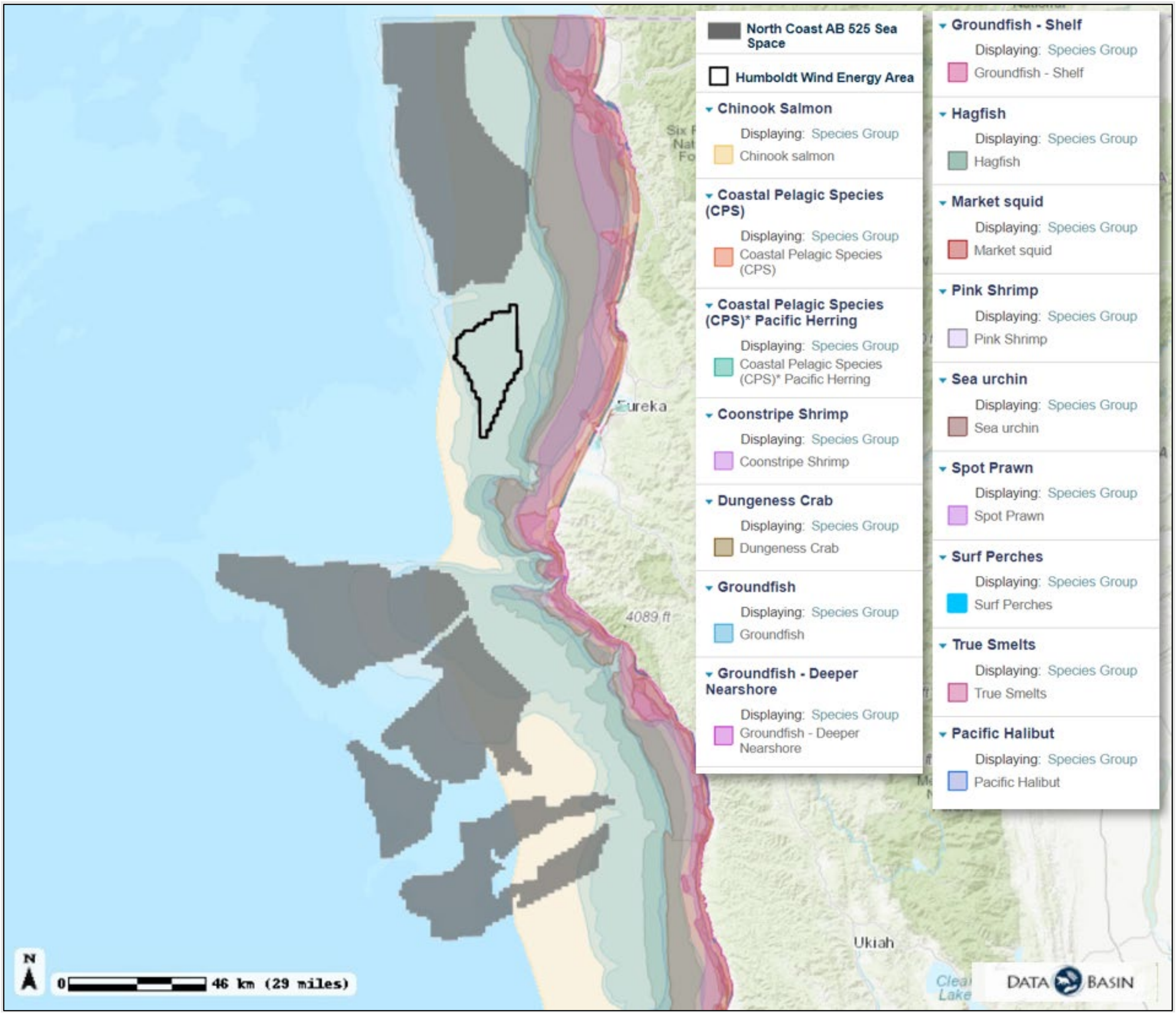
123 NOAA. August 2023. "Biden-Harris Administration proposes new Chumash Heritage National Marine Sanctuary off California coast." Available at https://www.noaa.gov/news-release/biden-harris-administration-proposes-new-chumash-heritage-national-marine-sanctuary-off-california.

124 NOAA. "Proposed Chumash Heritage National Marine Sanctuary." Available at https://sanctuaries.noaa.gov/chumash-heritage/.

provided spatial datasets to help inform sea space identification. The fishing areas mapped by the fishermen represent where fishing for that species or species complex would occur without fishing restrictions or conflicts. **Figure 5-8** shows the North Coast fisheries data that resulted from a collaboration with three Northern California Commercial Fishermen's Associations. The data was used to map community fishing grounds by species or species complex, gear type, depth, seafloor substrate, and season. The mapping project contains fisheries boundaries for all existing commercial fishing activities and potentially developing or emerging fisheries.

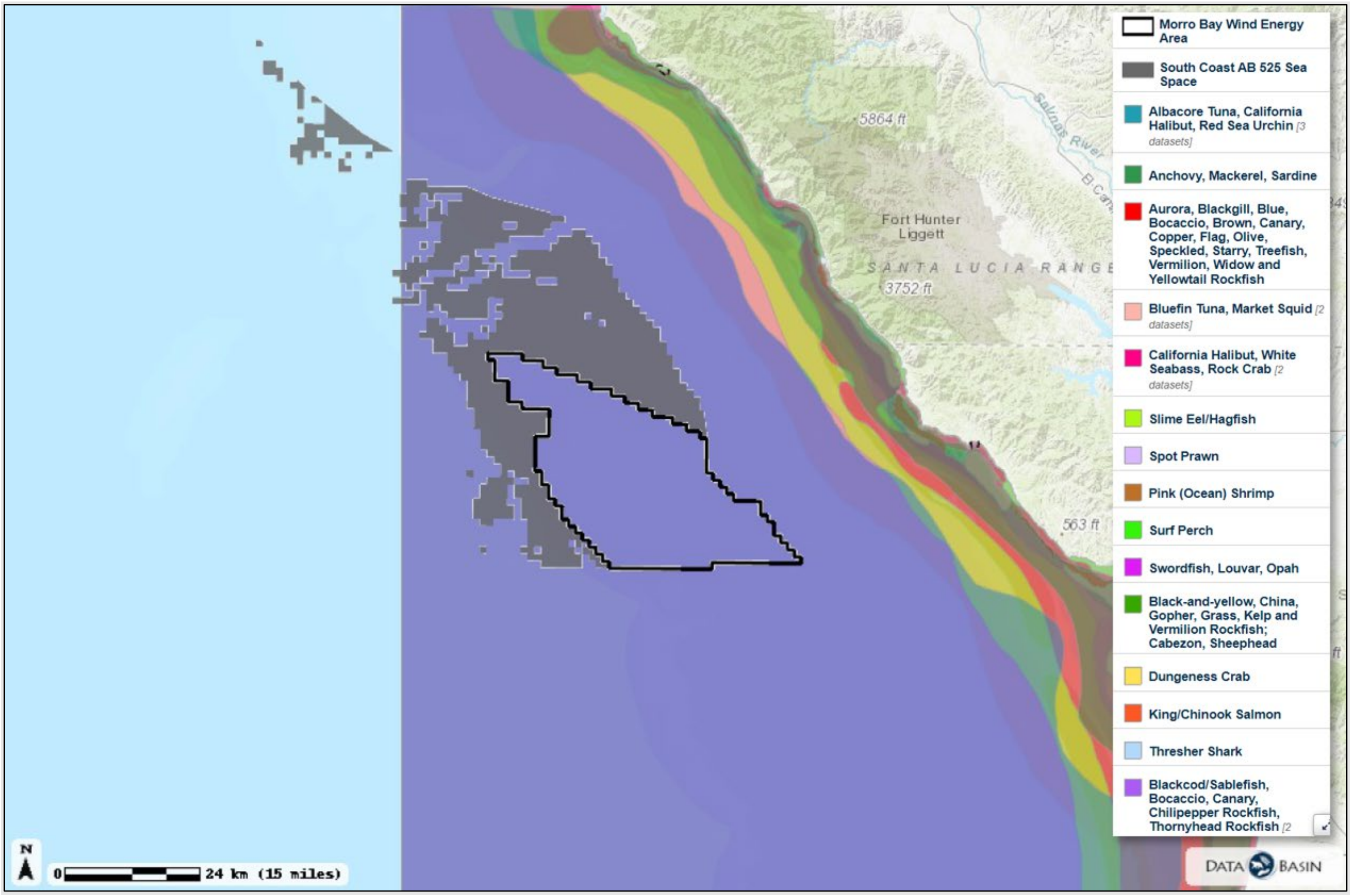
Figure 5-8: Map of North Coast California Commercial Fishermen Fishing Grounds



Source: CEC. 2023

Figure 5-9 shows the Central Coast fisheries data project led by the Morro Bay Commercial Fishermen's Organization, involving fishermen from San Diego to Santa Cruz. The data were used to map commercial fishing grounds between Point Sur and Point Conception. The maps provide a historically informed snapshot of the area's fishing grounds, some of which are expanding, declining, or are limited due to environmental, regulatory, and socioeconomic factors.

Figure 5-9: Map of Central Coast California Commercial Fishermen Fishing Grounds[125]



Source: CEC. 2023

Both fishing maps demonstrate that high fishing activity takes places closer to shore. By identifying sea space further from shore, most of the fisheries in the North and Central Coasts are avoided. However, the fisheries that operate closer to shore may still be impacted by the transmission cables coming to shore and the increased vessel traffic associated with offshore wind energy infrastructure deployment, operations, and maintenance. The North Coast fisheries that have considerable overlap with the sea space and a higher likelihood of being impacted are Chinook Salmon, Groundfish, Albacore, Bluefin Tuna, Pacific Bonito, Louvar, and Swordfish. The Central Coast fisheries that have considerable overlap with the sea space and a higher likelihood of being impacted are Albacore Tuna, Swordfish, Louvar, Opah, Bluefin Tuna, King/Chinook Salmon, Thresher Shark, Black cod/Sablefish, Bocaccio, Canary, Chilipepper Rockfish, and Thornyhead Rockfish.

125 Central Coast Fisheries data does not extend to the full sea space area which is why there is a clear-cut delineation, this does not indicate fishing stops after the purple area.

When considering the level of potential impacts to fisheries, not all fisheries have the same operational needs. Bottom trawl fisheries are more vulnerable to restrictions because of low maneuverability. **Figure 5-10** depicts observed fishing effort along the Pacific Coast for groundfish bottom trawl fisheries using data collected by NOAA. These maps are representative of fishing effort and density, measured using logbook data, and do not represent financial value of the fisheries.[126] Higher bottom trawl fishing effort takes place off the North Coast, particularly off Del Norte County. An additional consideration for the Del Norte area is the location of the Brookings Call Area in Oregon, which is located directly north of the California border. Wind energy development in this area could present greater restrictions for bottom trawl fishermen.

Commercial Shipping

The commercial shipping industry was not listed as a stakeholder in AB 525; however, analysis of ocean use data indicates commercial shipping is a large ocean user and therefore is an important consideration.[127] To understand vessel traffic, Automatic Identification System (AIS) Vessel traffic data was assessed. It shows dataset counts and aggregates the number of ships off the Western U.S. for 2018 through 2020. The highest vessel traffic takes places near San Francisco and Los Angeles. The USCG proposed shipping lanes from the Pacific Coast Port Access Route Study (PAC-PARS) are shown in **Figure 5-11** (data as of June 2023). This study evaluated safe access routes for the movement of vessel traffic to or from ports or places along the western seaboard of the US. The USCG recommends the establishment of voluntary shipping fairways for vessel traffic to promote the safe, unobstructed navigation of vessels.[128] The proposed shipping lanes are of 15 nautical miles wide and pass through each sea space area of interest. They also pass through the middle of the largest sea space areas off Humboldt and Mendocino Counties.

The proposed PAC-PARS fairways will occupy a significant amount of the remaining available space for potential future offshore wind development. Simply moving the shipping lanes further from shore to accommodate the identified sea space could result in higher shipping and transport costs for the vessels and higher emissions from fuel burning due to the longer routes. Further collaboration and discussion are needed between the shipping industry and state and federal governments.

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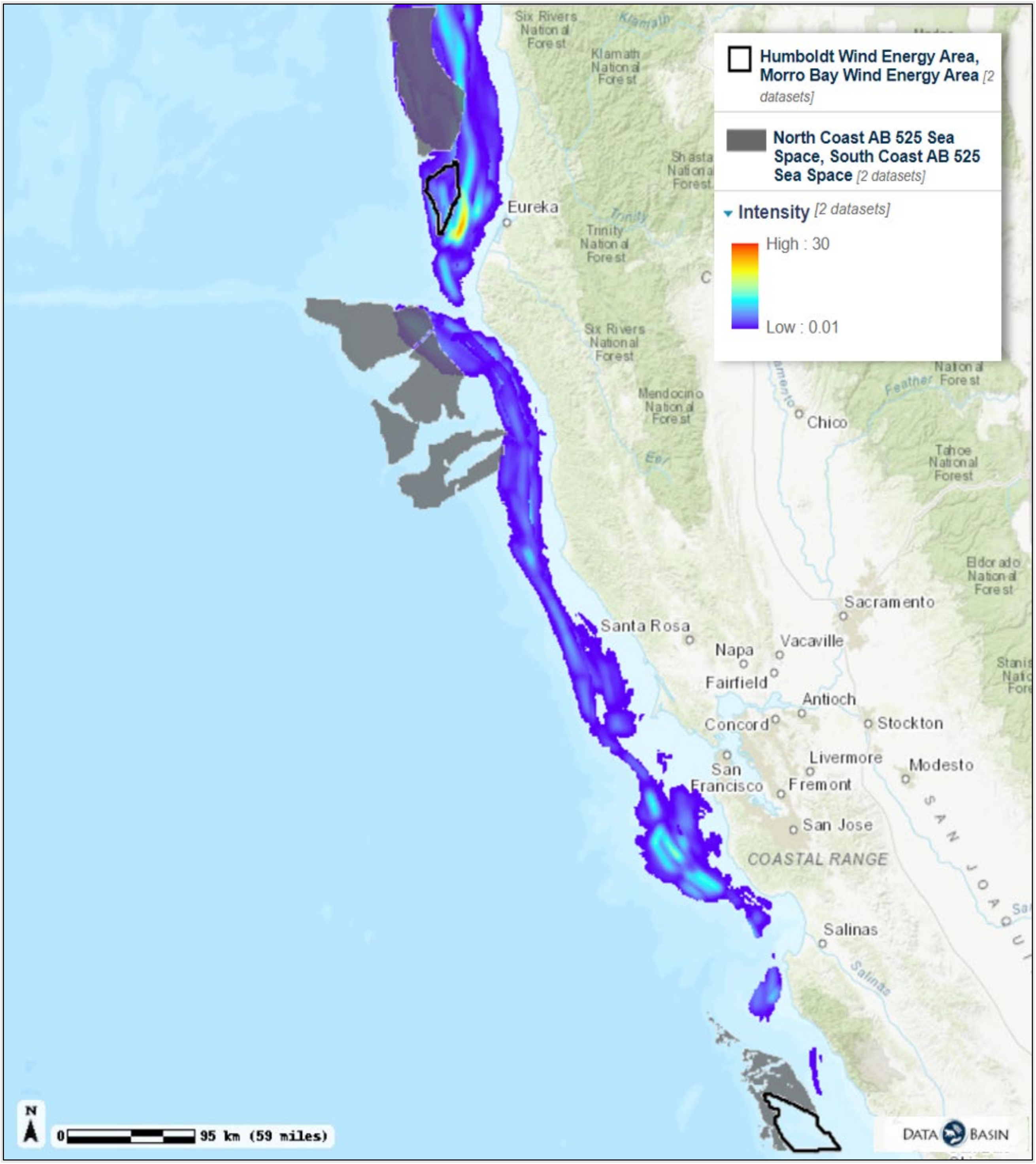
126 Logbooks are used on commercial fishing vessels and recreational charter fishing vessels to record catch of highly migratory species, effort, and other data.

127 Representatives of the commercial shipping industry participated in workshops and filed comments expressing interest in participating in sea space identification and other offshore wind related activities.

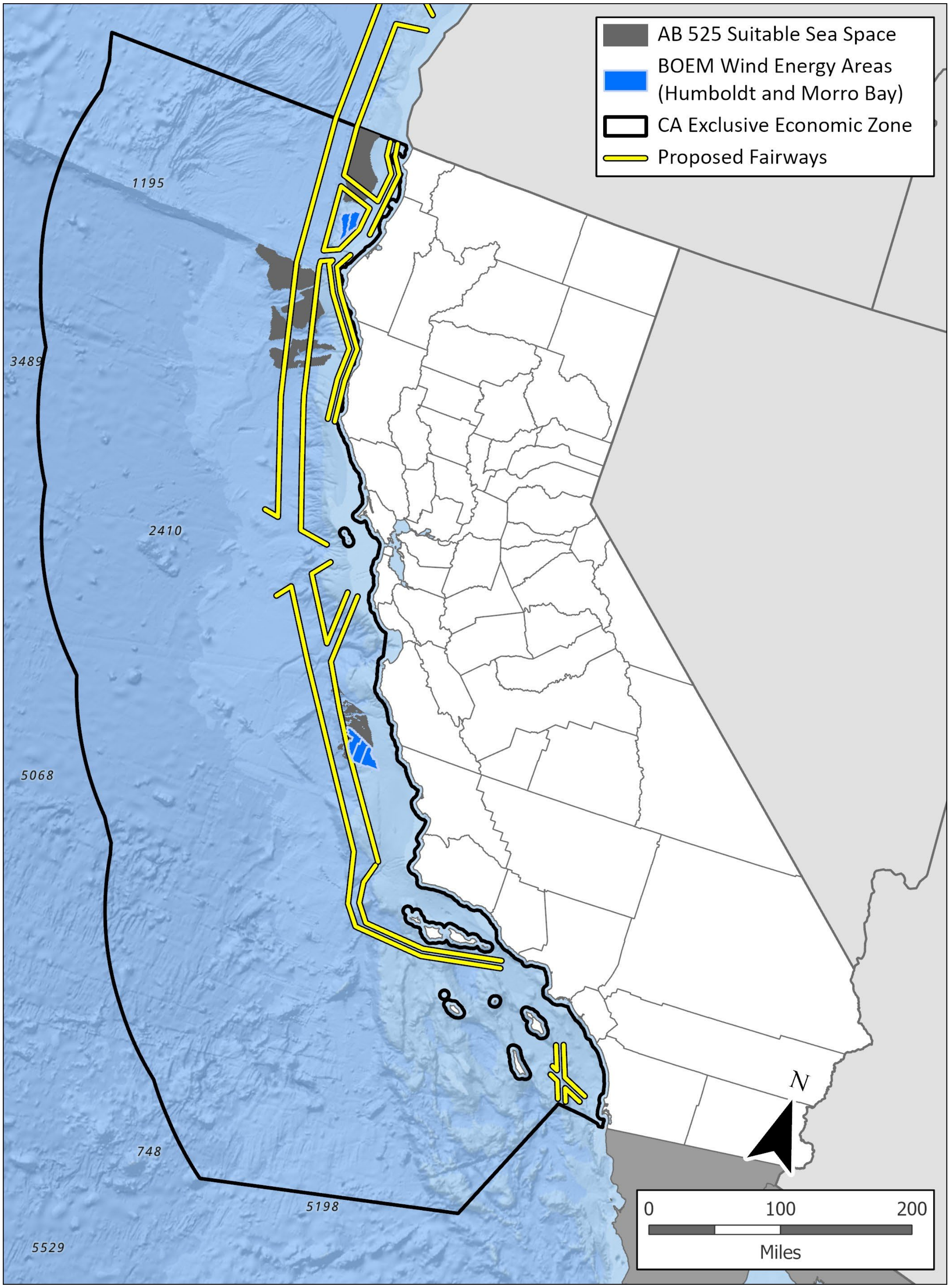
128 U.S. Coast Guard. June 2023. *Port Access Route Study: The Pacific Coast from Washington to California*. 88 Fed. Reg. 36,607. Notice. Available at https://www.federalregister.gov/d/2023-11878.

Figure 5-10: Map of California Bottom Trawl Fishing Effort



Source: CEC. 2023

Figure 5-11: US Coast Guard PAC-PARS Shipping Fairways



Source: CEC. 2023

Department of Defense Military Operations

The DOD conducts extensive training, weapons testing, and other operations south of the San Francisco Bay Area. This creates potential conflicts with offshore wind areas off the Central and Southern Coasts of California. **Figure 5-12** shows a map resulting from the 2018 Call for Information that designates areas of DOD military activity off the California Coast to determine potential compatibility for offshore wind development. The yellow area is designated as "Site-Specific Stipulations" which means DOD may recommend additional measures but does not presently deem offshore wind to be incompatible with its missions.[129] The salmon-colored area is designated as incompatible with wind energy development due to the wide array of critical DOD activities taking place.

Previously, DOD determined the 2018 Morro Bay and Diablo Canyon Call Areas were incompatible with offshore wind development because the areas were located within Federal Aviation Authority designated offshore warning areas that warn aircraft of hazardous military activities being conducted in the area. The newly identified sea space area of interest located north of the Morro Bay lease area will need to go through a review process by DOD to determine any conflicts or impacts to DOD testing, training, and operations.

During the June 1, 2023, AB 525 sea space identification workshop, a representative from DOD informed the CEC that the review process to identify challenges and impacts for further discussion with DOD would be conducted by the DOD Siting Clearinghouse. Most potential conflicts with DOD operations occur at the project development stage, where DOD works with project developers to analyze the specific effects of project design and operational impacts to the DOD mission.

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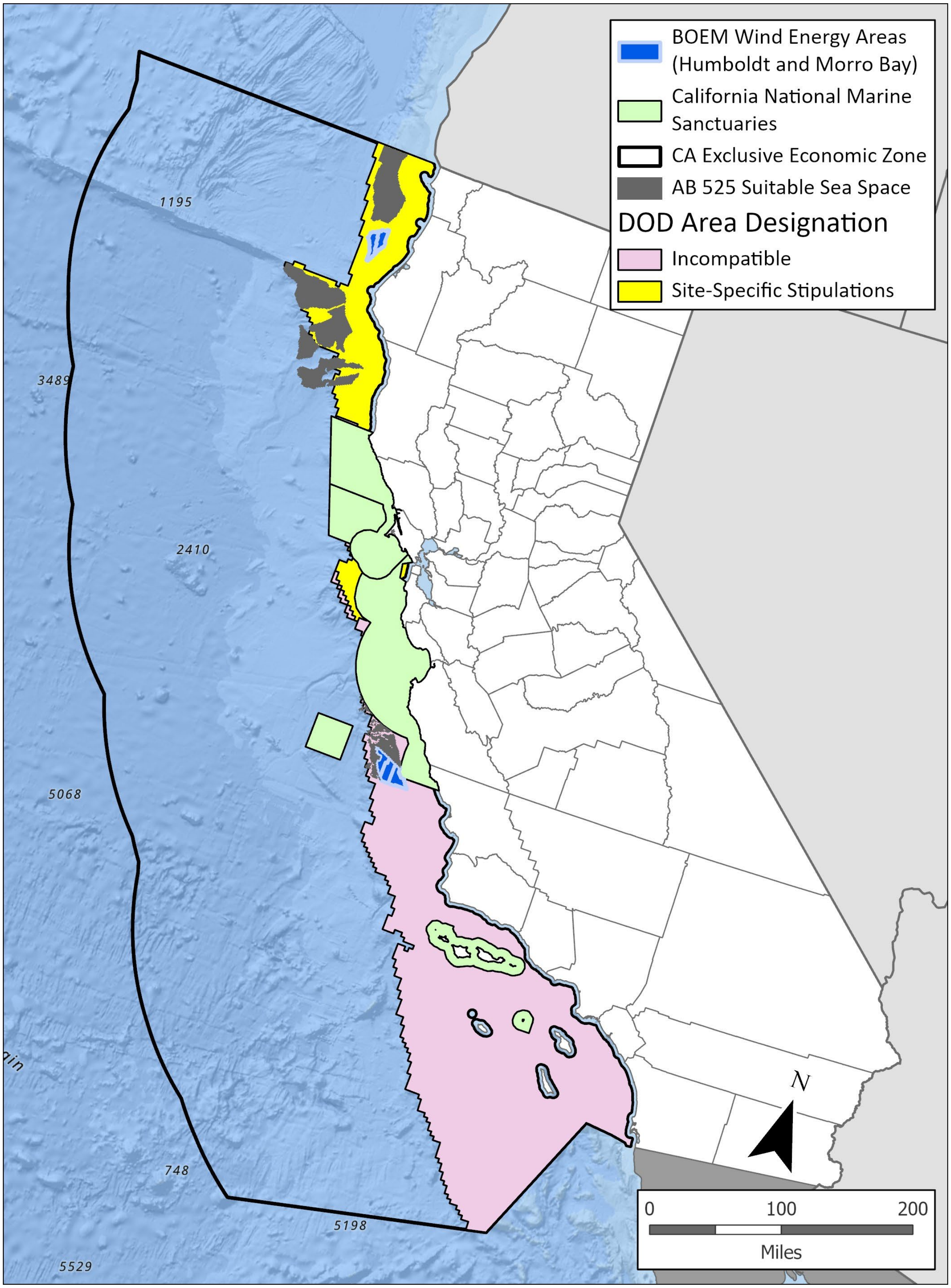
129 BOEM. October 2018. "Commercial Leasing for Wind Power Development on the Outer Continental Shelf (OCS) Offshore California-Call for Information and Nominations." 83 Fed. Reg. 53,096. Notice. Available at https://www.federalregister.gov/d/2018-22879.

Figure 5-12: US Department of Defense Military Area Designation



Source: CEC. 2023

AB 525 Offshore Wind Generation Potential

In accordance with the direction of AB 525, the CEC delineated the identified suitable sea space and then calculated the amount of potential capacity, or maximum rated output, that could be produced from offshore wind turbines deployed within the total area of the identified sea space. Based on work from NREL and BOEM, and feedback from the offshore wind industry, there are two sets of assumptions for the amount of offshore wind technology that could theoretically be deployed in a given area of sea space. The following assumptions were used as a basis for the potential generation estimates:

- Low (Conservative) Estimate: Given technology assumptions, deployment density of floating turbine technology results in an energy generation density of 3 megawatts per square kilometer (3 MW/KM2) of sea space.
- High Estimate: Given technology assumptions, deployment density of floating turbine technology results in an energy generation density of 5 MW/KM2 of sea space.

The range of potential offshore wind generation is shown in **Table 5-2** below.

Table 5-2: Range of Offshore Wind Generation Potential

Location	Potential Capacity: Low Estimate (GW)	Potential Capacity: High Estimate (GW)	Area (Square KM)	Area (Square Miles)	Avg. Ocean Depth (Meters)	Avg. Distance to Shore (Miles)
Humboldt Leases	1.6	2.7	536	207	500-1,100	21-35
North Coast Sea Space	26.9	44.8	8,950	3,456	980-2,350	33-57
North Coast Total	**28.5**	**47.4**	**9,486**	**3,663**	n/a	n/a
Morro Bay Leases	2.9	4.9	975	376	900-1,300	26-45
South-Central Coast Sea Space	4.4	7.3	1,462	564	900-2,500	20-48
South-Central Coast Total	**7.3**	**12.2**	**2,437**	**940**	n/a	n/a
CA Total	**35.8**	**59.6**	**11,923**	**4,603**	n/a	n/a

Source: CEC. 2023

It is expected that the 2030 goal of 2 to 5 GW can be accommodated from projects expected to be developed in the existing lease areas. The range of potential generation from the Humboldt lease areas is 1.6 to 2.7 GW, and from the Morro Bay lease areas the range is 2.9 to 4.9 GW, totaling a range for potential offshore wind energy development between 4.5 and 7.6 GW.

An additional increment of between 17.4 GW and 20.5 GW are needed to achieve the 2045 goal of 25 GW. The suitable sea space identified in this analysis could support between 26.9 and 44.8 GW on the North Coast and between 4.4 and 7.3 GW on the South Central Coast, totaling a range for potential offshore wind energy development between 31.3 GW and 52.1 GW.

Data Gaps and Research Needs

More information and data collection on marine biological resources that could be affected by offshore wind development are needed. While there is some understanding of potential impacts on species, there is a need for data that is at project-level scale, or detailed mapping at a greater resolution. Marine species data collection needed includes:

- Species density, distribution, and migration routes and timing
- Biological information on feeding, habitat, and breeding
- Species interaction with offshore wind infrastructure (environmental monitoring)
- Climate change effects on species activity patterns

Additional topics for research and data collection include:

- Seismic activity in sea space areas and its effect on offshore wind technology
- Tsunami effects on offshore wind infrastructure
- Effects of offshore wind development on local weather patterns (wind, rain, fog), ocean currents, and upwelling
- Spatial data on recreational fishing areas and activities
- Cultural resources information, with input from California Native American tribes and local and tribal communities

Addressing these data gaps and research needs can provide baseline information to inform project construction and operations plans, which include strategies to minimize and mitigate impacts to marine resources and existing ocean users.

Data transparency is important for data collected throughout all project phases and should be made available publicly. Project-specific data tends to be proprietary, but the data collection should be coordinated with academic institutions and government agencies to enable continued identification and prioritization of offshore wind research needs. Products, such as habitat maps, developed from project-specific data collection for public decision making, should be made publicly available. This will be critical for understanding environmental impacts, long-term monitoring, and to support adaptive management.

The CEC, SLC and OPC have made targeted investments to support a comprehensive planning approach and science-based decision and policy making. The results of these projects will provide essential information to guide offshore wind planning and decisions.

In addition, OPC is working to develop and establish an expert science entity to help guide the identification and prioritization of new ocean and coastal research projects related to offshore wind development in California. The science entity will also help focus efforts to collect, review, and disseminate the best available science-based data to help with the environmentally responsible planning and deployment of offshore wind along the California Coast. OPC is also granting funds to develop a comprehensive environmental monitoring guidance document for offshore wind development in California. The primary goal of the forthcoming guidance document is to provide a clear and practical resource for regulators, developers, and other stakeholders involved in offshore wind projects in California to ensure that environmental impacts of offshore wind development are properly monitored, evaluated, and mitigated throughout the project lifecycle. The information and lessons learned from these initiatives will also provide essential scientific information to help guide ongoing offshore wind planning activities.

Next Steps

The AB 525 suitable sea space identified in this report is intended to be a starting point for future BOEM activities related to offshore wind development off California's coast. Throughout the AB 525 process, existing and readily mappable data provided a basis for understanding potential suitable areas and potential conflicts. It is expected that BOEM's process of determining suitability will include newer data and more technical modeling to determine offshore wind suitability.

After identifying sea space in its process, BOEM will initiate a series of environmental reviews. These processes narrow the area within which leasing, and development of offshore wind facilities could take place and define the potential impacts of related offshore wind activities. These processes typically begin with the BOEM Call for Information and Nominations, which is followed by a public comment period and industry nominations of specific portions of the Call Areas for which they wish to obtain a commercial lease.

After BOEM considers the information it receives, a WEA would be identified, and an environmental assessment process would begin. The primary agencies involved in these environmental assessments of potential lease areas are BOEM, NOAA's National Marine Fisheries Service (NMFS), and the CCC. The NMFS and CCC processes occur generally concurrently, and both processes result in definition of requirements for protection of marine resources with which BOEM must comply. **Volume III, Appendix C** provides additional details on BOEM's and state agencies' environmental assessments.

Sea Space Conclusions

The CEC has identified sufficient sea space area to meet the 2045 offshore wind planning goal of at least 25 GW. Available information indicates that up to 50 percent of sea space identified could be unsuitable for offshore wind development due to conflicts with marine resources and other uses of the sea space. Visual comparison of available geospatial layers within the sea space shows large-scale conflicts with benthic habitats, shipping lanes, and DOD military activity. These conflicts could reduce the size of the sea space, depending on the decisions made regarding ocean use conflict minimization and marine resource protection. Maps showing these potential large-scale conflicts are presented in **Volume III, Appendix C**.

Offshore wind development in waters up to 1,300 meters deep is more feasible in the near term considering the current status of offshore technologies. In addition, the shorter distance to ports and transmission infrastructure, access to components and construction materials, and transportation costs are more favorable for offshore wind development and associated activities at 1,300 meters. To accommodate the offshore wind planning goals, sea space was identified that could support deployment in deeper waters up to 2,600 meters to help the industry meet the longer-term 2045 goals. Development in deeper waters is anticipated to be less challenging as technology matures and scales up and associated costs decline.

Offshore wind development should occur as far from shore as feasible, beginning at least 20 miles offshore to avoid the greatest degree of conflicts for marine biological resources and existing ocean uses. As a result, identified sea space begins at that distance.

Because available data show better wind speeds and consistency off the North Coast, these areas are more desirable for development from a wind resource perspective. In addition, data also show that higher concentrations of marine species occur south of the Greater Bay Area (Mendocino to Point Sur). Therefore, marine resource conflicts would be lower in sea space areas off the North Coast in the Del Norte, Humboldt, and Mendocino areas. However, the sea space areas off Humboldt and Mendocino Counties are impacted by proposed shipping fairways, designated areas for vessel traffic to promote safe and unobstructed navigation. Continued discussion with federal partners and the shipping industry are needed to consider the potential impacts of designated fairways in these water depths for leasing consideration. Finally, the Southern Central Coast sea space area off Monterey is likely to conflict with DOD military operations and will require additional review.

Potential ocean use, species, and ecosystem conflicts exist in the identified sea space areas that will require additional information to fully evaluate suitability for development. The potential impacts from offshore wind development are not fully understood because it is a new technology not previously used in conditions like those off the California Coast. Therefore, it is critical that offshore wind projects and decisions are based on empirical biological data collected at appropriate scales to accurately understand the potential impacts on marine life.[130]

Recommendations for Sea Space

- Continue suitable sea space identification, research, analysis and refinement, in coordination with BOEM, underserved and tribal communities, and stakeholders to inform the feasibility of offshore wind development that minimizes impacts to California's coast and ocean resources.

130 Maxwell, Sara, Francine Kershaw, Cameron Locke, Melinda Conners, Cyndi Dawson, Sandy Aylesworth, et al. April 2022. *Potential impacts of floating wind turbine technology for marine species and habitats.* Journal of Environmental Management. #307, 114577. Available at https://doi.org/10.1016/j.jenvman.2022.114577.

CHAPTER 6: Port and Waterfront Infrastructure

The offshore wind industry in California will require specialized seaport (or port) and waterfront facilities to build, assemble, and service the wind turbines needed to meet the OSW planning goals as discussed in this chapter. Current ports will need significant upgrades to meet these specifications. This chapter discusses the current state of California's ports and assesses the need for upgrades to support the State's nascent offshore wind industry.

AB 525 requires the CEC, in coordination with relevant state and local agencies and representatives of key labor organizations and apprenticeship programs, to 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. The bill also identifies important stakeholders including environmental justice organizations and communities, many of which are located near ports. 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 port, including competing and current uses, infrastructure feasibility, deep water access, bridge height restrictions, and the potential impact to natural and cultural resources, including coastal resources, fisheries, and Native American and Indigenous peoples.
- 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, surrounding communities, 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.

The important interconnection between ports and the offshore wind industry cannot be overstated. By way of example, without a port site to assemble the turbine components, the industry will not be able to develop in California. For other activities, a lack of investments in ports would result in the industry in California being dependent on imports of components and parts from other regions of the world, primarily China and Europe, which can lead to higher costs.[131] As detailed in the *Preliminary Assessment of Economic Benefits of Offshore Wind Related to Seaport Investments and Workforce Development,* California ports may not initially be able to handle all the activities to support an offshore wind industry. In developing this strategic plan report, the CEC relied on the *AB 525 Port Readiness Plan* (Port Plan) developed by Moffatt & Nichol, under contract to the CSLC.[132]

Offshore Wind Port Assessment

The Port Plan presents a detailed assessment of the necessary investments in California ports to support offshore wind energy activities, including staging and integration, manufacturing and fabrication, and operations and maintenance. It concludes that no one port site in California could serve all the needs of the offshore wind industry in meeting the state's offshore wind planning goals. Instead, the Port Plan concludes that a coordinated multi-port strategy will be needed and could require more than 16 large and 10 small port sites to support offshore wind development in the state. Based on the Port Plan, there are several port sites within the state that can be used to accommodate offshore wind staging and integration, manufacturing and fabrication, and operations and maintenance activities. Staging and integration and operations and maintenance sites are essential to the California offshore wind industry. The Port Plan concludes these sites must be developed as soon as possible to provide the state the best opportunity to achieve the offshore wind planning goals.

Main Offshore Wind Activities at Ports:

1. **Staging and integration** entails the assembly of the component parts into a functional wind turbine that will then be towed to an offshore site.
2. **Manufacturing and fabrication** entail the manufacturing of the individual components of a wind turbine.
3. **Operations and maintenance** entail the maintenance and repair activities on wind turbines.

The Port Plan includes a detailed assessment of ports using the following approach:

- Determine port needs for each offshore wind port activity.
- Determine how many port sites are required for each offshore wind port activity.
- Identify potential port sites that can accommodate the port activity.
- Determine port improvements required to meet offshore wind use.
- Evaluate and compare port sites to identify viable ports for offshore wind, including impacts to environmental resources and disadvantaged populations.

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131 Deaver, Paul and Jim Bartridge. December 2022. *Preliminary Assessment of Economic Benefits of Offshore Wind: Related to Seaport Investments and Workforce Development.* CEC-700-2022-007-CMD. Available at https://www.energy.ca.gov/publications/2022/preliminary-assessment-economic-benefits-offshore-wind-related-seaport.

132 Lim, Jennifer and Matt Trowbridge (Moffat & Nichol). July 2023. *AB 525 Port Readiness Plan*. 221194/02. Available at https://slcprdwordpressstorage.blob.core.windows.net/wordpressdata/2023/07/AB525-Port-Readiness-Plan_acc.pdf.

The results of this assessment are summarized below. While the Port Plan assesses a range of development scenarios for different years, the following discussion focuses on port needs to meet the state's 25 GW planning goal by 2045.

Port and Waterfront Facility Requirements

To determine port needs for offshore wind, a number of characteristics must be considered:[133]

- **Staging:** Physical size of the port's quayside and surrounding areas (or uplands).
- **Wharf & Frontage:** Length of the berth where the vessels can come in and out of port.
- **Load Capacity:** The amount of weight port areas can withstand.
- **Navigable Depth:** The water depth of the vessels coming in and out of port.
- **Air Draft:** The vertical clearance of vessels and the cargo they hold.
- **Geographic Location:** Relative proximity to development area with connectivity to modes of transportation (truck, rail, and other).

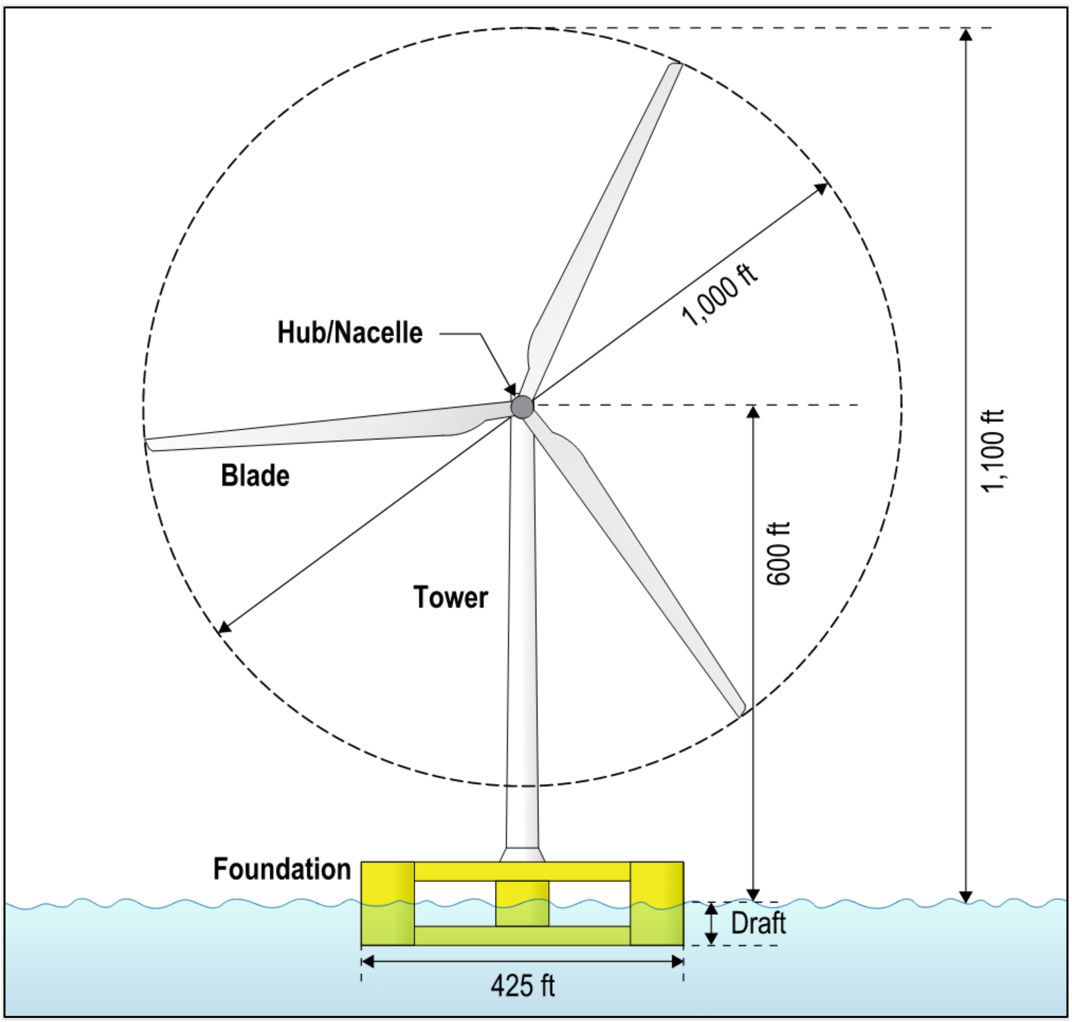
The location of sea space for offshore wind projects influences the port and workforce development strategies to needed achieve California's offshore wind planning goals of 2-5 GW by 2030 and 25 GW by 2045. The Port Plan assumes that approximately 60 to 70 percent of the offshore wind capacity would be located off the Northern California and the Central California Coasts. Conversely, sea space locations must consider where port sites that can support offshore wind development are located. For example, proximity of ports to the wind energy areas is crucial to determine the location of operations and maintenance sites, as transportation of crew across long distances is costly. As such, it is critical to achieve a balance between sea spaces that have both ample capacity for wind energy production and easy access to ports that can support offshore wind.

133 Ibid.

Offshore Wind Turbine Size

The port requirements for offshore wind are also driven by the size of turbines that will be manufactured, assembled and deployed. As the Port Plan notes, 15 MW offshore wind turbine systems are commercially available today and the industry trend is towards larger turbine sizes that increase over time to achieve economies of scale. Assuming a 50-year design life for port facilities, the Port Plan estimates that by 2045, based on industry trends and outreach to developers and manufacturers, floating offshore wind turbine systems are expected to reach up to 25 MW. **Figure 6-1** and **Table 6-1** show the current projected turbine dimensions that ports would have to accommodate for systems up to 25 MW.

Figure 6-1: Anticipated Floating Offshore Wind Turbine Dimensions



Source: Port Plan. 2023

Table 6-1: Anticipated Floating Offshore Wind Turbine Dimensions

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
Draft (Before integration)	15 to 25 ft	4.5 to 7.5 m
Draft (After integration)	20 to 50 ft	6 to 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: Port Plan. 2023

Floating Foundation Technology Type

A key assumption to determine offshore wind port needs is the selection of the floating offshore wind platform type that will be manufactured or assembled in ports, as port requirements vary by technology. As discussed in **Chapter 2**, the three primary types of floating offshore foundations include spar, semi-submersible or tension leg platforms. The Port Plan assumes that the semi-submersible floating platform is the most likely technology to be used on the U.S. West Coast. This is because semi-submersible foundations can be used in most water depths, although they have less stability than spars and tension leg platforms due to the shallower draft and lack of tensioned mooring tendons.

The Port Plan also notes that transport and installation of semi-submersible platforms is simpler than the other types of foundations, avoids offshore installation, and is more cost effective than tension leg platforms. The Port Plan assumes that semi-submersible foundations will be the primary technology deployed off the California coast. Designing ports on the assumption of semi-submersible foundations will also accommodate the manufacturing and assembly of tension leg foundations, as they are smaller and require less port infrastructure capacity. The Port Plan indicates that spar-buoy foundations were not feasible on the West Coast due to the very deep drafts required for construction at the port site.

The Port Plan identifies a major challenge for the industry in transferring completed platforms from the assembly wharf into the water, also referred to as launching. Possible approaches include using semi-submersible barges to partially submerge the foundations and move them to a 40- to 100-foot sinking basin where the foundations are then floated off the barge. Another approach would use a rail system to transport the foundation down a sloped ramp to the water, similar to boat launching. The foundations could also be lifted directly from the wharf into the water or pieces of the foundation could be placed in the water with construction finalized in the water.

Additional Offshore Wind Port Requirements

There are additional port requirements that vary by the types of infrastructure and specific activities that are performed at port sites. Staging and integration port sites are required to have no air draft restrictions, such as from bridges, flight paths or overhead powerlines. This is important so the fully assembled turbines, that may require more than 1,100 feet of clearance, can be deployed from a port to the lease areas without overhead obstructions.

There are also port wharf length and loading requirements. The wharfs at staging and integration ports must be able to accommodate two turbine assemblies adjacent to each other, requiring about 1,500 feet of quayside space. The uplands areas for staging and integration and component manufacturing sites need a capacity of 2,000 to 3,000 pounds per square foot (psf) to support storage of wind turbine generator components.[134] The wharf loading capacity at staging and integration and manufacturing sites is higher where cranes for turbine assembly and loading or unloading of delivery barges are located. As large cranes are used at these sites, the weight of wind turbine generator components requires a wharf load of 6,000 psf. In contrast, loading and unloading at operations and maintenance sites is expected to require a range from 100 to 500 psf.

The size of port facilities can also vary. For example, an operations and maintenance facility requires two to 10 acres, while component manufacturing and staging and integration sites can range from 30 to 100 acres. Based on outreach to developers, Moffatt & Nichol estimates that 80 acres is sufficient for upland space to receive, stage and store components for final assembly at a wharf. Developers also indicated that while larger sites are preferred, smaller sites can be used but it would limit production and increase costs. Wet storage space is also needed where floating foundations or integrated turbines can be safely moored to mitigate risk of weather-related downtime, vessel traffic, entrance channel congestion, and other transportation risks. Wet storage is key to maintaining production schedules to match the pace of offshore wind project deployment. The requirements for the types of port infrastructure sites are summarized in **Table 6-2**.

Additional port requirements must also be addressed including the need for specialized cargo unloading capabilities that allow for a range of fabrication and assembly needs, green port requirements for carbon reductions such as electrification of terminal operations, provision of ship services, and need for buildings to allow for indoor storage and warehouses. More details about port requirements, port needs to support offshore wind, possible port layouts, and governing codes and standards are discussed in the Port Plan.

Assessing Port Availability and Costs for Offshore Wind

The Port Plan assumes all port sites are located within California to achieve the maximum economic benefits and that the ports would only serve California's offshore wind energy needs. The Port Plan assessed approximately 25 existing California ports or facilities to determine their suitability to support offshore wind development using the criteria listed earlier under "Port and Waterfront Facility Requirements".

134 For context, a 6,000 psf wharf is six times stronger than most existing wharves in California.

The availability of ports was evaluated assuming that existing port operators and tenants are not displaced to meet offshore wind port needs. Military facilities were not considered as part of the assessment.

The Port Plan estimates the construction costs associated with port improvements based on prior project experience, conceptual engineering analysis, and professional judgement. The first step is to determine the infrastructure improvements needed for each type of port site: staging and integration, manufacturing and fabrication, and operations and maintenance. The second step involved calculating the amount of the various types of infrastructure improvements required, such as dredging, wharf construction, and uplands improvements. In the final step, the unit costs for each type of infrastructure improvement (by location) and information from previous studies were used to calculate the estimated costs for improvements.

Port Sites by Offshore Wind Activity

The following sections discuss the three major activities to take place in ports, including staging and integration, manufacturing/fabrication, and operations and maintenance. Two additional port facility needs, those for mooring lines and anchor laydown, and electrical cable laydown are described. For each port activity, infrastructure requirements are described, potential sites are identified, and site-specific cost estimates are provided.

Staging and Integration Sites

Staging and integration sites are where offshore wind components are received, staged, and stored and where floating turbine systems are assembled. The Port Plan determines that 80 acres is sufficient for uplands space. More information on infrastructure requirements for staging and integration is listed in **Table 6-2**. **Figure 6-2** shows a conceptual layout for an 80-acre staging and integration site. Components such as blades, nacelles, and tower sections are delivered to the site and stored within the uplands area. A sinking basin is shown near the site that can be used to transfer a floating foundation substructure into the water. A heavy lift wharf is shown that must be able to withstand the heavy loads of components and the equipment to load and unload cargo and assemble the wind turbine onto the floating foundation substructure.

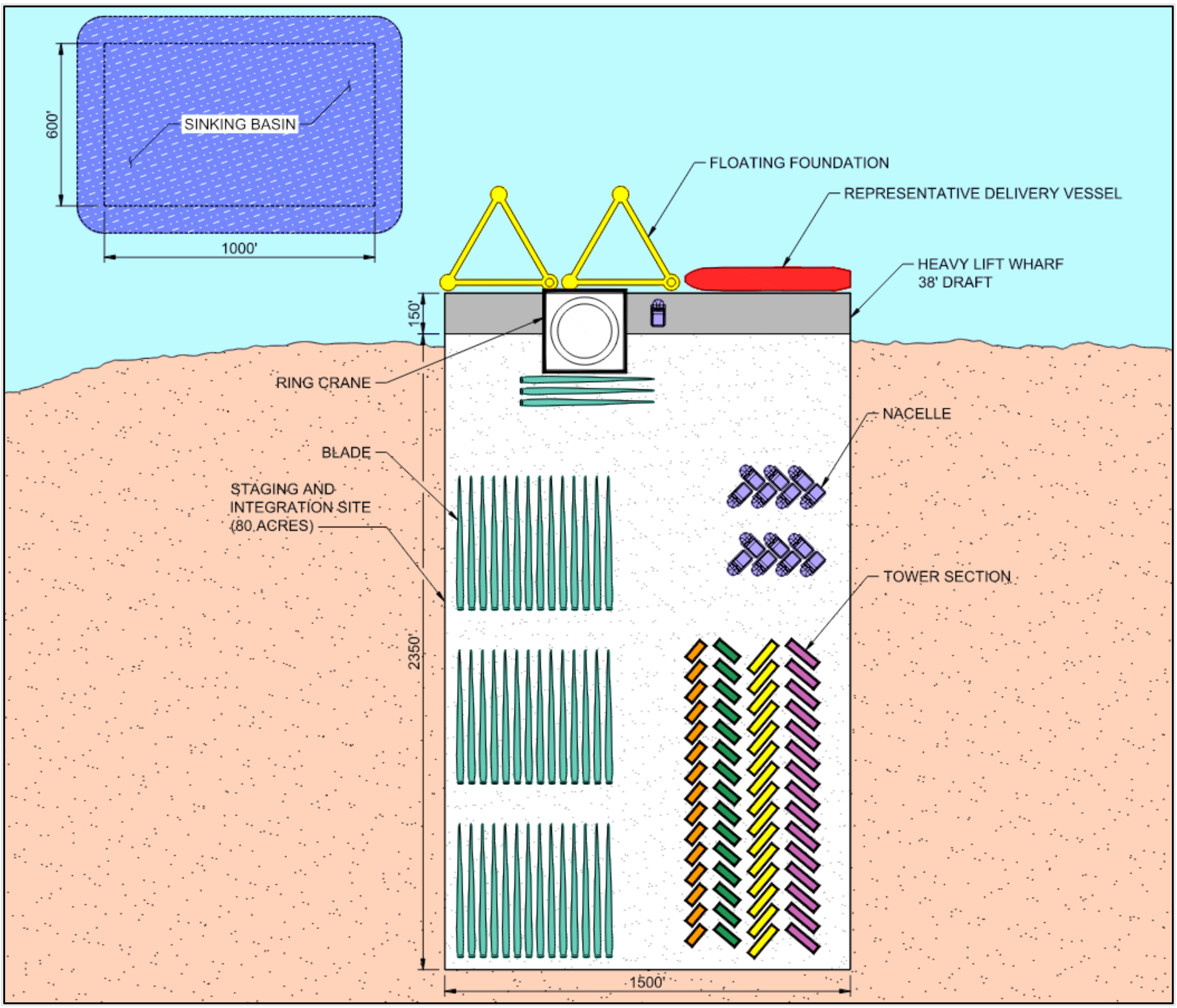
As previously discussed, two primary factors that determine the need for staging and integration sites are the size of the wind turbine generators – 15 MW in 2035 and increasing thereafter to 20MW – and the rate at which they can be assembled or integrated – 0.75 to 1.0 per week. The assessment then calculates the number of staging and integration sites needed per year to meet the goal. The Port Plan shows it may not be possible to meet the 2030 planning goal of 2 to 5 GW as it takes several years to complete planning, engineering, permitting and regulatory approval, and construction. To meet the 2045 planning goal of 25 GW, the Port Plan estimates that up to four staging and integration sites will be needed.

Table 6-2: Offshore Wind Port Requirements for Staging and Integration

Design Requirement	Staging and Integration
Acreage (minimum)	30 to 100 acres
Wharf Length	1,500 ft
Minimum Draft at Berth	38 ft
Draft at Sinking Basin	40 to 100 ft
Wharf Loading	> 6,000 psf
Uplands / Yard Loading (for components)	2,000 to 3,000 psf

Source: Port Plan. 2023

Figure 6-2: Conceptual Staging and Integration Site Layout



Source: Port Plan. 2023

Potential Staging and Integration Sites

The Port Plan indicates that staging and integration sites are most critical to identify and develop as there are few locations with the capabilities that meet the requirements for the related activities. They also play a key role by assembling the full turbine before it is towed to the final installation site. These sites require a significant amount of acreage and funding to be developed. The state will require approximately three to five 80-acre staging and integration sites to meet the State's 2045 offshore wind planning goal.

The Port Plan determines that among the established California port authorities, the Port of Humboldt, Port of Long Beach, and Port of Los Angeles offer the most viable sites for the development of staging and integration for offshore wind projects. These three ports have no air draft restrictions (sites are in front of any bridges), have available acreage in excess of 100 acres, and have deep draft navigation channels. Depending on the amount of space available, these sites can also accommodate manufacturing and fabrication, as well as operation and maintenance activities. The Port Plan concludes that all other existing port locations are not viable for staging and integration as they lack sufficient potentially available acreage or have air draft restrictions such as ports in the Bay Area located behind bridges. As discussed below, three locations for new or greenfield ports on the Central California – Port San Luis, China Harbor, and Gato Canyon- were evaluated but ultimately determined to be less feasible than existing ports.

Infrastructure Improvements and Costs for Staging and Integration Sites

The required infrastructure improvements identified in the Port Plan for the three existing port sites identified for staging and integration are summarized below.

Port of Humboldt

The Port of Humboldt is actively pursuing redevelopment of a 180+ acre site on the Samoa Peninsula to provide a new multipurpose, heavy-lift marine terminal facility to support the offshore wind energy industry. The Port of Humboldt's project will primarily serve as a staging and integration site but may also include manufacturing and fabrication and operation and maintenance on-site facilities. An additional 300 to 600+ acres of available coastal dependent industrial lands exist within Humboldt Bay with direct access to the Federal Navigation Channel. These additional sites have the potential to serve offshore wind port development.

- Demolition: Demolition is included for any existing structures or features such as a wharf, buildings on site, or any pavement.
- Wharf: A new wharf that can withstand 6,000 psf loading is required. The width is assumed to be 150 ft and the length is assumed to be 6,000 ft (1,500 ft per 80 acres).
- Site Acreage: Based on previous outreach to the Port of Humboldt, potentially 320 acres of existing uplands space may be available for staging and integration and manufacturing and fabrication sites. The uplands area will support at least 2,000 to 3,000 psf.

- Berth Pocket Dredging: The berth pocket at the wharf shall be dredged to a minimum water depth of 38 ft.
- Sinking Basin: Depending on the floating foundation technology, a sinking basin may be required to off-float the floating foundations. The base of the sinking basin is assumed to be 600 ft by 1,000 ft to accommodate semi-submersible barges. The cost for a sinking basin to various depths (water depth = -60 ft, -80 ft, and -100 ft) is included separately.

Port of Los Angeles

The Port of Los Angeles is developing 187 acres of existing sites to accommodate manufacturing and fabrication facilities, as well as a site for staging and integration and manufacturing and fabrication.

- Site Acreage: Based on previous outreach to the Port of Los Angeles, potentially 160 acres of new land could be created within the port for staging and integration and manufacturing and fabrication sites. This is assumed to be achieved by dredging portions of the port to provide the necessary sediment to create 160 acres, the existing bathymetry is approximately -15 ft. The uplands area shall support at least 2,000 to 3,000 psf. Demolition is not required since the site is not on existing land.
- Wharf: A new wharf that can withstand 6,000 psf loading is required. The width is assumed to be 150 ft and the length is assumed to be 3,000 ft (1,500 ft per 80 acres).
- Berth Pocket Dredging: Portions of the port will be significantly dredged to produce enough material to create 160 acres, therefore the berth pocket could be approximately -60 ft.
- Sinking Basin: Depending on the floating foundation technology, a sinking basin may be required to off-float the floating foundations. Since there are already deep waters to approximately -80 ft available within the port, only a sinking basin cost to 100 ft is provided. The base of the sinking basin is assumed to be 600 ft by 1,000 ft to accommodate semi-submersible barges.

Port of Long Beach

The Port of Long Beach finished the conceptual design phase for a 400-acre offshore wind project that can provide staging and integration and manufacturing and fabrication sites for the offshore wind industry. The Port of Long Beach is moving forward with field investigations and detailed engineering for their project. Additionally, the port is developing existing sites to accommodate manufacturing and fabrication facilities.

- Site Acreage: Based on previous outreach to the Port of Long Beach, potentially 400 acres of new land could be created within the port for staging and integration and manufacturing and fabrication sites. This would be achieved by dredging portions of the port to provide the necessary sediment to create 400 acres, the existing bathymetry is approximately -30 to -50 ft. The uplands area shall support at least 2,000 to 3,000 psf. Demolition is not required since the site is not on existing land.

- Wharf: A new wharf that can withstand 6,000 psf loading is required. The width is assumed to be 150 ft and the length is assumed to be 7,500 ft (1,500 ft per 80 acres).
- Berth Pocket Dredging: Portions of the port will be significantly dredged to produce enough material to create 400 acres, therefore the berth pocket is anticipated to be approximately -60 ft.
- Sinking Basin: Depending on the floating foundation technology, a sinking basin may be required to off-float the floating foundations. Since there are already deep waters to approximately -80 ft available within the port, only a sinking basin dredging cost to 100 ft is provided. The base of the sinking basin is assumed to be 600 ft by 1,000 ft to accommodate semi-submersible barges.

Cost estimates for infrastructure improvements to existing ports to provide staging and integration sites are summarized in **Table 6-3**. The cost of a staging and integration site at the Port of Humboldt is less than a site at the Port of Los Angeles and Port of Long Beach since it can utilize existing land within the port. The cost of a sinking basin is included as a separate cost (for various depths). Constructing a sinking basin within the Port of Los Angeles or Port of Long Beach costs less than the Port of Humboldt due to the deep waters available within these Southern California ports. The estimated costs and schedules, which includes environmental review, permitting, and construction, are based on the assumed infrastructure improvements listed below. The Port of Long Beach recently published a report that provides a more detailed evaluation of cost and schedule for their 400-acre facility.[135] Based on their concept design, the cost estimate for the Port of Long Beach 400-acre facility is $4.7 billion, and thus an 80-acre staging and integration site is approximately $0.94 billion. The construction duration to provide or upgrade an 80-acre staging and integration site with a 1,500 feet heavy lift wharf at the Port of Humboldt, Los Angeles, and Long Beach could be between 4 to 6 years.

135 Moffatt & Nichol. April 2023. *Pier Wind Project Concept Phase: Final Conceptual Report*. 10800-24. Port of Long Beach. Available at https://polb.com/download/547/pier-wind/17042/2023-04-20-pier-wind-concept-report-final.pdf.

Table 6-3: Staging and Integration Improvements and Costs for Existing Ports

Item	Port of Humboldt	Port of Los Angeles	Port of Long Beach
Site Acreage and Source	320 acres Use existing land	160 acres Land creation	400 acres Land creation
Wharf Improvement	6,000 ft long wharf 6,000 psf capacity	3,000 ft long wharf 6,000 psf capacity	7,500 ft long wharf 6,000 psf capacity
Berth Pocket Dredging	-38 ft	-60 ft	-60 ft
Breakwater	N/A	N/A	N/A
Total Cost Estimate (Millions (M))	**$2,700 M**	**$2,100 M**	**$5,400 M**
Cost Accuracy Range	$1,900 M to $4,100 M (-30% / +50%)	$1,500 M to $3,200 M (-30% / +50%)	$3,800 M to $8,100 M (-30% / +50%)
Cost per 80 acres	$700 M	$1,000 M	$1,110 M
Sinking Basin to -60 ft	$200 M	Deep water to -80 ft is available within the harbor	Deep water to -80 ft is available within the harbor
Sinking Basin to -80 ft	$350 M	Deep water to -80 ft is available within the harbor	Deep water to -80 ft is available within the harbor
Sinking Basin to -100 ft	$600 M	$35 M	$35 M

Source: Port Plan. 2023

Alternative Central Coast Sites – Port San Luis, China Harbor, and Gato Canyon

Moffat & Nichol, under contract to the CSLC developed a report entitled the *Alternative Port Assessment to Support Offshore Wind.*[136] The report evaluated potential undeveloped, or greenfield, sites along the California coast between San Francisco and Long Beach to determine whether an alternative port location within Central California is feasible to support floating offshore wind activities in the Morro Bay Wind Energy Area. For undeveloped sites, the *Alternative Port Assessment to Support Offshore Wind* focuses on potential staging and integration and operations and maintenance sites. However, this discussion focuses on issues related to the development of staging and integration sites as these are the most challenging

136 Trowbridge, Matt, Jennifer Lim, and Ashley Knipe (Moffatt & Nichol). January 2023. *Alternative Port Assessment to Support Offshore Wind.* 21194/01. Available at https://slcprdwordpressstorage.blob.core.windows.net/wordpressdata/2023/02/Alternative-Port-Assessment-To-Support-Offshore-Wind-Final.pdf.

to develop. Based on an environmental, engineering, and workforce assessment, the *Alternative Port Assessment to Support Offshore Wind* identifies three potential undeveloped sites on the Central Coast for staging and integration sites: Port San Luis, China Harbor, and Gato Canyon.

The required infrastructure improvements for Port San Luis, China Harbor, and Gato Canyon to meet the requirements of a staging and integration site are as follows:

- Site Acreage: 80-acres of new land would be created at these three locations. It is assumed this would be achieved by importing material to create 80 acres. The uplands area shall support at least 2,000 to 3,000 psf. Demolition is not required since the site is not on existing land.
- Wharf: A new wharf that can withstand 6,000 psf loading is required. The width is assumed to be 150 ft. and the length is assumed to be 1,500 ft.
- Sinking Basin: Depending on the floating foundation technology, a sinking basin may be required to off-float the floating foundations. The base of the sinking basin is assumed to be 600 ft. by 1,000 ft. to accommodate semi-submersible barges. The cost for a sinking basin to various depths (water depth = -60 ft., -80 ft., and -100 ft.) is included separately.
- Breakwater: A breakwater would need to be constructed around the site to protect the site from metocean (meteorological and oceanographic) conditions for offshore wind activities. It is assumed this could be achieved by importing material.

The *Alternative Port Assessment to Support Offshore Wind* estimates that the Central Coast port sites would require extensive improvements to meet the necessary requirements, which may include significant environmental impacts. When compared with staging and integration sites at existing ports, the new or greenfield sites would require more investments and have longer development schedules, as shown in **Table 6-4**.

Costs for improvements for an 80-acre site on the Central Coast range from approximately $2.5 to $3 billion, compared to improvement costs for the three existing sites of approximately $0.7 to $1.1 billion. Construction at the Central California sites could take up to 10 years or more due to limited road access, procurement of material to construct a breakwater, and potential weather delays. This is compared with the timeline for existing sites of 4 to 6 years, with significant development activities already underway at the Ports of Humboldt and Long Beach.

The *Alternative Port Assessment to Support Offshore Wind* identifies additional challenges and delays for the Central Coast port sites. While the Port San Luis Harbor District governs Port San Luis, the CSLC has jurisdiction and management authority over China Harbor and Gato Canyon. To develop and construct a new port site at China Harbor or Gato Canyon, a project proponent is required to either obtain a lease from the CSLC or the lands are granted in trust to a new established authority, which would require legislation and several years to pursue.

Table 6-4: Staging and Integration Improvements and Costs for Alternative Ports

Item	Port San Luis	China Harbor	Gato Canyon
Site Acreage and Source	80 acres Land creation	80 acres Land creation	80 acres Land creation
Wharf Improvement	1,500 ft long wharf 6,000 psf capacity	1,500 ft long wharf 6,000 psf capacity	1,500 ft long wharf 6,000 psf capacity
Berth Pocket Dredging	-38 ft	-38 ft	-38 ft
Breakwater	Requires New Breakwater	Requires New Breakwater	Requires New Breakwater
Total Cost Estimate (Millions (M))	**$2,700 M**	**$2,500 M**	**$3,000 M**
Cost Accuracy Range	$1,900 M to $4,100 M (-30% / +50%)	$1,800 M to $3,800 M (-30% / +50%)	$1,800 M to $3,800 M (-30% / +50%)
Cost per 80 acres	$2,700 M	$2,500 M	$3,000 M
Sinking Basin to -60 ft	$70 M	$70 M	$50 M
Sinking Basin to -80 ft	$200 M	$200 M	$150 M
Sinking Basin to -100 ft	$400 M	$400 M	$350 M

Source: Port Plan. 2023

In addition, although these locations are near the Morro Bay Wind Energy Area, a towing assessment shows that similar annual throughput goals can likely be achieved by a staging and integration site at the Port of Long Beach. In addition, the long lead time for a site within this region to be ready for industry use far exceeds when a staging and integration site would be needed to meet the state's offshore wind planning goals.

Manufacturing and Fabrication Sites

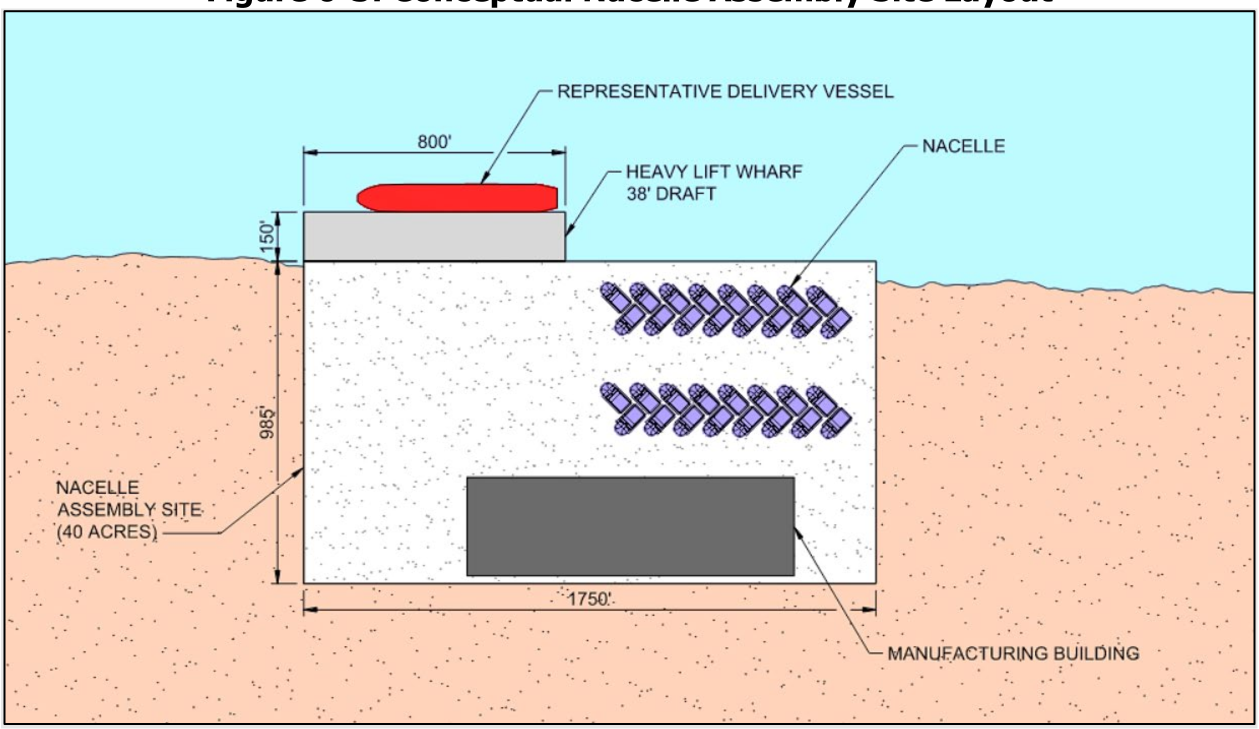
Manufacturing and fabrication sites are located on navigable waterways where larger components are created from raw materials received by road, rail, or waterborne transit. This includes manufacturing of blades and towers and the assembly of nacelles and foundations. The amount of acreage needed for these sites ranges from 30 to 100 acres. More information on infrastructure requirements for manufacturing and fabrication is listed in **Table 6-5**. **Figure 6-3** shows a conceptual 40-acre nacelle assembly site. For the site, nacelles are assembled in the manufacturing building, stored on site, and then transferred by waterborne transport to a staging and integration site where the turbine is assembled.

Table 6-5: Offshore Wind Port Requirements for Manufacturing and Fabrication

Design Requirement	Manufacturing and Fabrication
Acreage (minimum)	30 to 100 acres
Wharf Length	800 ft
Minimum Draft at Berth	38 ft
Draft at Sinking Basin[137]	N/A
Wharf Loading	> 6,000 psf
Uplands / Yard Loading (for components)	2,000 to 3,000 psf

Source: Port Plan. 2023

Figure 6-3: Conceptual Nacelle Assembly Site Layout



Source: Port Plan. 2023

137 Options for transfer of floating foundations from land to water include use of semi-submersible barge and sinking basin, ramp system, or direct transfer methods (lifting portions or complete foundation units from land into water).

The Port Plan evaluated the number of sites needed for manufacturing and fabrication by 2045 and identified the following:

- Two blade manufacturing and fabrication sites, assuming sites could produce 200 blades per year starting by early 2030.
- One site for tower manufacturing and fabrication, assuming it could produce 500 tower sections per year.
- One nacelle manufacturing and fabrication site, assuming it receives prefabricated components and assembles 275 nacelles per year (one nacelle per turbine system).
- Four foundation subcomponent manufacturing and fabrication sites, assuming a site could produce 350 columns, trusses, and other subcomponents per year.
- Four foundation assembly sites, assuming they receive components that are assembled into a full foundation at the same rate of turbine integration, but not faster than a rate of 52 foundations per year.

These sites would need to be available by the early 2030s to meet the 2045 offshore wind demand.

Infrastructure Improvements and Costs for Manufacturing and Fabrication Sites

Manufacturing and fabrication sites for nacelles, towers, foundations, and other offshore wind components require less space than staging and integration sites and can be located at sites with air draft restrictions because the components can be transported horizontally by vessel or barge. Therefore, ports located behind bridges, such as those in the Bay Area, are candidates for manufacturing and fabrication. The Port Plan identifies the following ports (ordered from north to south) with adequate acreage as good candidate sites:[138]

- Port of Humboldt
- Port of Benicia
- Port of Stockton
- Port of Richmond
- Port of San Francisco
- Port of Redwood City
- Port of Los Angeles
- Port of Long Beach
- Port of San Diego

The Port Plan identifies the required infrastructure improvements for nine potential manufacturing and fabrication sites as discussed below. All of the sites evaluated would require some demolition of existing structures or features such as wharves, buildings and

138 Moffatt & Nichol outreach identified two additional private terminals; Antioch AMPORTS and a site within the City of Pittsburg.

pavement. They would also require a new wharf (with a width of 150 ft and a minimum length of 800 ft for vessel delivery) that can withstand 6,000 psf of loading. In addition, the following improvements would be needed:

- The Ports of Oakland, Richmond, Stockton, and San Diego potentially have up to 40 acres of existing uplands space for a manufacturing and fabrication site, while the Port of Redwood City potentially has 20 acres of existing uplands space. These ports would need to support at least 2,000 to 3,000 psf of loading. Dredging would also have to be performed to create a berth pocket at the wharf to a minimum depth of -38 ft. Cost estimates for upgrades range from about $275 million to $375 million for a 20- to 40-acre site.[139]
- The Port of San Francisco announced a project to upgrade up to 95 acres of existing uplands space that could be used for manufacturing and fabrication. No dredging would be required as the berth pocket at the wharf is -40 ft and meets the minimum depth requirements. Cost estimates for upgrades range from $290 million for a 20-acre site to $480 million for a 95-acre site.
- Private terminals at Antioch and Pittsburg have potentially 100 acres of existing space for manufacturing and fabrication and dredging to -38 ft would be required. Cost estimates range from $300 million for a 20-acre site to $520 million for a 100-acre site.

The Ports of Humboldt, Los Angeles, and Long Beach have significant acreage that could be used for both staging and integration and manufacturing and fabrication sites; at this time, it is uncertain how much would be used for each. Since infrastructure improvements are similar for both types of facilities (heavy lift wharf, acreage, and berth pocket depth), cost estimates for manufacturing and fabrication are assumed to be similar to the costs for the staging and integration improvements discussed above.

Operations and Maintenance Sites

Operations and maintenance facilities provide for the transfer of crews needed to perform minor maintenance and repair of turbines at the offshore wind lease areas. The Port Plan assumes major repairs and maintenance would be performed at staging and integration sites. For minor repairs and maintenance, terminals would be needed to host service operation vessels, crew transfer vessels, and an operations base with offices, warehouses, and a storage yard. More information on infrastructure requirements for operations and maintenance is listed in **Table 6-6**. **Figure 6-4** shows a conceptual operations and maintenance site with a 300 ft wharf and a 10-acre nearshore area. Service operation and crew transfer vessels would use the wharf for loading and unloading and transferring crew to the offshore wind areas.

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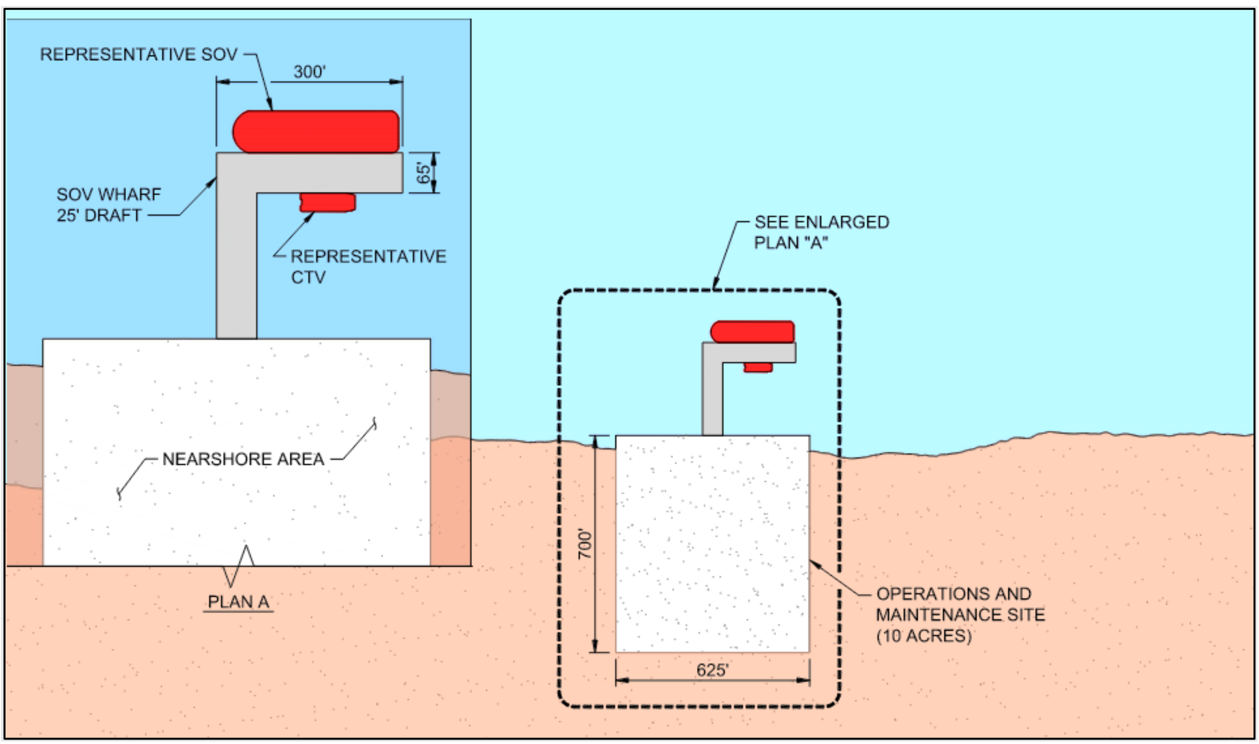
139 Costs vary by location; for example, the Port of San Diego is the least expensive at $275 million for 40 acres and the 20-acre sites for Redwood City and Benicia are more expensive at $300 million and $325 million, respectively.

Table 6-6: Offshore Wind Port Requirements for Operations and Maintenance

Design Requirement	Operations and Maintenance (O&M)
Acreage (minimum)	2 to 10 acres
Wharf Length	300 ft
Minimum Draft at Berth	20 to 30 ft
Draft at Sinking Basin	N/A
Wharf Loading	100 to 500 psf
Uplands/Yard Loading (for components)	100 to 500 psf

Source: Port Plan. 2023

Figure 6-4: Conceptual Operations and Maintenance



Source: Port Plan. 2023

As noted in the Port Plan, the scale and functionality of these facilities depends on the offshore wind farm size, distance to the offshore wind area, and the strategy of the contractor providing the service. The operations and maintenance facilities also vary depending on the number of vessels hosted at the terminal. This assessment assumed that service operation vessels would be the main support vessel, while crew transfer vessels could provide fast response and additional flexibility.[140]

The Port Plan estimates that 14 to 24 service operation vessels would be needed to perform operations and maintenance, assuming the following:

- A single service operation vessel could support 100 turbines and serve more than one wind farm in the same region.
- Five to 10 total developers would be active in 2045.
- Each wind turbine generator produces an average of 17 to 18 MW each.

The Port Plan estimates the need for nine to 16 berths, assuming that one berth could support one to two vessels that could remain in the field for over two weeks at a time. The operations and maintenance strategy for offshore wind projects can vary the requirements for vessels and berths.

Infrastructure Improvements and Costs for Operations and Maintenance Sites

The Port Plan concludes that multiple operations and maintenance sites would likely be required to support multiple offshore wind development areas. Operations and maintenance sites to transfer crew to and from the offshore wind farm would ideally be located close to the wind farm location to minimize travel time. The Port Plan identifies the following ports (ordered from North to South) as good candidate sites:

- Crescent City Harbor
- Port of Humboldt
- Port of Richmond
- Port of Oakland
- Port of San Francisco
- City of Alameda
- City of Morro Bay
- San Luis Obispo Bay
- Port of Hueneme

To support operations and maintenance facilities, some existing waterfront facilities will need to be upgraded or converted. The Port Plan assumes that primarily service operations vessels will be used for operations and maintenance, with some support from crew transfer vessels,

140 The amount of moorage for crew transfer vessels (CTVs) at port sites varies by distance to offshore wind facilities at the lease areas. Since the range for a CTV will limit the operations and maintenance port sites than can support the vessels, this assessment assumed an approximate range of 31 miles or 50 kilometers. Port sites located closer to wind lease areas may need to accommodate more CTVs.

where possible. These facilities are required to berth the two types of vessels, as well as providing facilities (either nearby or at the marine facility) to serve as a base of monitoring and operations for offshore wind projects. Service operation vessels are intended to support operation and maintenance activities by remaining at the wind project site for approximately two weeks at a time. Crew transfer vessels service single-day trips for maintenance workers to and from the wind projects.

In general, the cost estimates for improvements for two to 10-acre sites at the above locations range from $10 to $60 million, depending on the need for dredging and wharf extension. Only a few of the locations could accommodate a 10-acre site.

Mooring Line and Anchor Laydown

Mooring line and laydown storage areas are needed to stage and maintain the different mooring components required to install a floating wind turbine generator. Marine infrastructure will also be needed to berth anchor handling tug vessels that load and unload components, as well as access to a wharf that can accept such a vessel. Storage areas could be standalone or part of a larger facility. The Port Plan assumes that semi-taut mooring systems using synthetic rope or wire in between two lengths of chain would be the preferred technology for California water depths.[141] The amount of storage area needed for laydown depends on the number of ongoing offshore wind installation projects. Depending on the number of active staging and integration sites – with an assumed throughput of one offshore wind installation project at a time – the amount of storage area for mooring line and anchor laydown in 2045 is estimated to be between 20 and 65 acres. More information on infrastructure requirements for anchor and mooring line storage is listed in **Table 6-7**.

Table 6-7: Offshore Wind Port Requirements for Anchor and Mooring Line Storage

Design Requirement	Anchor and Mooring Line Storage
Acreage (minimum)	10 to 30 acres
Wharf Length	300 ft
Minimum Draft at Berth	20 to 30 ft
Draft at Sinking Basin	N/A
Wharf Loading	500 psf
Uplands/Yard Loading (for components)	500 psf

Source: Port Plan. 2023

Electrical Cable Laydown

Laydown areas are also needed to store and deploy export and array electrical cable and they need the ability to transfer cables to a cable laying vessel. The number of staging and

141 Other mooring systems, such as catenary chain systems and tension leg systems, may be considered for offshore wind projects in California and would have different requirements.

integration sites, and their capacity for active project installation are key factors in determining the number of cables needed and the storage area requirements for cable laydown areas. The Port Plan estimates that electrical cable laydown areas will need to hold one to two array cable carousels and two to six export cable carousels for each active project the area is supporting. Assuming three to five staging and integration sites are needed to support the 2045 planning goal, three to 10 array cable carousels and six to 30 export cable carousels will need to be stored, requiring nine to 35 acres at the laydown site. Storage of spare cable, which the Port Plan estimates as 5 percent of the total installed length of cable, would require 12 to 22 acres in 2045.

Like mooring lines and anchors, electrical cable laydown could be located at other offshore wind port sites with access to a wharf meeting the size and strength requirements and where operational conflicts can be mitigated. In addition, cable manufacturing sites that also require berths could be used for cable storage and may reduce the overall number of cable carousel transfers needed. More information on infrastructure requirements for electrical cable laydown is listed in **Table 6-8**.

The Port Plan also considers the different export cable options since projects may use high voltage alternating current or high voltage direct current in the future even though some of the technology is not yet commercially available, as discussed in **Chapter 8** on transmission. The two cable systems differ in design and installation, but the critical factor in determining the needed space for laydown is the total distance required for the export cables.

Table 6-8: Offshore Wind Port Requirements for Electrical Cable Laydown

Design Requirement	Electrical Cable Laydown
Acreage (minimum)	20 to 30 acres
Wharf Length	500 ft
Minimum Draft at Berth	30 to 35 ft
Draft at Sinking Basin	N/A
Wharf Loading	1,000 psf
Uplands/Yard Loading (for components)	1,000 to 2,000 psf

Source: Port Plan*.* 2023

Summary of Port Sites by Offshore Wind Activity

Table 6-9 below summarizes the infrastructure requirements for each port activity type. **Table 6-10** furthers the analysis by identifying the number and acreage of each port site type needed for California to meet its 2045 goal of 25 GW. Finally, **Figure 6-5** is map of potential port sites using the three major offshore wind port activity types. The color of each hexagon associated with the port indicates the suitability of the port for the activity (for example, green represents a good candidate site, yellow a moderate candidate site, and red being a site that should not be considered for that particular activity.)

Table 6-9: Offshore Wind Port Infrastructure Requirements by Port Activity Type

Design Requirement	Staging and Integration	Manufacturing and Fabrication	Operations and Maintenance (O&M)	Anchor and Mooring Line Storage	Electrical Cable Laydown
Acreage (minimum)	30 to 100 acres	30 to 100 acres	2 to 10 acres	10 to 30 acres	20 to 30 acres
Wharf Length	1,500 ft	800 ft	300 ft	300 ft	500 ft
Minimum Draft at Berth	38 ft	38 ft	20 to 30 ft	20 to 30 ft	30 to 35 ft
Draft at Sinking Basin[142]	40 to 100 ft	N/A	N/A	N/A	N/A
Wharf Loading	> 6,000 psf	> 6,000 psf	100 to 500 psf	500 psf	1,000 psf
Uplands / Yard Loading (for components)	2,000 to 3,000 psf	2,000 to 3,000 psf	100 to 500 psf	500 psf	1,000 to 2,000 psf

Source: Port Plan. 2023

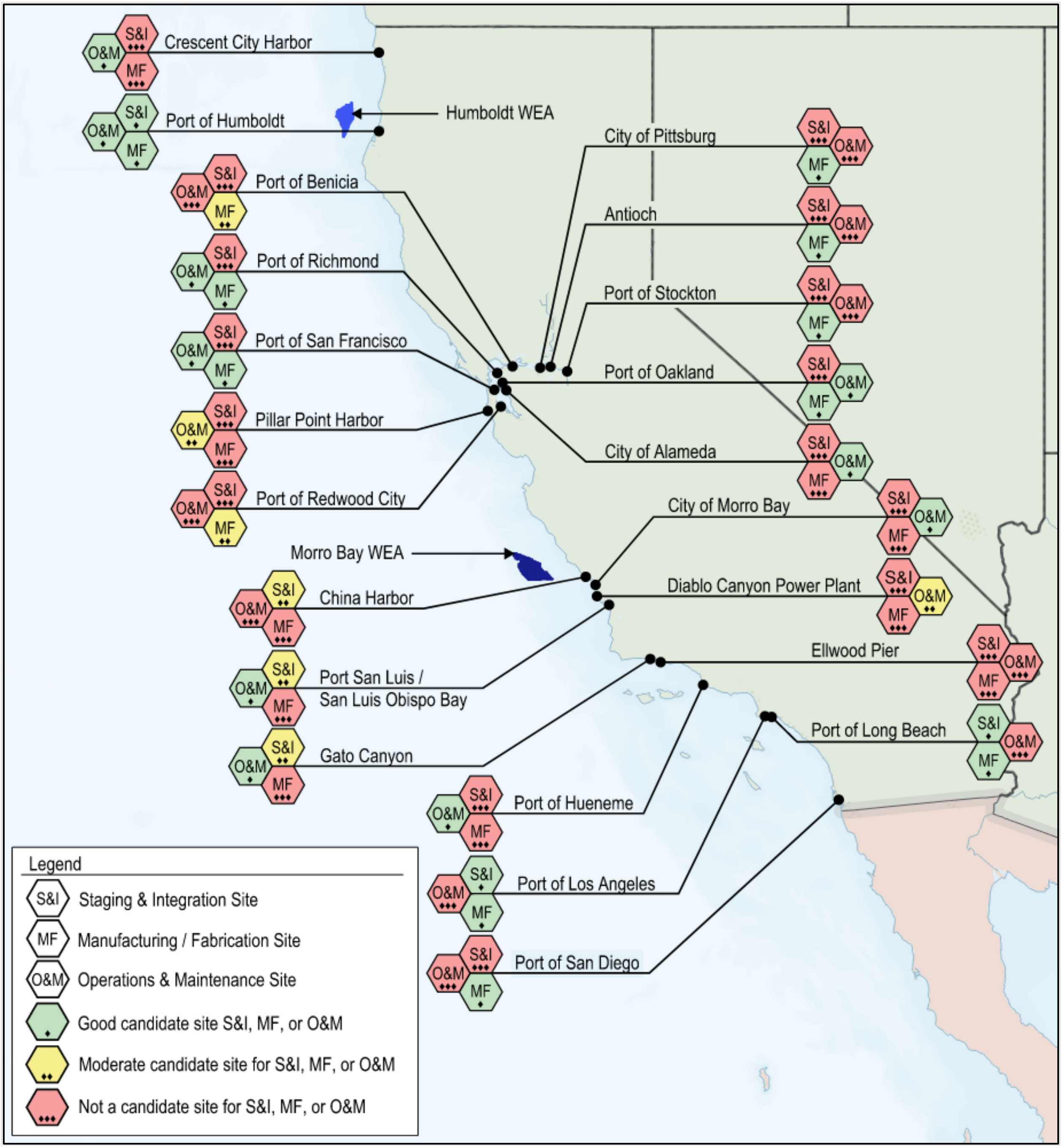
Table 6-10: Number of Port Sites or Acreage Needed to Meet 25 GW by 2045

Type of Site	Number of Port Sites or Acreage Required
Staging and Integration Sites	**3 to 5**
Blade Manufacturing and Fabrication Sites	**2**
Tower Manufacturing and Fabrication Sites	**1**
Nacelle Assembly Sites	**1**
Foundation Subcomponent Manufacturing and Fabrication Site	**4**
Foundation Assembly Sites	**4**
Service Operations Vehicles berths for Operations & Maintenance Activities	**9 to 16**
Mooring Line and Anchor Storage Sites	**20 to 65 acres**
Electrical Cable Laydown Sites	**12 to 22 acres**

Source: Port Plan. 2023

142 Options for transfer of floating foundations from land to water include use of semi-submersible barge and sinking basin, ramp system, or direct transfer methods (lifting portions or complete foundation units from land into water).

Figure 6-5: Potential Port Sites for Offshore Wind



Source: Port Plan. 2023

Offshore Wind Port Development and Investment Plan

The Port Plan identifies numerous potential port sites, and as noted above, concludes that no one port can meet all of the port needs for the offshore wind industry in California. Instead, the state will need to strategically develop a port network that can efficiently, cost effectively, and reliably support staging and integration, manufacturing and fabrication, and operation and maintenance activities along the California Coast. A multi-port strategy will be critical to provide the necessary port and waterfront facilities needed to meet the 2045 offshore wind planning goal. The Port Plan assesses several port development scenarios and identifies an example port development approach that would meet the 2045 offshore wind planning goal. **Table 6-11** shows one potential port development approach, including the number of site types needed, potential locations, dates by which the sites would need to be available, and approximate cost estimates (in 2023 dollars, escalation not included) for upgrading port facilities.

The Port Plan estimates that an investment of approximately $11 to $12 billion would be required for upgrading existing port infrastructure to meet the 2045 offshore wind planning goal. Funding and permitting for these projects are a critical challenge to address. The Port Plan suggests that the state's collaborative port development strategy outline a funding plan to subsidize the various port upgrades needed, along with identification of funding sources at the state, federal, and local level. The Port Plan emphasizes the need for programs to incentivize early-stage port development work including port readiness, concept design, and engineering, as well as permitting and environmental assessments. For comparison, this is approximately 11 to 12 percent of the total investment required to create 25 GW of offshore wind energy, as it is estimated that 1 MW may require $4 million of capital investment. The Port Plan also notes that permitting and environmental approvals in California can take multiple years and identifies the need to accelerate review and approval timelines to ensure port facilities are ready when needed.

Table 6-11: Port Development Locations, Ready Dates, and Costs

Site Type	Location	Assumed Ready Date	Cost (In 2023 million dollars)
Staging and Integration	Port of Humboldt	2028	$700
Staging and Integration	Port of Humboldt	2031	$700
Staging and Integration	Port of Long Beach	2031	$1,100
Staging and Integration	Port of Long Beach	2035	$1,100
Manufacturing and Fabrication (Floating Foundation Assembly)	Port of San Francisco	2030-2032	$520
Manufacturing and Fabrication (Floating Foundation Assembly)	Port of Long Beach	2030	$1,100
Manufacturing and Fabrication (Floating Foundation Assembly)	Port of Long Beach	2033	$1,100
Manufacturing and Fabrication (Floating Foundation Assembly)	Port of Long Beach	2035	$1,100
Manufacturing and Fabrication (Floating Foundation Subcomponents)	Port of San Diego	2030-2035	$275

Site Type	Location	Assumed Ready Date	Cost (In 2023 million dollars)
Manufacturing and Fabrication (Floating Foundation Subcomponents)	Bay Area Port	2030-2035	$375
Manufacturing and Fabrication (Floating Foundation Subcomponents)	Bay Area Port	2030-2035	$350
Manufacturing and Fabrication (Floating Foundation Subcomponents)	Bay Area Port	2030-2035	$350
Manufacturing and Fabrication (Blades)	Bay Area Port	2030-2035	$520
Manufacturing and Fabrication (Blades)	Bay Area Port	2030-2035	$520
Manufacturing and Fabrication (Tower)	Bay Area Port, Port of Humboldt, or Port of Los Angeles	2030-2035	$1,000
Manufacturing and Fabrication (Nacelle Assembly)	Bay Area Port	2030-2035	$350
Operations and Maintenance	Assume 10 sites at $50 M each	2028-2045	$500
Mooring Line and Anchor Storage	Port of Humboldt and Bay Area Port	2030-2035	<$50
Electrical Cable Laydown Sites	Port of Humboldt and Bay Area Port	2030-2035	<$50
Total			**$11,760**

Source: Port Plan. 2023

Environmental Considerations for Port Development Sites for Offshore Wind

The Port Plan includes an environmental evaluation and a comparative site ranking for the previously identified staging and integration, manufacturing and fabrication, and operations and maintenance port sites. Within each port site type, the Port Plan evaluates each potential site location using a standard set of environmental factors, and then compares them to the other potential locations of the same type. The potential site locations are then ranked in order of likely severity of potential environmental concerns. A high-level overview of potential environmental impacts from offshore wind port facilities is presented in **Volume II, Chapter 3**. The environmental ranking process was not a formal environmental impact analysis in compliance with applicable regulatory requirements or standards (such as CEQA).[143] Rather, the evaluation process includes a high-level review of the potential effects that typically would be most severe from development of waterfront facilities and the factors that would create more serious public concerns.

The following eight environmental ranking factors were considered:

- **Federal, State, and Regional Parks and Marine Protected Areas:** Review of maps and open-source data to identify the locations of federal protected lands (including National Marine Sanctuaries, Bureau of Land Management lands and recreation areas, California Coastal National Monuments), Marine Protected Areas (including State Marine Conservation Areas and State Marine Reserves), state parks and state beaches, and regional parks. Locations within or near the proposed Chumash Heritage National Marine Sanctuary (CHNMS) were also identified.
- **Existing Infrastructure Development at the Site:** Use of geospatial data tools for each of the potential sites to identify the types of infrastructure development within and surrounding the site. This evaluation considered whether the existing infrastructure could support the proposed use and the extent of new infrastructure development that would be required for proposed operations at the site.
- **Compatibility of Development with Surrounding Land Uses:** Use of informal desktop land use inventory to define potential sensitive land uses within one mile of the site boundaries. The inventory determines whether land uses surrounding each port site would be compatible with the industrial scale land use that would result from development of each port site type. Sensitive land uses include residences, schools, recreational facilities, churches, and other similar facilities. These land uses are considered sensitive because they are susceptible to the adverse nuisance effects of large-scale development (such as air emission and greenhouse gas emissions, dust, construction and operational noise, traffic, environmental hazards, and degradation of views).
- **Environmental Justice Demographic Index:** Use of the U.S. Environmental Protection Agency's Environmental Justice (EJ) Screen model to generate the Demographic Index project effects related to disadvantaged populations. The Demographic Index in EJ Screen is a combination of the percentage of low-income individuals and the percentage of people of color (such as minority populations). For

143 A coalition of environmental nongovernmental organizations (eNGOs) have suggested that assigning qualitative values to the anticipated positive and adverse effects, as fully as possible, facilitates comparison using common metrics, recognizing that it is not possible to quantify all potential impacts.

Gutierrez, Irene, Andrea Folds, Lewis Grover, Lisa Belenky, Kristen Hislop, Luis Neuner, Jennifer Kalt, Garry George, and Michael Stocker. February 2023. "ENGOs Comments – on Permitting Roadmap for Offshore Wind." TN 248737. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=248737&DocumentContentId=83257.

staging and integration sites and manufacturing and fabrication sites, a five-mile radius was considered appropriate because of the extent of construction and operational effects on already burdened disadvantaged populations. For operations and maintenance facilities, a one-mile radius was used because the construction associated with these facilities is unlikely to create substantial effects on disadvantaged populations, especially potential health effects often resulting from major industrial developments.

- **Viewshed Sensitivity:** Comparison of staging and integration sites and manufacturing and fabrication sites (within site categories) for their likely sensitivity to visual change that would result from the construction and operation of the facilities.
- **Terrestrial Biological Resources:** Consideration of the documented presence of protected species (State and Federal Endangered Species), the level of protection (indication of species rarity) for each species present, the presence of protected native plants, and presence of nearby drainages.
- **Marine and Aquatic Resources:** High-level screening assessment of potential critical issues related to aquatic physical and biological resources for each of the potential locations to explore the feasibility of developing or expanding already developed waterfronts. The species considered include cetaceans (whales and dolphins); pinnipeds (seals); and fish, avian, and vegetation or other species (kelp beds, turtles, abalone, etc.). The evaluation assumes that construction effects would result from dredging and associated testing and analysis, along with construction of breakwaters and pile driving.
- **Cultural Resources:** Use of data from the California Historical Resources Information System (CHRIS) relating to historical resources (buildings, structures, objects, historic and archaeological sites, landscapes, districts).[144] To evaluate development at the port site locations for potential effects on resources important to Native American and Indigenous peoples and resources that contribute to knowledge of the history of each area, information was gathered for each site. This includes records of historic and prehistoric sites located within a one-half mile radius of each site, both onshore and offshore (for shipwreck data) and information on Sacred Lands in the vicinity of the facility sites was acquired from the Native American Heritage Commission. **Table 6-12** presents the comparative ranking for staging and integration sites, **Table 6-13** presents the comparative ranking for manufacturing and fabrication sites, and **Table 6-14** presents the comparative ranking for operations and maintenance sites. Overall comparative rankings across all factors by site type are presented in the Port Plan.

144 CHRIS data is assembled from previous cultural resources surveys in which a team of archaeologists methodically physically evaluate a site to identify every potential resource of importance.

Table 6-12: Staging and Integration Site Rankings (by Factor)

Staging and Integration Site	State and Federal Protected Areas	Existing Infrastructure Development	Land Use Compatibility	Demographic Index (EJ 5-mi Radius)	Viewshed Sensitivity
Ports of LA & Long Beach	Least Impact	Least Impact	Least Impact	Greatest Impact	Least Impact
Port of Humboldt	Least Impact	Least Impact	Least Impact	Medium Impact	Least Impact
Port San Luis	Medium Impact	Medium Impact	Greatest Impact	Least Impact	Medium Impact
China Harbor	Greatest Impact	Greatest Impact	Medium Impact	Least Impact	Medium Impact
Gato Canyon	Greatest Impact	Greatest Impact	Medium Impact	Medium Impact	Greatest Impact

Staging and Integration Site	Terrestrial Biology	Marine/ Aquatic Biology	Cultural Resources	Impact Tier
Ports of LA & Long Beach	Medium Impact	Least Impact	Least Impact	Least Impact
Port of Humboldt	Greatest Impact	Least Impact	Medium Impact	Least Impact
Port San Luis	Least Impact	Medium Impact	Medium Impact	Medium Impact
China Harbor	Medium Impact	Medium Impact	Least Impact	Medium Impact
Gato Canyon	Least Impact	Greatest Impact	Medium Impact	Greatest Impact

Source: Port Plan. 2023

The site rankings presented in the tables indicate only the likely comparative level of development challenges among the sites considered within each facility type. A less favorable ranking does not indicate that a project at that location would be infeasible. All of the sites evaluated could be successfully developed with thoughtful planning and specific mitigation applied based on the effects identified through a future site-specific CEQA and NEPA analyses and coordination with permitting agencies and the public. The overall comparative rankings within each port site type and ranking factors are presented in three tiers: least impact (green); medium level impact (yellow); most severe impact (red).

Table 6-13: Manufacturing and Fabrication Site Rankings (by Factor)

Manufacturing and Fabrication Site	State and Federal Protected Areas	Existing Infrastructure Development	Land Use Compatibility	Demographic Index (EJ 5-mi Radius)	Viewshed Sensitivity
Ports of LA & Long Beach	Least Impact	Least Impact	Least Impact	Greatest Impact	Least Impact
Port of Benicia	Least Impact	Least Impact	Medium Impact	Least Impact	Medium Impact
Port of San Francisco	Medium Impact	Least Impact	Least Impact	Medium Impact	Least Impact
Port of Humboldt	Least Impact	Least Impact	Medium Impact	Least Impact	Medium Impact
Pittsburg	Least Impact	Least Impact	Medium Impact	Medium Impact	Medium Impact
Antioch	Medium Impact	Least Impact	Least Impact	Medium Impact	Medium Impact
Port of Richmond	Least Impact	Least Impact	Least Impact	Greatest Impact	Greatest Impact
Port of Stockton	Least Impact	Least Impact	Medium Impact	Greatest Impact	Greatest Impact
Port of Redwood City	Greatest Impact	Least Impact	Medium Impact	Medium Impact	Greatest Impact

Manufacturing and Fabrication Site	Terrestrial Biology	Marine / Aquatic Biology	Cultural Resources	Impact Tier
Ports of LA & Long Beach	Least Impact	Least Impact	Least Impact	Least Impact
Port of Benicia	Least Impact	Medium Impact	Medium Impact	Least Impact
Port of San Francisco	Medium Impact	Medium Impact	Least Impact	Least Impact
Port of Humboldt	Greatest Impact	Least Impact	Medium Impact	Medium Impact
Pittsburg	Medium Impact	Greatest Impact	Medium Impact	Greatest Impact
Antioch	Medium Impact	Greatest Impact	Medium Impact	Greatest Impact
Port of Richmond	Least Impact	Medium Impact	Greatest Impact	Greatest Impact
Port of Stockton	Least Impact	Greatest Impact	Medium Impact	Greatest Impact
Port of Redwood City	Medium Impact	Greatest Impact	Least Impact	Greatest Impact

Source: Port Plan. 2023

Table 6-14: Operations and Maintenance Site Rankings (by Factor)

Operations and Maintenance Sites	State and Federal Protected Areas	Existing Infrastructure Development	Land Use Compatibility	Demographic Index (EJ 1-mi Radius)
Port of Hueneme	Least Impact	Least Impact	Least Impact	Greatest Impact
Diablo Canyon	Greatest Impact	Least Impact	Least Impact	Least Impact
Port of Humboldt	Least Impact	Least Impact	Least Impact	Greatest Impact
Port San Luis	Greatest Impact	Medium Impact	Medium Impact	Least Impact
Pillar Point	Medium Impact	Medium Impact	Greatest Impact	Medium Impact
Ellwood Pier	Medium Impact	Medium Impact	Greatest Impact	Medium Impact

Operations and Maintenance Sites	State and Federal Protected Areas	Existing Infrastructure Development	Land Use Compatibility	Demographic Index (EJ 1-mi Radius)
Crescent City	Medium Impact	Medium Impact	Greatest Impact	Greatest Impact
Morro Bay	Greatest Impact	Least Impact	Greatest Impact	Medium Impact

Operations and Maintenance Sites	Terrestrial Biology	Marine / Aquatic Biology	Cultural Resources	Impact Tier
Port of Hueneme	Medium Impact	Least Impact	Least Impact	Least Impact
Diablo Canyon	Least Impact	Medium Impact	Least Impact	Least Impact
Port of Humboldt	Greatest Impact	Least Impact	Medium Impact	Medium Impact
Port San Luis	Least Impact	Medium Impact	Medium Impact	Medium Impact
Pillar Point	Medium Impact	Medium Impact	Medium Impact	Greatest Impact
Ellwood Pier	Medium Impact	Greatest Impact	Least Impact	Greatest Impact
Crescent City	Medium Impact	Least Impact	Medium Impact	Greatest Impact
Morro Bay	Greatest Impact	Medium Impact	Medium Impact	Greatest Impact

Source: Port Plan. 2023

Underserved Community Impacts from Offshore Wind Activities in Ports

The environmental ranking discussed above is narrow and not the rigorous analysis that typically would be conducted for an environmental review document, in which the potential disproportionate burdens on disadvantaged and underserved populations would be identified. The effects of the offshore wind port sites are not yet defined in a detailed enough way to allow this analysis to be completed. More detailed analysis and strategies will be required to address potential impacts to underserved communities.

Ports have significant economic importance both locally and statewide. However, industrial activity and development at ports can result in significant environmental burdens for communities of concern living near ports, including air, water, noise and light pollution. The industrialized ports highlighted in this report all have significant impacts on the health of nearby communities. During the CCC's Consistency Determination review, stakeholders noted that port emissions reduce the life expectancy of community members and cause high childhood asthma rates in their communities, particularly surrounding the Ports of Long Beach and Los Angeles.

Any existing pollution burdens and environmental hazards that may be intensified by constructing, assembling, and transporting offshore wind turbines at these industrialized ports should be considered. New development proposed for ports should come with demonstrable reductions in air pollution and other sources of pollution that harm the health of nearby communities. Port electrification has some promise to achieving these reductions, but many emissions from port activities come from the vessel traffic moving goods and resources in and out. In addition to port electrification, the state should pursue options to reduce air emissions from cargo vessel traffic.

Marine Operations and Offshore Wind Challenges

The Port Plan identifies that there are significant marine operations that are required to support floating offshore wind. This will require the construction of new vessels. These vessels will primarily be anchoring handling tug supply vessels, tugboats, barges, crew transfer vessels, and service operation vessels. The Port Plan identifies several challenges for marine operators in meeting California Air Resources Board (CARB) regulations including that: existing CARB-compliant vessels are not adequate to the meet the needs of the floating offshore wind industry; new-build vessel costs will be higher, and diesel-particulate filter technology is not currently compatible with operational vessels in the California towage market.

The Port Plan identifies challenges for the offshore wind industry in complying with the Jones Act, which generally requires vessels carrying cargo between two points in the U.S. to be owned and crewed by U.S. citizens, registered under the U.S. flag, and built in the U.S. Under Jones Act requirements, the vessels that will be transporting wind turbine generation components between various California ports must be built within the U.S. The Port Plan lists a number of challenges posed by the Jones Act, including a large gap between vessel demand and supply, a potential shortage of qualified U.S. mariners, shipyard availability, vessel build costs, and lack of long-term contracts. The Port Plan indicates that without significant investment and new vessel build programs, the state's offshore wind planning goals may not be achieved.

The Port Plan also discusses the risks associated with conducting maritime operations, noting that the risks of conducting an operation for the first time, such as for offshore wind development, are magnified. The large size of fully integrated offshore wind turbines presents a challenging maritime project. These challenges include ensuring a common understanding of severe weather and ocean conditions and transportation logistics, including all the necessary procedures from departure of the turbine to final installation. Safety for workers who operate and maintain offshore wind projects and infrastructure in a potentially hazardous environment is critical. Maintenance and repair operations will need to have strict weather parameters to mitigate potential risk. In addition, it will be important to develop standardized operating procedures for connecting offshore wind turbines to mooring spreads considering that various vessels are involved in the mooring operations.[145]

Port Infrastructure Conclusions

Offshore wind ports are instrumental in the manufacturing and fabrication, staging and integration, logistics and transport, and operations and maintenance of offshore wind facilities. These port facilities must meet numerous requirements to support offshore wind development

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145 Spread mooring systems are multi-point mooring systems that moor vessels to the seabed using multiple mooring lines.

and the ports assessment performed to date indicates that no one port in California will meet all these requirements. However, an individual port could focus on one or more specific activities related to the offshore wind industry. The Port Plan estimates that an investment of about $11 billion to $12 billion would be required for upgrading existing port infrastructure to meet the 2045 offshore wind planning goal. A collaborative port development strategy is needed to support various port upgrades, along with the identification of funding sources at the state, federal, and local levels. Particularly important are programs to encourage early-stage port development, including port readiness, concept design, and engineering, as well as permitting and environmental assessments. Permitting and environmental approvals in California can take multiple years and opportunities to accelerate review and approval timelines should be considered to ensure port facilities are ready when needed.

Recommendations to Address Port Infrastructure Needs

The following recommendations will help to ensure adequate port infrastructure:

- Continue to support, in coordination with federal, tribal, and local governments, developers, and underserved and local communities a port development and readiness framework. This should include consideration of potential funding sources and strategies, as well as local content and prevailing wages, to identify port site developments needed for offshore wind project development and operations.
- A port development and readiness framework should continue to be coordinated with larger West Coast port network evaluation efforts and state and national supply chain development.
- Continue to collaborate with ports and harbor districts, tribal governments, underserved communities, local communities, port users and tenants, and developers to understand the unique challenges and opportunities of each port and harbor district and their potential role in supporting offshore wind development and operations.
- Continue to engage with industry leaders, developers, and supply chain entities to explore options to support local supply chain development.

CHAPTER 7: Workforce Development

AB 525 finds that investment in offshore wind energy development, especially in ports and waterfront facilities, can offer career pathways and workforce training in the clean energy transition. Offshore wind energy can provide additional blue collar industrial work opportunities and support apprenticeship opportunities for a diverse labor pool. AB 525 recognizes the opportunities that workforce development can provide to local communities experiencing high unemployment by prioritizing hiring local community members first. AB 525 directs the CEC to coordinate with relevant state and local agencies, tribes, and representatives of key labor organizations, apprenticeship programs, and environmental justice organizations. As discussed in **Volume II, Chapter 6**, development activities for offshore wind include construction and staging of foundations, manufacturing of components, final assembly, and long-term operations and maintenance facilities.

AB 525 requires that the strategic plan include:

- Analysis of offshore wind workforce development needs, including occupational safety requirements, the need to require a skilled, diverse, 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.

In February 2023, the CEC adopted an interim report required by AB 525 entitled *Preliminary Assessment of Economic Benefits of Offshore Wind Related to Seaport Investments and Workforce Development*.[146] As noted in the report, the legislature found that offshore wind energy presents an opportunity for California to attract investment capital and provide economic and workforce development benefits to communities. These benefits can accrue through the development and preservation of a skilled, diverse, and well-trained workforce, the creation of long-term jobs, and the development of a local offshore wind energy supply chain.

Workforce needs can be assessed for numerous stages of offshore wind planning and development. The workforce for offshore wind is not limited directly to the workers who are

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146 Deaver, Paul and Jim Bartridge. December 2022. *Preliminary Assessment of Economic Benefits of Offshore Wind: Related to Seaport Investments and Workforce Development.* CEC-700-2022-007-CMD. Available at https://www.energy.ca.gov/publications/2022/preliminary-assessment-economic-benefits-offshore-wind-related-seaport.

installing offshore wind turbines, cables, and offshore substations. In the near term, the workforce would include workers needed to upgrade infrastructure across the state, such as port and waterfront facilities and transmission infrastructure. Additionally, the need for secondary and tertiary workers expands to include construction of housing and transportation system upgrades. The CEC engaged Catalyst Environmental Solutions to support the development of the AB 525 Strategic Plan through the report entitled *Analytical Guidance and Benefits Assessment for AB 525 Strategic Plan* (Catalyst Assessment).[147] In addition, the CSLC contracted with Moffatt & Nichol to prepare a workforce readiness assessment, entitled the *AB 525 Workforce Development Readiness Plan* (Workforce Plan) with support from Xodus Group and BW Research.[148] The reports prepared by Catalyst and Moffat & Nichol are the primary sources of information and analysis for this workforce development chapter.

Estimating Workforce Development Needs

Establishing a new industry in California requires the support of an expansive workforce comprised of diverse, skilled, and trained labor. The analysis of workforce development needs provides information to support the CEC's offshore wind planning goals of 2 to 5 GW by 2030 and 25 GW by 2045. To plan for the training and education of the workforce, it is critical to understand the scale of development, which dictates the demand for workers possessing a certain skill set, education, training, and experience. A skilled, diverse, and well-trained workforce is required to construct offshore wind projects and related infrastructure. The types and number of jobs provided can be assessed using a variety of methods including workforce assessment models that estimate a potential range of jobs for the offshore wind industry.

As offshore wind development feasibility increases over time, the costs, measured as the levelized cost of energy (levelized cost), trends downward and turbine generation capacity increases.[149] The reduction in costs is displayed in **Figure 7-1**.

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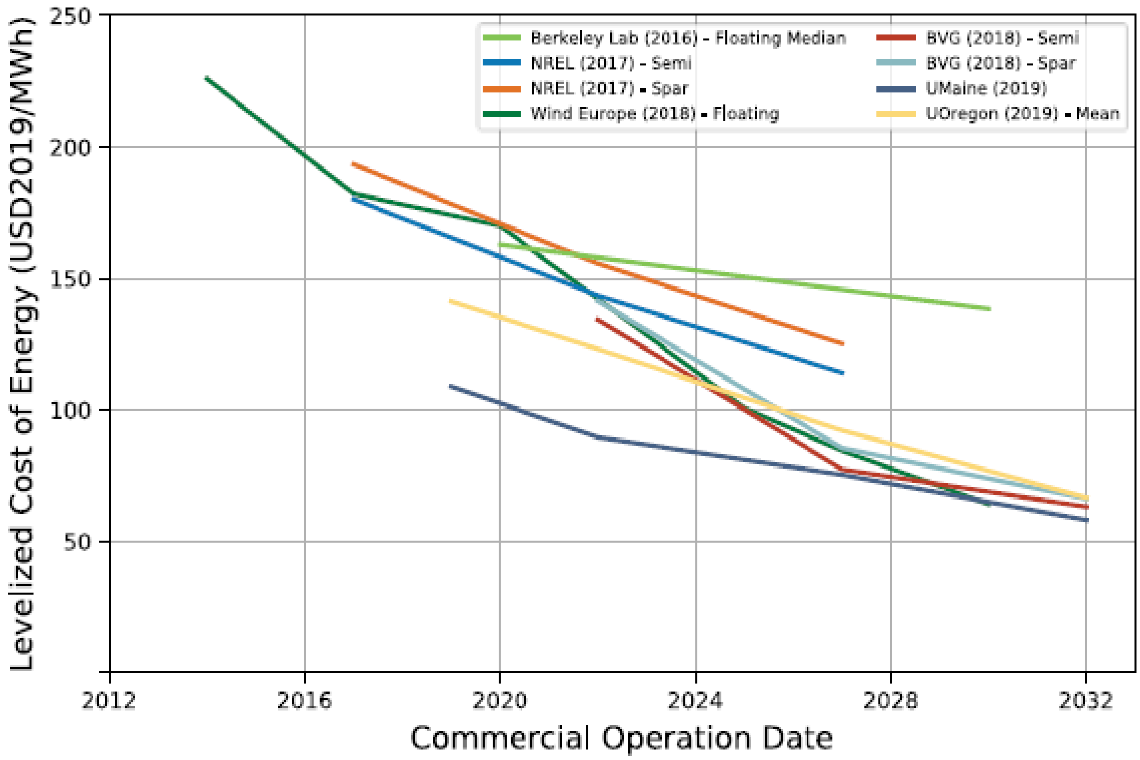
147 Catalyst Environmental Solutions. April 2023. *Analytical Guidance and Benefits Assessment for AB 525 Strategic Plan: Seaport and Workforce Development for Floating Offshore Wind in California*. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250296.

148 Fox, Brooklyn and Sarah Lehmann (Moffatt & Nichol). June 2023. *AB 525 Workforce Development Readiness Plan*. 221194/02. Available at https://slcprdwordpressstorage.blob.core.windows.net/wordpressdata/2023/07/AB525-Workforce-Readiness-Plan_acc.pdf.

149 Levelized cost of energy represents the average revenue per unit of energy generated that would be required to recover the costs of building and operating a generation unit.

Catalyst Environmental Solutions. April 2023. *Analytical Guidance and Benefits Assessment for AB 525 Strategic Plan: Seaport and Workforce Development for Floating Offshore Wind in California*. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250296.

Figure 7-1: Levelized Cost of Energy Trends



Source: NREL. 2020

Catalyst reviewed levelized cost analysis from NREL,[150] American Jobs Project (AJP),[151] and Lawrence Berkeley National Laboratory (LBNL).[152] NREL estimates a projected 37 percent reduction in levelized costs for floating offshore wind in California from 2019 to 2032, which reflects the expansion of the local supply chain and workforce and will support the development of 25 GW by 2045. **Figure 7-1** shows the levelized cost estimates from the various studies. The latest NREL estimates for floating offshore wind energy projects are

150 Beiter, Phillipp, Walt Musial, Patrick Duffy, Aubryn Cooperman, Matt Shields, Donna Heimiller, and Mike Optis (National Renewable Energy Laboratory). November 2020. *The Cost of Floating Offshore Wind Energy in California Between 2019 and 2032.* NREL/TP-5000-77384. Available at https://www.nrel.gov/docs/fy21osti/77384.pdf.

151 American Jobs Project. February 2019. *The California Offshore Wind Project: A Vision for Industry Growth*. Available at http://americanjobsproject.us/wp/wp-content/uploads/2019/02/The-California-Offshore-Wind-Project-Cited-.pdf.

152 Mills, Andrew, Dev Millstein, Seongeun Jeong, Luke Lavin, Ryan Wiser, and Mark Bolinger (Lawrence Berkeley National Laboratory). April 2018. *Estimating the Value of Offshore Wind Along the United States' Eastern Coast*. DE-AC02-05CH11231. Available at https://eta-publications.lbl.gov/sites/default/files/osw_value_es_final.pdf.

estimated to decline from approximately $82 to $255 per MWh in 2022 to $66 to $128 per MWh in 2030.[153]

More certainty regarding future development contributes to the reduced levelized costs. Technology advancement of wind turbines also contributes to lowering the levelized cost; NREL estimates 15 MW turbine generation capacity by 2032. As offshore wind development expands to reach the 2045 goal, the workforce will need to expand to include manufacturing, transportation, and assembly of components, and the benefits of a skilled, diverse, and well-trained local workforce will improve the economics of constructing projects. The benefits of workforce development can be assessed as a contributor to overall project success. Workforce development can contribute to cost reductions, as a trained workforce is more efficient, and critical to the long-term success of the offshore wind industry in California.

To evaluate workforce development needs, the type and number of jobs created by offshore wind development and the distribution across phases of development must be analyzed. The Catalyst Assessment uses the findings from key economic modeling of workforce development for 2030 and 2045 to generate a high and low estimate of jobs as shown in **Table 7-1** to meet the 2030 goals and in **Table 7-2** to meet the 2045 goals.[154] The total jobs needed estimate is approximately 2,400 to 8,300 for a 5 GW build out by 2030 and between 5,000 and 18,000 jobs for an 18 GW build out by 2045.

The type and number of jobs needed varies for each phase of project development (supply chain and manufacturing, integration and assembly, and operations and maintenance) and by component type (turbines, nacelles, blades, foundations, cables for transmission and mooring, etc.). Approximately 66 percent, or two-thirds, of the offshore wind workforce is centered around the supply chain and manufacturing of key components.[155] Only 11 percent of the total workforce is represented by construction of wind energy components, such as turbines, cables, and foundations. The remaining 23 percent of the workforce is responsible for wind farm operations, and the maintenance and service of turbines, foundations, subsea cables,

153 Musial, Walter, Paul Spitsen, Patrick Duffy, Philipp Beiter, Matt Shields, Daniel Hernando, Rob Hammond et al. (National Renewable Energy Laboratory). August 2023. *Offshore Wind Market Report: 2023 Edition*. Available at https://www.energy.gov/sites/default/files/2023-09/doe-offshore-wind-market-report-2023-edition.pdf.

154 The economic models vary by modeling assumptions and type of quantitative model. Although the goal of reaching 25GW by 2045 was not explicitly used to develop workforce estimates, the most optimistic scenario was considered for each model and should provide reasonable estimates and establish bounding-level range of possible estimates for workforce needs.

155 BVG Associates Limited. October 2017. *U.S. Job Creation in Offshore Wind: A Report for the Roadmap Project for Multi-State Cooperation on Offshore Wind*. NYSERDA Report 17-22. Available at https://www.cesa.org/wp-content/uploads/US-job-creation-in-offshore-wind.pdf.

and substations. The approximate number of jobs by job category for each phase are detailed in the Catalyst Assessment.[156]

Table 7-1: Estimated Jobs Needed for Workforce Development for 2030 Goals

Source/Model	Supply Chain	Construction	Operations & Maintenance	Total Jobs
American Jobs Project	2,100	350	1,200	3,650
NREL	5,490	1,130	1,660	8,280
Guidehouse	1,936	125	314	2,375
Total Range	**1,936 – 5,490**	**125 – 1,130**	**314 – 1,660**	**2,375 – 8,280**

Source: Catalyst Assessment. 2023

Table 7-2: Estimated Jobs Needed for Workforce Development for 2045 Goals

Source/Model	Supply Chain	Construction	Operations & Maintenance	Total Jobs
American Jobs Project	9,000	1,400	2,600	13,000
NREL	11,280	2,340	4,330	17,950
Guidehouse	1,936	173	1,508	5,063
Total Range	**3,382 – 11,280**	**173 – 2,340**	**1,508 – 4,330**	**5,063 – 17,950**

Source: Catalyst Assessment. 2023

The offshore wind workforce requires a diverse set of skills for each job type. The job types can be grouped into 6 categories: technicians and trades; construction and assembly; maritime and port workers; engineers; management; and administrative and clerical.[157] The majority of skills needed for the near-term workforce are in the trades, technician, and construction sectors, which aligns with studies that estimate that over 65 percent of the workforce is in the supply chain and manufacturing sector. **Figure 7-2** shows the distribution of workforce by job type and sector for each phase of project development in 2030.

The potential economic growth from creating a new and sizeable workforce will be extensive. As explained in this section and shown in **Figure 7-2**, the supply chain and manufacturing sector account for the majority of offshore wind jobs, which will likely be stable, long-lasting (more than 30 years), and high-paying jobs, which provide the most significant economic benefits to communities, especially those most historically impacted by the energy industry. Supply chain and manufacturing jobs will be distributed across the state as the offshore wind supply chain expands, and port facilities are upgraded to manufacture and provide materials, services, and components. These jobs do not require a bachelor's degree, and instead much of

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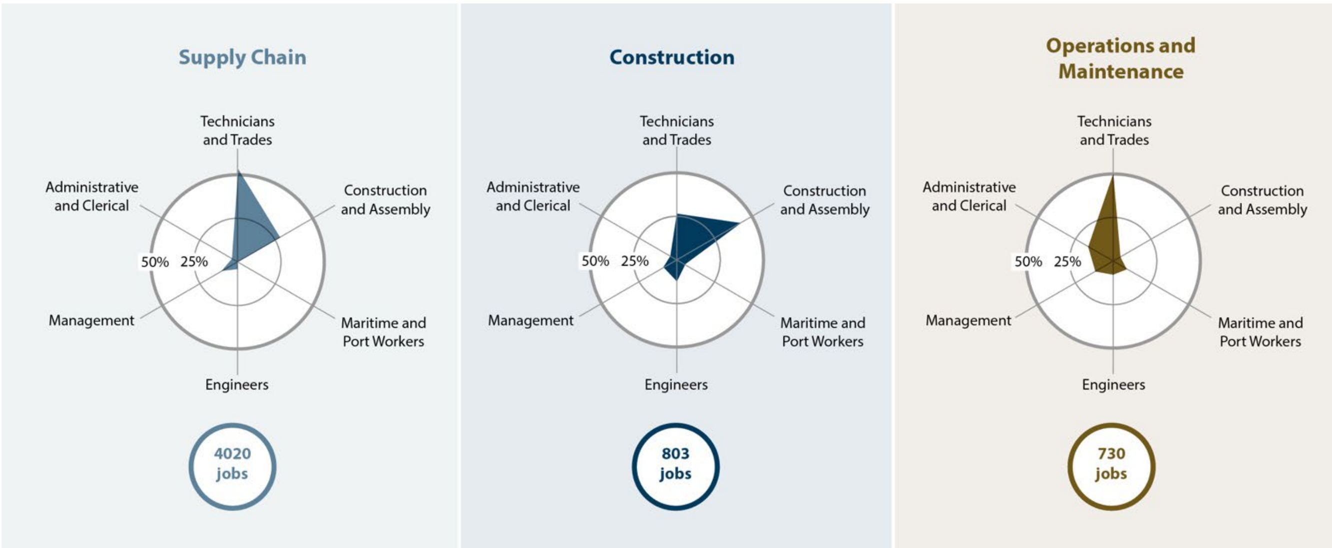
156 Catalyst Environmental Solutions. April 2023. *Analytical Guidance and Benefits Assessment for AB 525 Strategic Plan: Seaport and Workforce Development for Floating Offshore Wind in California*. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250296.

157 Ibid.

the education for this portion of the workforce will be centered on some form of post-secondary education, or training and certification.

Figure 7-2: Workforce by Job Type and Sector for Each Project Development Phase



Source: Catalyst Assessment. 2023

Figure 7-3 overlays the graphs in **Figure 7-2** to present the overall distribution of jobs per category, highlighting the emphasis on trade and technicians. The workforce must be supported by new training standards and curriculums, as well as training facilities to ensure a readily available workforce for the offshore wind industry. The presence of a trained workforce increases the likelihood of additional investment and expansion of the supply chain.

Offshore wind projects are divided into five primary supply areas: project development, wind turbine supply, balance of plant supply, installation and commissioning, and operations and maintenance.[158] The Workforce Plan used industry data and engaged with developers and original equipment manufacturers to determine the required workforce for each supply area.

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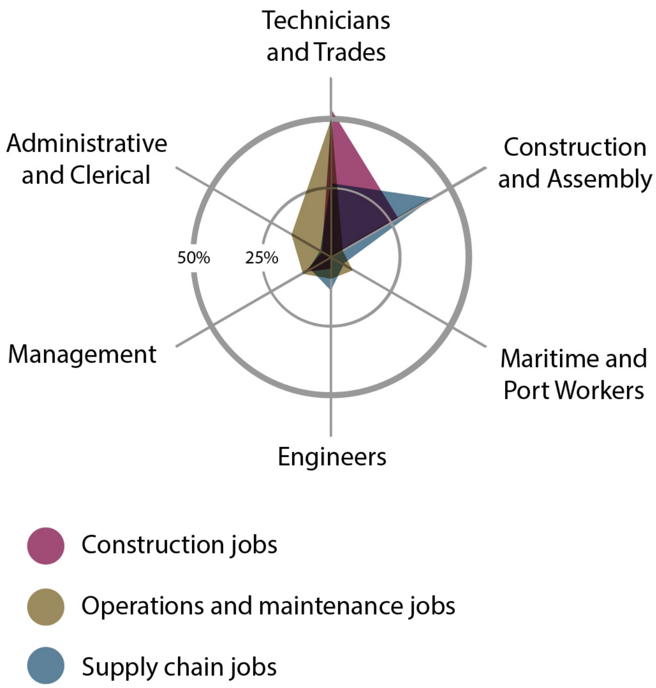
158 The project development phase consists of the supply of services to support project permitting, surveys, engineering and design, and project management. Wind turbine supply consists of the manufacture of turbine nacelles, blades and towers. Balance of plant supply includes the manufacture of turbine foundations, array and export cables, anchors, mooring systems, offshore substations, and onshore electrical infrastructure. The installation and commissioning phase includes the supply of services to install offshore the anchors, mooring systems, array and export cables, and offshore substations, and services to integrate the turbine with the foundation at port. It additionally includes port staging and logistics services and the construction of onshore infrastructure. The operations and maintenance phase includes services related to wind farm operations and the maintenance and service of turbine and balance of plant components.

Fox, Brooklyn and Sarah Lehmann (Moffatt & Nichol). June 2023. *AB 525 Workforce Development Readiness Plan*. 221194/02. Available at https://slcprdwordpressstorage.blob.core.windows.net/wordpressdata/2023/07/AB525-Workforce-Readiness-Plan_acc.pdf.

Analyzing the workforce demand per supply area allows for an understanding of the timing of workforce demand for each supply element.

Figure 7-3: Radar Graph of Workforce Skills by Job Sector (By Percentage of Overall Workforce)



Source: Catalyst Assessment. 2023

As shown in **Table 7-3**, offshore wind project development (Years -5 to -1) typically begins five or more years before the commercial operation date (Year 0). The signing date of a lease agreement with BOEM typically occurs immediately before formal project development and permitting, which also includes site assessment, surveys, engineering and design, and project management. The supply of manufactured products accumulates in the two years leading up to project operation. In the year prior to operation, installation begins for some components. The turbines are maintained for the lifetime of a project, approximately 25 years.

Table 7-3: Workforce Requirements for Each Supply Element Relative to Offshore Wind Project Commercial Operation Date

	Project Development/Manufacturing/Installation								
						Operations			25+yr Lifetime>>
Supply Element	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
Development and permitting	X	X	X	X					
Surveys	X	X	X	X					
Engineering and design	X	X	X	X					
Project management	X	X	X	X	X	X			
Nacelle					X	X			
Rotor					X	X			
Tower					X	X			
Floating Foundation					X	X			
Secondary steel components					X	X			
Foundation assembly					X	X			
Offshore substation				X	X				
Onshore substation					X	X			
Array cables				X	X				
Export cables				X	X				
Anchors				X	X				
Mooring				X	X				
Foundation tow out/hook up						X	X		
Offshore substation installation					X				
Subsea cable installation					X	X			
Anchors installation					X	X			
Mooring installation					X	X			
Turbine intergration (crane)						X	X		
Ports and logistics						X	X		
Onshore construction				X	X				
Operations						X	X	X	X
Turbine maintenance and service						X	X	X	X
BoP maintenance and service						X	X	X	X

Source: Workforce Plan. 2023

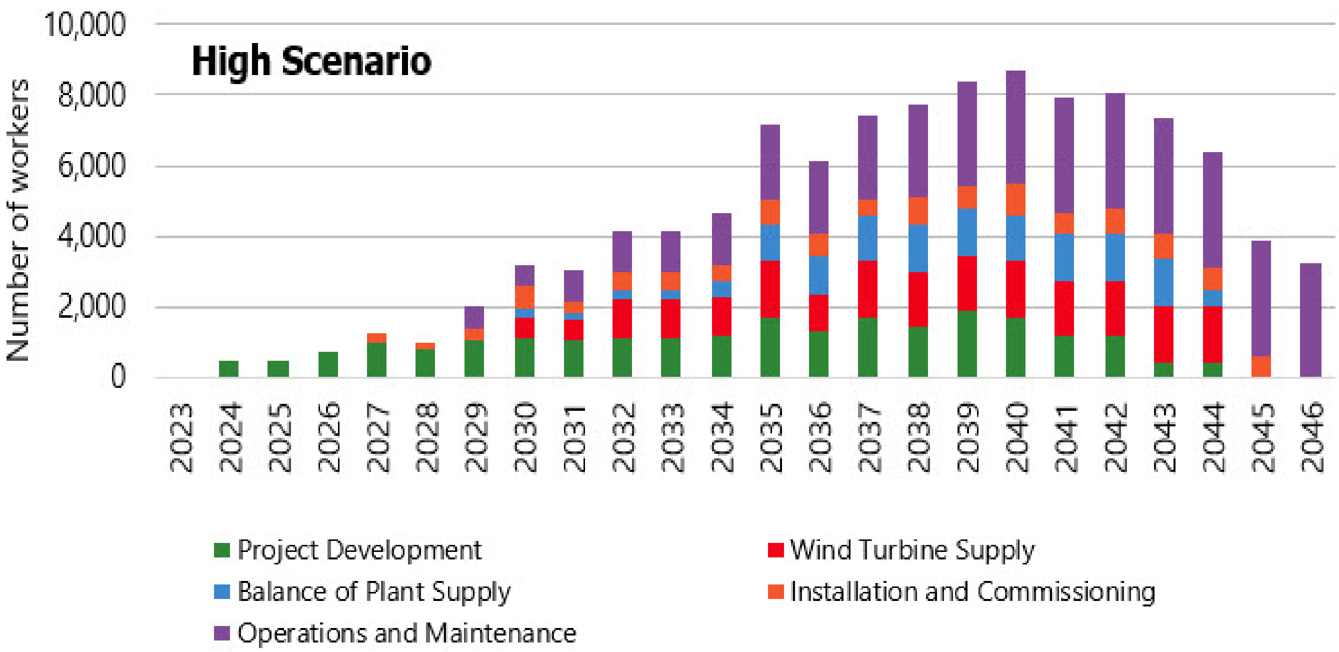
As discussed in **Volume II, Chapter 6**, the Port Plan presents a build out scenario with significant investment in multiple local and key component manufacturing facilities in California.[159] The Port Plan identifies that approximately three to five 80-acre sites are required for staging and integration, twelve sites are required for manufacturing and fabrication (including two sites for blades, one site for towers, one site for nacelles, four sites for floating foundation subcomponent manufacturing, and four sites for floating foundations assembly), and nine to 16 berths at several port sites are required for operations and maintenance.

As the certainty of the offshore wind deployment schedule increases, the potential for infrastructure upgrades increases, and in turn increases manufacturing and supply chain development. Workforce demand for infrastructure upgrades can be evaluated by assessing

159 Fox, Brooklyn and Sarah Lehmann (Moffatt & Nichol). June 2023. *AB 525 Workforce Development Readiness Plan*. 221194/02. Available at https://slcprdwordpressstorage.blob.core.windows.net/wordpressdata/2023/07/AB525-Workforce-Readiness-Plan_acc.pdf.

the number of full-time equivalents required.[160] Port and transmission infrastructure are the most critical upgrades needed to ensure successful development of offshore wind in California. These infrastructure upgrades offer opportunities for the local workforce to engage in offshore wind development in the immediate future by applying existing training, primarily construction skills, to port and transmission projects supporting offshore wind.

Figure 7-4: Number of Workers Per Year of Offshore Wind Development



Source: Workforce Plan. 2023

Workforce demand for infrastructure upgrades is distributed across the coastal region of the state as each region will participate in offshore wind industry differently, based on the role and construction timelines for port facilities. Construction activities will make up 95 percent of the direct full-time equivalents for port upgrades, which amounts to almost 9,300 full-time equivalents every year between 2027 and 2030. The remaining 5 percent, approximately 530 full-time equivalents, will provide professional services like engineering, architecture, and design.[161]

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160 Full-time equivalents are units that represent a full-time workload of 2,080 hours (40 hours per week for 52 weeks). Full-time equivalents are not equivalent to full-time jobs, rather represent the number of hours worked to complete the work done by one full-time employee in one year.

161 Fox, Brooklyn and Sarah Lehmann (Moffatt & Nichol). June 2023. *AB 525 Workforce Development Readiness Plan*. 221194/02. Available at https://slcprdwordpressstorage.blob.core.windows.net/wordpressdata/2023/07/AB525-Workforce-Readiness-Plan_acc.pdf.

The Workforce Plan identified the annual installed capacity, the project delivery timeline for each offshore wind project, and the local content expectations to estimate workforce demand. The study separately indicates the demand for a highly skilled workforce early in project development will require more than 650 workers by 2026 and 1,600 workers by 2039. This need must be addressed by either attracting experienced workers from other regions or related offshore industries. The number of workers needed peaks in 2040 with over 8,000 workers as shown in **Figure 7-4**.

Workforce Skills and Qualifications

As the state attracts more supply chain investment through port upgrades, more skilled-trade workers will be needed. The build out of the offshore wind supply chain will have the highest demand for skilled-trade standard and skilled trade specialist jobs, due to their involvement in activities across a broad range of project phases. In addition, laborers, engineers, and welders, will be needed as their skills are essential for the manufacturing, installation, and operation of an offshore wind project.[162] Many skilled-trade jobs require specific certifications obtained through apprenticeships. The demand for skilled-trade workers is supported by various legislation, including the Inflation Reduction Act, which include stipulations for hiring apprentices and prevailing wages.[163]

The Workforce Development Institute identified 74 different occupations for the offshore wind workforce requiring a broad range of skill sets.[164] A portion of offshore wind construction occurs at sea, subject to federal regulations. The remainder of supply chain, manufacturing, transportation, and on-shore activities, which constitutes approximately two-thirds of the potential workforce, will be subject to state-level standards. A workforce with the right skill sets will require training that must be timed to accommodate industry needs for different types of workers. The planning and development of training programs and facilities must align with industry training needs and development timelines to maximize the effectiveness of the available workforce.

Offshore wind jobs require different qualifications which correlate to the length of training and education, as shown in **Table 7-4**. A readily available workforce includes jobs that require two years or less of training. A highly skilled workforce is also needed that requires four or more years of training. Project development jobs require an undergraduate degree. Wind turbine

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162 Ibid.

163 The Inflation Reduction Act includes apprenticeship requirements for a percentage of labor hours for construction, alteration, or repair work: 10 percent for projects under construction before 2023, 12.5 percent for projects under construction in 2023, and 15 percent for projects under construction after 2023.

164 Gould, Ross and Eliot Cresswell (Workforce Development Institute). May 2017. *New York State and the Jobs of Offshore Wind Energy.* Available at https://wdiny.org/Portals/0/New%20York%20State%20and%20The%20Jobs%20Of%20Offshore%20Wind%20Energy_%20WDI2017.pdf?ver=2017-05-03-150746-023.

supply jobs require specific certifications for working with steel, operating heavy lift machinery, and performing specialized testing and design work.

Table 7-4: Qualification Levels Offshore Wind Workforce

Qualification Level	Description of Minimum Training and/or Certification	Training Length
Manager	Formal education/combination of education and experience	5+ years
Skilled trade – Specialist	Requires training and apprenticeship pls additional experience or specialization (e.g., senior vessel crew, supervisory roles, etc.).	5+ years
Engineer	Engineering degree from university	4+ years
Scientist	Science degree from university	4+ years
Other University Degree	University degree other than engineering/science	4+ years
Skilled trade - Standard	Requires skilled vocational training	2+ years
Support staff	Requires some formal training (e.g., admin, HR, etc.)	2+ years
Tradesperson	Requires training/certification/apprenticeship	1+ years
Nonskilled labor	Requires no formal training, only on-the-job experience	>1 year

Source: Workforce Plan. 2023

Balance of plant supply, which includes the manufacture of turbine foundations, array and export cables, anchors, mooring systems, offshore substations, and onshore electrical infrastructure, uses multiple unique skill sets.[165] For the installation and commissioning phase, which includes the supply of services to install anchors, mooring systems, arrays and other components, integrate the turbine with the foundation, and for port staging and logistics, and certifications for working in the marine environment are essential for construction workers and vessel operators. A large and diverse workforce is employed during operations and maintenance that require certifications, including Basic Safety Training developed by the Global Wind Organisation (GWO).[166] Each supply area and job-type require specific training certifications obtained from apprenticeships and vocational training programs that occur over the course of several days, weeks or months. California will need to develop additional curriculum and programs to provide the relevant training and certifications to the workforce.

In addition, infrastructure project upgrades, including port improvements and transmission ahead of the commercial operation date of the offshore wind projects will increase workforce demand. The majority of port upgrade workers will be in construction and extraction. For transmission upgrades, the work relies primarily on traditional transmission jobs in supply chain, manufacturing, and construction industries, except for offshore wind specific roles involving offshore cable installation. Workforce institutions, including labor unions, workforce

165 Ibid.

166 The Global Wind Organisation is a nonprofit body founded by leading wind turbine manufacturers and operators.

More information on the Global Wind Organisation is available at https://www.globalwindsafety.org/.

development boards, and training centers, must be aware of port and transmission upgrades that will create an employment pipeline.

The existing supply of workers in California's coastal regions is approximately 2.8 million individuals, however, there is low supply of specialized offshore wind workers. Offshore wind will create new working-class jobs and workforce development programs to support the employment of underserved communities. The demographic data shows that California’s coastal regions have an unemployment rate of 5 percent, which is higher than the approximate 4 percent state and national average. The Central Coast also has the highest portion of working age individuals. These workers, with additional training, could be deployed to support offshore wind and port development. Professional services, including architecture and engineering occupations, and support jobs are the major employment categories. The Bay Area and Southern California employ the most potential offshore wind related workers in these occupations in the state.

Workforce Standards

Workforce standards are proactive policy mechanisms embedded in state statutes, state contracts, and state regulations that may support the creation of high-quality jobs for underserved and dislocated workers by enacting specific requirements regarding worker job quality and job access.[167] These standards can support a successful industry as they can support the attraction and development of a workforce to construct and maintain the necessary infrastructure. Workforce standards can include prevailing wage, workforce skills, workforce training, apprenticeship programs, local hiring initiatives, targeted hiring standards, and equitable hiring standards. Workforce standards address worker safety and ensure consistent quality in all phases of offshore wind development.

Oversight and regulation for offshore wind projects is shared between federal and state agencies. The Bureau of Safety and Environmental Enforcement (BSEE), a Department of Interior (DOI) and partner agency with the BOEM, oversees safety coordination with the United State Coast Guard (USCG). The USCG oversees vessel safety in both federal and state waters, tracks vessel traffic, assists with harbor navigation and clearance, and provides support and rescue services. In addition, the USCG establishes requirements that all offshore workers attain certification under the Standards of Training, Certification, and Watchkeeping for Seafarers.[168]

167 U.C. Berkeley Labor Center. 2023. *California’s Climate Investments and High Road Workforce Standards: A Brief Prepared for the California State Senate Committee on Lab, Public Employment and Retirement*. Available at https://sbud.senate.ca.gov/sites/sbud.senate.ca.gov/files/State%20Climate%20Workforce%20Brief.pdf.

168 United States Coast Guard. September 2021. *USCG Marine Safety Manual, Vol II: Matriel Inspection. Section G: Outer Continental Shelf Activities*. COMDTINST 1600.76. Available online at: https://www.dco.uscg.mil/Portals/9/OCSNCOE/References/COMDTINSTs/CI-16000.76-OCS-Activities.PDF?ver=KXStelJ-e-XS5VzhMBweeA%3d%3d.

California's role in workforce standards will primarily be limited to onshore activities (such as supply chain, manufacturing, logistics, port operations).[169] The workforce needs assessment indicates onshore activities provide two thirds of the offshore wind related job opportunities.

Workforce Training

The offshore wind occupations differ by type of education, certification, or credentialing. The majority of occupations will require some form of post-secondary education/training (such as a bachelor's degree; apprenticeship; technical certification). California workforce standards and requirements would apply primarily to supply chain jobs, while the BSEE oversees construction in the outer continental shelf beyond state waters. Regardless of the regulatory entity, workers will need specific training for each occupation.[170]

With support from Catalyst Environmental, the CEC engaged with representatives of key labor organizations and apprenticeship programs that would be involved in dispatching and training the construction workforce. To more clearly understand the industry and other key training entities' vision, Catalyst interviewed Engineering-Procurement-Construction-Installation (EPCI) organizations, developers, manufacturers, training entities, and experts. Developers noted the need for education in science, technology, engineering, and math (STEM), including computer competency, for operating and maintaining offshore wind components and facilities. Developers and training stakeholders highlighted the importance of maritime training for California.[171] Maritime experience, engineering, and technical skills needed for the offshore wind industry are transferable from other existing industries. The original equipment manufacturers typically require GWO safety training, and the developers expect insurance companies to require that all offshore construction workers have training that meets GWO standards.[172] GWO training is a globally recognized offshore wind safety training specific to offshore wind focused on safety and survival in the marine and ocean environments.

A diverse and robust skills training program geared toward offshore wind should be created with support from offshore wind developers, manufacturers, and training entities. The Workforce Plan identifies the need for further clarification on the key differences between onshore and offshore wind development skill sets. The technology selection and other logistics

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169 Catalyst Environmental Solutions. April 2023. *Analytical Guidance and Benefits Assessment for AB 525 Strategic Plan: Seaport and Workforce Development for Floating Offshore Wind in California*. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250296.

170 Ibid.

171 Fox, Brooklyn and Sarah Lehmann (Moffatt & Nichol). June 2023. *AB 525 Workforce Development Readiness Plan*. 221194/02. Available at https://slcprdwordpressstorage.blob.core.windows.net/wordpressdata/2023/07/AB525-Workforce-Readiness-Plan_acc.pdf.

172 Catalyst interview with Mr. Alex Obell – Head of Business Development for Maersk Training. October 14, 2022.

determined by the developers create some uncertainty regarding the specific skills and job types will need further refinement as the industry develops and gains experience. Additionally, California can benefit from collaboration and lessons learned from the U.S. East Coast experience of operating engineers, laborers, carpenters, and electricians to support curriculum and other workforce development strategies. California state agencies, industry, and training organizations can also benefit from the existing globally recognized training requirements, skills requirements, curriculum, and safety requirements to establish training programs for offshore wind. Effective workforce development planning depends heavily on partnerships between industry, educational and training institutions, government entities, and community.

Workforce Safety Requirements

Workforce safety is a top priority for the offshore wind workforce and industry. Onshore workers manufacturing and handling large components must have proper safety training. Offshore workers installing turbines and operating vessels must also have safety training for working offshore. Workers can obtain training relevant to each job type by completing a combination of courses. An industry led offshore wind standards initiative started in 2017 to establish consensus-based guidelines for offshore wind development. The Offshore Wind Standards Initiative is a collaboration led by NREL, BOEM, the DOE, the Business Network for Offshore Wind, American Clean Power (ACP), and the American National Standards Institute (ANSI).

Offshore wind project activities are conducted both onshore and offshore, presenting a need to delineate responsibility for workforce safety to the appropriate federal and state entities.[173] Offshore safety is primarily overseen by the federal entities, with responsibility for activities conducted on vessels and in federal waters. The USCG is primarily responsible for maritime safety, security, and environmental stewardship in U.S. ports and inland waterways.[174] The USCG will inspect and oversee U.S. vessels that support offshore wind installation, operations, and maintenance. The existing Basic Offshore Safety Induction and Emergency Training certification is required to work offshore and is currently offered by training organizations including the Offshore Petroleum Industry Training Organization. The GWO, a nonprofit body founded by leading wind turbine manufacturers and operators, has also published international standards for safety training and emergency procedures, and The Basic Safety Training Standard is a well-accepted safety program.[175] Finally, onshore worker safety is under the

173 The agencies with oversight include the Bureau of Ocean Energy Management, Bureau of Safety and Environmental Enforcement, United States Coast Guard (USCG), and California Division of Occupational Safety and Health (Cal/OHSA).

174 More information on the United States Coast Guard is available at https://www.uscg.mil/About/.

175 More information on the Global Wind Organisation is available at https://www.globalwindsafety.org/about/about.

Global Wind Organisation. "Training Standards." Available at https://www.globalwindsafety.org/trainingstandards/trainingstandards.

authority of California Division of Occupational Safety and Health (Cal/OHSA). Several offshore wind construction jobs are relevant to both Cal/OHSA and the Bureau of Safety and Environmental Enforcement; specific training courses may meet certification requirements of multiple governing agencies. Coordination between agencies on the safety training requirements and programs can provide a more streamlined path for workforce training and certification.

Workforce Training Programs & Apprenticeships

California has a robust education and training network to support workforce development for port development and offshore wind activities. Unions (32 percent) and community adult schools (27 percent) provide half of the available programs, supplemented by community colleges (16 percent), training centers (12 percent), public universities (5 percent), and technical schools (34 percent).[176] The training assessment in the Workforce Plan provides additional details about training programs in California including geographic distribution, occupational data, provider types, and educational outcomes.

Apprenticeship programs, where workers earn a paycheck while learning on-the-job to develop a skilled trade, provide a pathway for supplying a workforce to meet the demand of the offshore wind industry. Apprenticeships are under the guidance of experienced workers and related classroom training.[177] Pre-apprenticeship programs attract individuals and provide opportunities for underserved communities to develop the skills needed to enter a full-time apprenticeship program. The Training Resources Database discussed in the Workforce Plan identifies 145 apprenticeship, certification, and degree programs across 69 different labor unions, community colleges, technical schools, universities, maritime academies, and other training providers. Union labor has voiced its ability to meet the demands of the industry with the ability to ramp up training and recruitment.

The California Apprenticeship Initiative (CAI) New and Innovative Grant Program administered by the Chancellor of the California Community Colleges seeks to create new and innovative apprenticeship opportunities in priority and emerging industry sectors or areas in which apprenticeship training is not fully established or does not exist.[178] The California Division of

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176 Fox, Brooklyn and Sarah Lehmann (Moffatt & Nichol). June 2023. *AB 525 Workforce Development Readiness Plan*. 221194/02*.* Available at https://slcprdwordpressstorage.blob.core.windows.net/wordpressdata/2023/07/AB525-Workforce-Readiness-Plan_acc.pdf.

177 NYSERDA. "Definitions and Frequently Asked Questions." Available at https://www.offshorewindtraining.ny.gov/faq.

178 California Community Colleges. "California Apprenticeship Initiative (CAI) New and Innovative Grant Program." Available at https://www.cccco.edu/About-Us/Chancellors-Office/Divisions/Workforce-and-Economic-Development/apprenticeship/ca-apprenticeship-initiative.

Apprenticeship Standards (DAS) administers apprenticeship law and standards and would need to be involved in developing curriculum for offshore wind training.

Workforce Development Initiatives

Successful workforce development relies on engagement and support from industry, labor, educational and training institutions, and regulatory and government agencies. The objective of workforce development is to attract and train an adequate workforce to meet the diverse and specific demands of the industry. Partnership is critical for identifying the immediate and long-term workforce needs, establishing training curriculum and programs, funding training and education centers, recruiting entry-level as well as experienced workers, considering local and equitable hiring standards, and supporting prevailing wage and union labor.

Many partnership structures exist to connect labor and industry, including project labor agreements (PLAs), community benefits agreements (CBA) and community workforce agreements (CWA), and the California Workforce Development Board (CWDB) High Road Training Partnership program. PLAs have been recently used for offshore wind projects in the U.S. to outline equitable and local hiring standards and other terms and conditions of the project, including the wage rates.[179]

The offshore wind industry offers a long-term career path. Workforce development includes training the existing workforce with transferable skills and recruiting additional workers to meet the demand of the industry. In addition to the apprenticeship, pre-apprenticeship and certification trainings, curriculum for public education can be developed to educate students about offshore wind. Labor organizations are active in high schools, sharing information about the benefits of union jobs.

High-Road Training Partnerships

High-Road Training Partnerships (HRTP) provide specific training programs that prioritize job quality, equity, and environmental sustainability.[180] The California Offshore Wind HRTP is funded through California Climate Investments, a statewide initiative with cap-and-trade funding to reduce greenhouse gas emissions, strengthen the economy, and improve public health and the environment, particularly in disadvantaged communities.[181] A pathway for this initiative is outlined in the California Workforce Development Board's report pursuant to Assembly Bill 398, *Putting California on the High Road: A Jobs and Climate Action Plan for*

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179 U.S. Department of Labor. "Project Labor Agreement Resource Guide." Available at https://www.dol.gov/general/good-jobs/project-labor-agreement-resource-guide.

180 Catalyst Environmental Solutions. April 2023. *Analytical Guidance and Benefits Assessment for AB 525 Strategic Plan: Seaport and Workforce Development for Floating Offshore Wind in California*. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250296.

181 Collier, Robert, David Vallee, Miriam Noonan, and Stephanie Tsai. July 2023. *Trial Run for California's Offshore Wind Workforce: Lessons Learned From the CADEMO High Road Training Partnership*. Available at https://offshorewindhrtp.slocoe.org/.

2030.[182] The report focuses on job quality, equity, and climate resilience to support high road economic and workforce development.

The HRTP initiatives include construction and pre-apprenticeship partnerships throughout the state, bringing together labor, community, education, and workforce organizations to serve disadvantaged Californians. These programs provide pre-apprenticeship training and supportive services that prepare at-risk youth, women, veterans, ex-offenders, and other disadvantaged job seekers to apply for, enter, and successfully complete state-registered apprenticeship programs in the building and construction trades.

The proposed CADEMO offshore wind demonstration project would include four 15 MW turbines in state waters off the coast of Vandenberg Space Force Base in northern Santa Barbara County. CADEMO is testing a High-Road Training Partnership through early 2024, using a high-road concept of labor-management cooperation, job creation, and community benefits.[183] The project is providing a means to model the high road labor practices and community engagement for offshore wind projects. A PLA between Floventis, the CADEMO project developer, and the labor unions was signed in November 2022.

Local and Targeted Hiring Initiatives

Local hiring supports economic growth and community development. Offshore wind activities will be spread out across the state and the region, supporting local workforces in numerous coastal communities. Local hiring requirements, community benefits agreements (CBAs) and community workforce agreements (CWAs), partnering with local employers, and equitable access to contracts are policy tools that may support local jobs. Environmental justice through economic development around clean energy is a priority for the White House and federal agencies, as evidenced by the Environmental Justice (EJ) Advisory Council, the Justice40 Initiative, Inflation Reduction Act, Bipartisan Infrastructure Law, and the American Rescue Plan. These activities are also being replicated in many states with offshore wind activity, with states implementing legislation, procurement rules, and funding initiatives in coordination with developers. Local hiring initiatives like CBAs, CWAs, PLAs, and other labor partnerships, which

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182 California Workforce Development Board. June 2020. *Putting California on the High Road: A Jobs and Climate Action Plan for 2030*. Available at: https://cwdb.ca.gov/wp-content/uploads/sites/43/2020/09/AB-398-Report-Putting-California-on-the-High-Road-ADA-Final.pdf.

183 Collier, Robert, David Vallee, Miriam Noonan, and Stephanie Tsai. July 2023. *Trial Run for California's Offshore Wind Workforce: Lessons Learned From the CADEMO High Road Training Partnership*. Available at https://offshorewindhrtp.slocoe.org/.

include wage requirements and outline targeted and local hiring requirements, may help ensure offshore wind development supports local and equitable job growth in California.[184]

Prevailing Wage

The prevailing wage rate is defined as the average wage paid to similarly employed workers in a specific occupation in the area of intended employment.[185] Prevailing wage rates (mean hourly wage rate and mean annual salary), collected by the U.S. Department of Labor's Bureau of Labor Statistics, can be used to compare wages to the national average and other states. California wages and salaries tend to be higher than the national average, including for key job types like engineering, captains, mates, pilots, and technicians and trades. The higher wages may attract workers, including skilled workers from existing industries or out-of-state, to fill the workforce gap. Attracting skilled and experienced labor from out-of-state initially can help ensure offshore wind projects move forward on a timely schedule, while providing assurances to the industry that the large workforce demand can be met.

The Inflation Reduction Act (IRA) provides renewable energy tax credits to projects that meet the prevailing wage and apprenticeship requirements. Projects may qualify for the "increased" rate, five times the base rate, if all laborers employed are paid prevailing wages during construction and the entire tax credit period. The U.S. Department of Treasury and the Internal Revenue Service published guidance on the IRA's prevailing wage and apprenticeship requirements.[186] The process for claiming tax credits for the entire project is still undefined, as the Internal Revenue Service views individual turbines and towers as separate facilities. The IRA considers individual turbines, pads, and towers as separate facilities, and clarification of the specific requirements to receive maximum tax credits is needed. Project developers benefit from cost savings by operating under the prevailing wage and apprentice requirements of the renewable energy tax credits.

Prevailing wage provisions are typically included in PLAs. The BOEM Final Sale Notice includes a stipulation for projects to enter into a PLA for construction. Manufacturing of components may not be included within the scope of PLA. Prevailing wage requirements are not enforceable by the state; however, under the Commerce Clause of the U.S. Constitution,

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184 On August 10, 2023 the Humboldt Bay Harbor, Recreation, and Conservation District Board of Commissioners approved a Project Labor Agreement with multiple unions and local hiring targets for the construction of the Offshore Wind and Heavy Lift Terminal at the Port of Humboldt in Eureka, California.

The Project Labor Agreement is agenda item 11b (pg. 31 – 79) and is available at https://humboldtbay.org/sites/humboldtbay.org/files/Agenda%20Packet%2008-10-2023.pdf.

185 U.S. Department of Labor. "Prevailing Wage Information and Resources." Available at https://www.dol.gov/agencies/eta/foreign-labor/wages.

186 Internal Revenue Service. November 2022. Prevailing Wage and Apprenticeship Initial Guidance Under Section 45(b)(6)(B)(ii) and Other Substantially Similar Provisions. 87 Fed. Reg. 73,580. Notice. Available at: https://www.federalregister.gov/d/2022-26108.

states and local jurisdictions can impose labor and wage requirements on state and local government procurement contracts and subsidy programs. These requirements cannot be imposed on private, third-party contracts, unless a state agency is directly a party to those contracts.

By offering upper bound rates and salaries, California-based offshore wind projects can attract already skilled workers from other existing industries and geographies to the new offshore wind workforce.

Community Benefits Agreements

Community benefits agreements (CBAs) are an important economic and negotiation tool that can help ensure offshore wind energy and infrastructure projects support communities. CBAs create space for residents to have a voice in the future of their communities, can expand economic opportunity, and make development more equitable.[187] A CBA is a legally binding, enforceable contract that is mutually beneficial for both project developers and impacted communities.

For communities, CBAs can be tailored to their individual needs and unique circumstances. CBAs can also boost coalition building and increase the transparency, clarity, and enforceability of outcomes. For developers, CBAs are beneficial by building and ensuring a community's support for a project while also reducing the risk of lengthy litigation that has previously derailed clean energy projects. The CBA process incentivizes cooperation from local government and communities, which is crucial throughout lengthy energy project timelines.[188]

BOEM's December 2022 lease sale allowed developers to voluntarily commit to future CBAs in exchange for credits on top of their cash bid during the lease auction. All five developers with winning bids committed to fund a Lease Area Use CBA (fishermen and other ocean users) and four of the five committed to fund a General CBA, as shown in **Table 7-5**.[189] Executed CBAs

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187 Hoff, Katherine and Katie Segal. June 2023. *Offshore Wind & Community Benefits Agreements in California: An Introduction*. Center for Law, Energy, & the Environment. Available at https://www.law.berkeley.edu/wp-content/uploads/2023/06/CBA-Policy-Paper.pdf.

188 U.S. Department of Energy. August 2017. *Guide to Advancing Opportunities for Community Benefits through Energy Project Development.* Available at https://www.energy.gov/diversity/articles/community-benefit-agreement-cba-resource-guide.

189 Bureau of Ocean Energy Management. December 2022. "PACW-1 Round by Round Results." Available at https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/PACW-1-Round-by-Round-Results.pdf.

are potentially years away, but lessees must have signed documentation to provide to BOEM prior to their first Facility Design Report.[190]

A General CBA credit, like that offered in the California offshore wind lease auction, would be established between the developer(s) and, one or more communities, Native American tribes, or stakeholder groups that are expected to be affected by the potential impacts resulting from lease development.[191] In the past, CBAs have been used to negotiate and fund parks, grocery stores, childcare centers, recreation centers, community programs, payments to residents, fair or living wage guarantees, environmental protections, targeted workforce development and hiring programs, education and training, affordable housing, and more.[192]

Table 7-5: Overview of Offshore Wind Community Benefits Agreements

Wind Energy Area	Developer Lessees	Cash bid Amount (Millions)	5% General CBA (Millions)	5% Lease Area Use CBA (Millions)	Total (Millions)
Humboldt	RWE Offshore Wind Holdings	$121.3	$6.065	$6.065	$12.13
Humboldt	California North Floating	$133.7	$6.685	$6.685	$13.37
Morro Bay	Equinor Wind US	$100.0	$5.000	$5.000	$10.00
Morro Bay	Golden State Wind	$120.2	$0	$6.012	$6.012
Morro Bay	Invenergy California Offshore	$111.8	$5.588	$5.588	$11.18

Source: CEC based on BOEM. 2022

The Lease Area User CBA would be established between the developers and, one or more communities, stakeholder groups, or Native American tribes whose use of the geographic space of the Lease Area, or whose use of resources harvested from that geographic space, is expected to be impacted.[193] A CBA could include funding projects that increase the resiliency and sustainability of the local fishing industry, improve infrastructure, cold storage and fish

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190 The Facility Design report is submitted during the Construction and Operations phase of the BOEM lease process. Lessees are currently in the Site Assessment phase which can take up to 5 years to complete.

More information on BOEM Regulatory Framework and Guidelines is available at https://www.boem.gov/renewable-energy/regulatory-framework-and-guidelines.

191 BOEM. October 2022. Pacific Wind Lease Sale 1 (PACW-1) for Commercial Leasing for Wind Power on the Outer Continental Shelf in California—Final Sale Notice. 87 Fed. Reg. 64,093. Notice. Available at https://www.federalregister.gov/d/2022-22871.

192 Hoff, Katherine and Katie Segal. June 2023. *Offshore Wind & Community Benefits Agreements in California: An Introduction*. Center for Law, Energy, & the Environment. Available at https://www.law.berkeley.edu/wp-content/uploads/2023/06/CBA-Policy-Paper.pdf.

193 BOEM. October 2022. Pacific Wind Lease Sale 1 (PACW-1) for Commercial Leasing for Wind Power on the Outer Continental Shelf in California—Final Sale Notice. 87 Fed. Reg. 64,093. Notice. Available at https://www.federalregister.gov/d/2022-22871.

processing facilities, gear storage, safety equipment, equipment repair, gear replacement, scholarships, apprenticeship programs, and more.[194]

The CBA process is dynamic. Both the General CBA and Lease Area Use CBAs will be negotiated and tailored to the specific requests of each stakeholder group or coalition involved. The amounts listed in **Table 7-5** represent the minimum financial commitment developers would commit to CBAs to fulfill their lease stipulations. The North and Central Coast will have different agencies, Native American tribes, leaders, organizations, institutions, local governments, and developers involved in their CBA processes. Although finalized CBAs are years away, developers are expected to increase engagement and begin conversations in the coming months and years, as the process is expected to be lengthy and ongoing.

The Redwood Regional Climate & Community Resilience (CORE) Hub expressed optimism at the opportunity to proactively shape the industry in a way that improves community well-being; strengthens partnerships with local communities, Native American tribes, state and federal agencies; and protects biodiversity. The comments also note that many communities throughout the North Coast region are considered underserved, underrepresented, or environmental justice communities.[195]

CBA negotiations are important for all stakeholder groups and host communities, and they are especially vital to protect and uplift underserved communities that are burdened by environmental and social injustice. The Central Coast and North Coast both have underserved communities near currently proposed offshore wind port development and in coastal communities near the WEAs, as identified by the CCC's Adopted Findings.[196]

Social Impact Partnerships

There are additional models that could provide benefits to communities and improve relationships with local communities and stakeholders. The Social Impact Partnership (SIP) model that San Francisco Public Utility Commission (SFPUC) uses could be an additional opportunity to support equitable outcomes for communities. The utility engages in a competitive process for most Covered Contracts by issuing a Request for Proposals or Invitation for Bids or similar solicitation document (Solicitation). The SIP Program is one component of the competitive process for Covered Contracts and may, or may not, be a deciding factor in determining the successful Contractor. The SFPUC considers each SIP Program Commitment Proposal (Proposal) as a factor separate from and in addition to other

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194 Tom Hafer, President of the Morro Bay Commercial Fishermen's Organization, included these potential stipulations in a Public Comment in response to the PACW-1 Proposed Sale Notice. Comment ID# BOEM-2022-0017-0007. Available at https://www.regulations.gov/docket/BOEM-2022-0017.

195 CORE Hub Public Comment in response to the PACW-1 Proposed Sale Notice. Comment ID# BOEM-2022-0017-0068. Available at https://www.regulations.gov/docket/BOEM-2022-0017.

196 The California Coastal Commission has identified several communities of concern in the Humboldt Bay region and in the Morro Bay region.

qualitative or quantitative scoring criteria for the Covered Contract. Following a competitive process, the SFPUC may or may not award a Covered Contract and reserves the right in all Solicitations to reject any or all proposals.

To participate in the SIP Program, a prospective Contractor (Proposer) must submit a Proposal in response to a Solicitation. A Proposal may include one or more proposed commitments (Proposed Commitment). For each Proposed Commitment, the Proposer identifies the type and amount, the program area, the geographic area(s), and the Contractor's key SIP Program personnel. Commitments for participation in the SIP program must be direct financial contributions that the Proposer will pay directly to the Beneficiary; and volunteer hours that the Proposer will provide to support a Beneficiary. These come at no cost to the city and can focus on job exposure, training, and internships, small business support, public education, environment and community health. These Proposed Commitments must be performed in the geographic area(s) where the work is taking place. By participating in this program, the Proposer will get an additional bonus in their application response to the Solicitation.[197]

In sum, Social Impact Partnerships present another opportunity to increase and ensure communities receive benefits by focusing on contracting. SIPs should be included as options for potential Contractors to propose and participate in when bidding for and executing offshore wind related contracts.

Workforce Development Conclusions

The most needed skills in the near term for the offshore wind industry are in the trades, technician, and construction sectors. In the longer term, the majority of jobs are in the supply chain and manufacturing sector. A workforce with the right skillsets will require training that must be timed to accommodate industry needs for different types of workers. Many skilled-trade jobs will require specific training and certifications that can be obtained from apprenticeships, pre-apprenticeships, and vocational training programs. As described, the state's robust education and training network can be leveraged to support workforce development for offshore wind activities and port development, although additional curricula and programs will be needed.

197 San Francisco Public Utilities Commission. April 2023. *Rules and Regulations Implementing the Social Impact Partnership Program.* Resolution No. 23-0075. Available at https://sfpuc.org/sites/default/files/construction-and-contracts/SIP-Rules-and-Regs.pdf.

Recommendations for Workforce Development

The following recommendations will help California develop an equitable, skilled, and trained workforce to support the offshore wind industry:

- Identify immediate and long-term workforce needs, understand diversity gaps, develop targeted and equitable hiring standards, establish training curriculum and programs, fund training and education centers, recruit entry-level as well as experienced workers, set local, tribal, and equitable hiring standards, and prioritize prevailing wage and union labor.
- Coordinate with local communities, tribes, workforce training centers, government agencies, community organizations, employers, high schools, community colleges, and universities to create career opportunities, workforce training, and economic development benefits.
- Support the development of project labor agreements that provide local and underserved communities and tribes with meaningful economic benefits from offshore wind development.

CHAPTER 8: Transmission Technology and Alternatives Assessment

AB 525 requires the CEC to include a chapter on transmission in the strategic plan:

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

Transmission development is a long lead-time activity and assessing the investments and upgrades required to support the 2030 and 2045 offshore wind planning goals, as required by AB 525, can help inform existing state infrastructure planning processes. Delivery of reliable, diverse, secure, and affordable renewable energy from offshore wind projects will allow them to be a critical part of a future electricity system that operates with 100 percent renewable and zero-carbon resources.

This chapter discusses the transmission infrastructure needed to bring offshore wind generation to shore from the current lease areas, which are up to 110 kilometers (or 70 miles) from shore and at depths of more than 700 meters (or 2,300 feet). This creates new technological challenges not previously faced on the East Coast of the U.S. and other areas around the world deploying offshore wind resources. This will likely require development of floating infrastructure for electrical substations and other interconnection equipment, as well as advancements in current cable and other transmission technologies. Viable transmission technologies for offshore wind development are rapidly advancing and additional technologies are emerging globally through the efforts of transmission providers and offshore wind developers. This chapter provides an assessment of transmission technologies needed to support offshore wind. The chapter also discusses the current transmission systems that serve the North and Central Coasts of California, as well as transmission upgrades and their associated costs needed to accommodate offshore wind development. The interconnection and planning processes for transmission infrastructure are also discussed.

The transmission alternatives assessment discussed in this chapter is a starting point for identifying the transmission investments necessary to deliver 2 to 5 GW by 2030 and 25 GW by 2045. The state will need to develop a comprehensive, long-term transmission capacity expansion plan to help establish an efficient and economic path for offshore wind transmission development. There are many uncertainties regarding where, when, and the amount of offshore wind generation that will be developed. The strategic plan provides information that can help inform the needed transmission upgrades and investments to support the offshore wind planning goals. This will be especially important for the first phase of offshore wind development, as BOEM has already finalized leases for offshore renewable energy off the California coast, as discussed in **Volume II, Chapter 2**.

This assessment builds off the existing body of work including transmission studies over the last few years in the CPUC's Integrated Resources Plan (or IRP) and the California ISO's Transmission Planning Process (or TPP), as well as reports by the Schatz Energy Research Center. A new study, commissioned by the CEC and funded by the Department of Defense Office of Local Defense Community Cooperation, was conducted by the Schatz Energy Research Center, entitled the *Northern California & Southern Oregon Mission Compatibility and Transmission Infrastructure Assessment* (Schatz Study). This study assesses transmission needs and options to deliver offshore wind from the North Coast of California and the Southern Coast of Oregon. The CEC also funded an assessment of transmission technologies to support the strategic plan, as some of the technologies that will be needed are not yet commercially available or tested in conditions similar to those off the California coast.

Transmission Technology – Interconnecting Offshore Wind Projects

Transmission and interconnection infrastructure is needed to transport power from offshore wind projects and connect them to the larger transmission system to deliver generation to load centers. The water depths and distances to shore of the current and anticipated wind energy areas off the California coast will most likely require new and emerging transmission technologies, such as floating infrastructure for substations, as well as dynamic power cables.[198] Some of these technologies are not yet commercial but are considered viable and developers expect them to be widely available for large scale offshore wind deployment off the California coast. The CEC engaged Guidehouse, under subcontract to Aspen Environmental Group, to conduct a technical assessment of the current status and industry experience with existing and emerging technologies for the transmission and interconnection of offshore wind to the onshore grid.[199] The assessment, entitled *Draft Offshore Wind Transmission Technologies: Overview of Existing and Emerging Transmission Technologies* (Guidehouse Assessment). Guidehouse examined the development status and costs of these technologies by reviewing the literature, consisting of publicly available offshore transmission and interconnection studies, offshore wind research papers, information from technology

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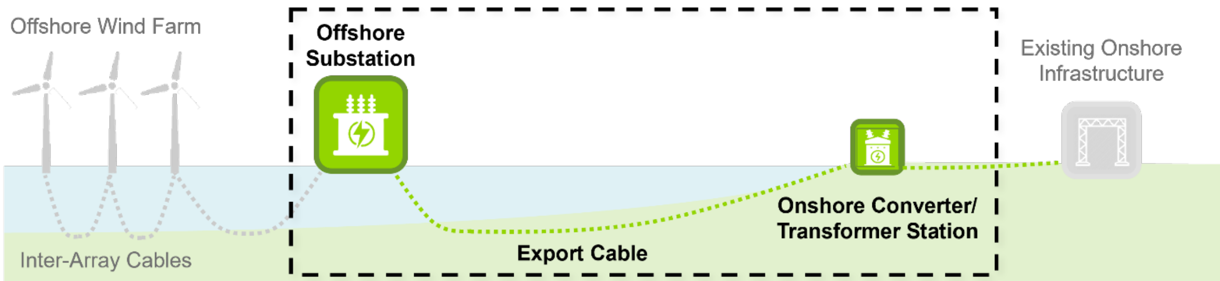
198 With floating wind projects ocean waves and currents subject the cables that connect the turbines to the grid to significant and varying dynamic loads. In static subsea cables a water barrier can be provided by extruding a lead sheath on to the cable. However, a lead sheath cannot flex to accommodate the movement to which subsea cables are exposed and high voltage cables cannot tolerate any water penetrating into the insulation system. Dynamic cables can use a metallic foil or polymer sandwich to provide a barrier thick enough to provide reliable protection, but not so thick that it resists the movement of the cable.

199 Huang, Claire, Lily Busse, and Robert Baker (Guidehouse Inc.). June 2023. *Offshore Wind Transmission Technologies: Overview of Existing and Emerging Transmission Technologies*. 223437. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250520&DocumentContentId=85289.

manufacturers, demonstration projects, and wind power deployments. The Guidehouse Assessment collected primary data through interviews with offshore wind developers holding California leases and an offshore transmission developer to supplement and enhance the available data.

The Guidehouse Assessment addresses offshore wind transmission technologies, including high voltage alternating current (HVAC) and high voltage direct current (HVDC) export cables, substations and related electrical components.[200] It also discusses offshore substation platforms and meshed grid transmission and interconnection concepts.[201] **Figure 8-1** shows the offshore wind transmission technologies within the scope of this report.

Figure 8-1: Offshore Wind Transmission Technologies



Source: Guidehouse Assessment. 2023

Current Transmission Technologies and Concepts

Existing offshore wind projects in other regions have primarily used HVAC systems for the transmission of power to shore, although HVDC systems are beginning to be deployed as well. HVAC systems include HVAC substations, reactive power compensation, HVAC export cables, and interconnections to onshore HVAC substations. In a typical HVAC transmission configuration for an offshore wind project, individual wind turbines generate power and deliver electricity to an offshore HVAC substation through a series of array cables. The power from the array cables is then aggregated and transformed to high voltage on the offshore substation. The resulting HVAC power is exported to shore via an export cable that drops down from the substation platform to the seabed. The export cable terminates on shore at a landing position, or landfall, from which it is routed to an onshore substation. Once at the onshore substation, the power can be transformed to serve local load requirements or be routed into the system without transformation to serve load elsewhere. The voltage level of an

200 In a direct current (DC) circuit, the current flows in one direction unlike the alternating current (AC) where the current reverses direction 50 or 60 times a second depending on the frequency of the supply. As the direct current flows, the electrons, which constitute the electric charge, flow from the point of low potential to the point of high potential. They move from the negative terminal to the positive terminal and the resulting current is in the opposite direction (from positive to negative).

201 Meshed grids allow clusters of offshore wind turbines to be connected to the shore with fewer cables and improve the efficiency of power delivery.

HVAC system depends on several factors. In general, higher voltage components, such as export cables and substation equipment, are used to transfer more power. Higher voltage levels incur lower line losses as they are more efficient but involve higher capital costs for more extensive substation equipment.

Offshore substations house the electrical components necessary for high voltage transmission of power from the wind projects to shore. An offshore HVAC substation collects power from offshore wind projects, transforms the voltage for export to shore, and can house reactive power compensation components if necessary.[202] An offshore HVDC substation serves the same function, but also converts the transformed HVAC power to HVDC before the power is exported. HVDC substations can also house DC gas-insulated switchgear and, in the future, DC circuit breakers for meshed grid applications. Because of the additional equipment, offshore HVDC substations are typically larger and heavier than their HVAC counterparts. While floating platforms will be necessary for offshore substations at the water depths of California wind energy areas, existing deployed offshore substation platforms are all fixed bottom platforms.[203] Onshore substations house similar components as their offshore counterparts but have less restrictive space and weight limitations.

Considering the distance to shore from the California wind energy areas, both HVAC and HVDC transmission systems are viable options for the export of power from offshore wind projects. HVAC transmission technology is highly mature, with more than 20 years of experience in the offshore wind industry. HVAC export cables face some technical and economic limitations related to transmission distance, as they require reactive power compensation for transmission over long distances. HVDC transmission is better suited for long-distance transmission since reactive power losses do not occur in HVDC systems.

However, HVDC transmission technology has a higher upfront cost and is less mature, especially for offshore applications. In addition, key components such as DC gas-insulated switchgear and DC circuit breakers are still relatively nascent. In interviews, lessees seemed open to utilizing either HVAC or HVDC and indicated they would need additional information about supply chain and availability of key technologies in each system, as well as long-term transmission plans before making a final decision.

Many considerations go into deciding between HVAC or HVDC transmission systems for offshore wind projects. Cost of infrastructure (including cables, substations, and other necessary equipment), electrical losses, transmission capacity, space requirements, technological maturity, supply chain status, and cable corridor space all impact the choice between HVAC or HVDC cables. While HVDC systems have a higher upfront cost, a literature

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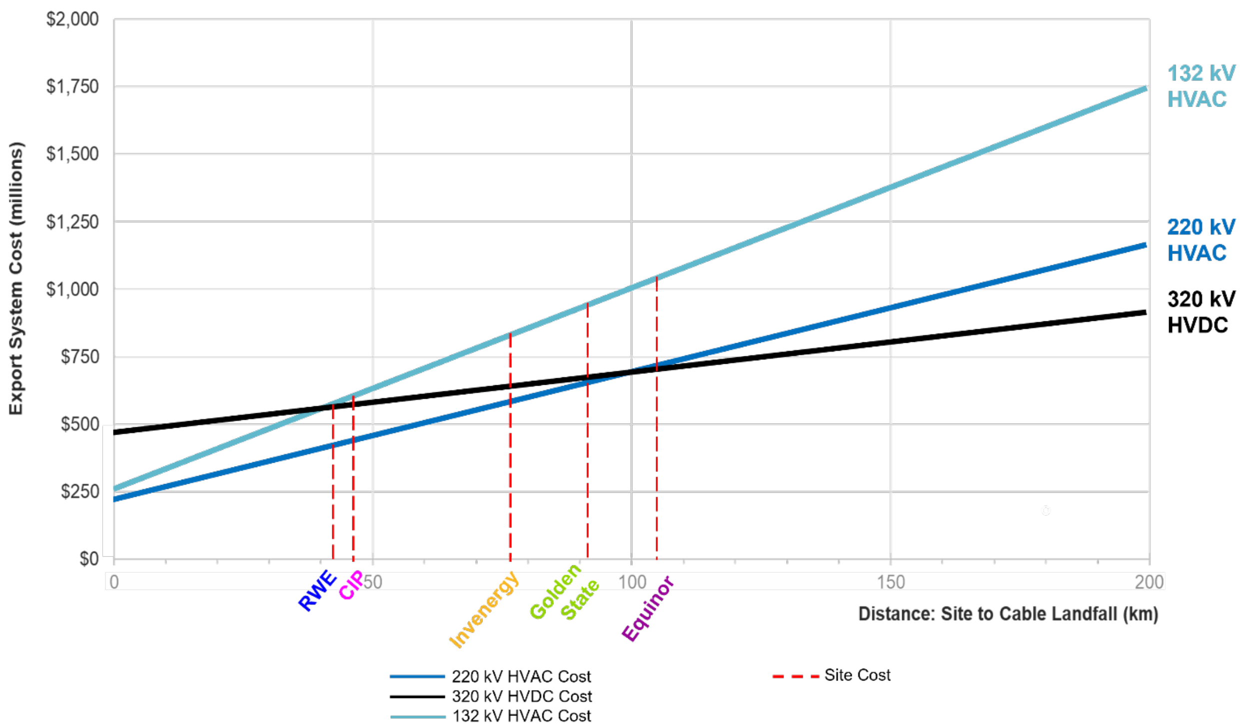
202 Reactive power compensation is essential to power flow because it helps to regulate voltage in electricity systems. Reactive power compensation is defined as the management of reactive power to improve the performance of alternating-current (AC) power systems.

203 One floating offshore substation was demonstrated as part of the Fukushima FORWARD project but was decommissioned in 2021.

review shows that there is a breakeven point at 80–100 km, beyond which HVDC is more economical. This breakeven point occurs due to higher line losses experienced by HVAC export cables and the need for reactive power compensation equipment for transmission over longer distances. **Figure 8-2** shows the relationship between the distances from project site to cable landfall and technology costs. The total export system costs – including design, installation, and the technology – are shown in millions of dollars, as well as the distance to shore for the five lease areas within the Humboldt and Morro Bay Wind Energy Areas.[204]

Figure 8-2: Comparison of HVAC vs. HVDC Cabling Technology Cost



Source: Guidehouse Assessment. 2023 (Adapted from NREL)

A summary of costs for transmission technologies including HVAC and HVDC export cables is in **Table 8-1** and substations is in **Table 8-2.**[205]

204 These costs come from an NREL report for BOEM, which was published in 2016. While costs may be different in 2023, the graph illustrates the relationship between cost and distance to shore for HVAC and HVDC systems and the breakeven point beyond which HVDC is more economical.

205 Cost figures in this table come from Appendix D of the NYSERDA Power Grid Study (2020) and the New Jersey State Agreement Approach (2022), and cost figures are assumed to be applicable for the year each study was published. Additional detail on the source of the figure can be found in the *Port Plan*.

Table 8-1: Export Cable Unit Costs (HVAC and HVDC)

Transmission System Type	NYSERDA ($/MW/km)	NREL ORBIT ($/MW/km)	National Grid Study UK ($/MW/km)
HVAC	$3,600 - $5,167	$3,746	n/a
HVDC	$1,476 - $1,800	$4,900	$2,360

Source: Guidehouse Assessment. 2023

Table 8-2: Offshore Substation Costs (HVAC and HVDC)

Transmission System Type	NYSERDA ($/MW)	NREL ORBIT ($/MW)	National Grid Study UK ($/MW)
HVAC	$150,000	$235,065	$143,753
HVDC	$200,000	$240,227	$242,129

Source: Guidehouse Assessment. 2023

Emerging Transmission Technologies

As noted in the Guidehouse Assessment, bringing power to shore from the current lease areas off the California coast of up to 110 kilometers from shore and at depths of more than 700 meters creates new technological challenges not previously faced for offshore wind development in other parts of the world. Advancements in existing export cable and substation technology will be necessary to enable higher capacity, deep-water, floating wind projects.[206] Original equipment manufacturers (OEMs) and other key players in the industry are working to develop higher voltage cables to support the increasing capacity requirements of offshore wind projects, as well as dynamic export cables to enable transmission from floating substations. These dynamic cables must flex with the movement of the ocean while remaining insulated from water.

While dynamic cabling technology does exist in lower voltages for HVAC, HVAC dynamic cables are not yet available at commercial export levels anticipated in California. Additionally, dynamic cables do not exist in any form for HVDC, which is a critical technology gap for offshore wind transmission in California's deep waters. Manufacturers are currently working on solutions to address this technology gap and to create a less fatigable export cable. Developers cited a lack of market signal as contributing to this existing gap and expect that dynamic HVDC cables would be commercially available by 2035, which is outside of the range of most of the developer's estimated commercial operation dates.

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206 Comments filed by Anbaric, a renewable transmission system developer, noted the technical challenges involved in designing and constructing floating base foundations and dynamic cable systems in deep waters off the California coast.

Anbaric comments are available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=248347&DocumentContentId=82762.

At depths past 60 meters, fixed platforms for substations are no longer economically feasible due to high material and installation costs. There are deep-water fixed platforms that can potentially be competitive at 100 meters of depth, but for depths of 700–1,200 meters or more off the California coast, fixed bottom offshore substations are no longer economically or technically feasible. Floating offshore substations will be a critical piece to deep-water offshore wind transmission, which are expected to use designs similar to floating offshore wind turbine platforms or platforms already in use in the oil and gas industry. However, the topside of floating substation platforms would be significantly heavier than for wind turbine platforms, with a different weight distribution. This will require different platform dimensions from floating turbine platforms. Offshore HVDC substations would require an even larger topside than HVAC substations due to the additional electrical equipment like switchgear and converters.

Some developers cited concerns that HVDC technology may not be well suited to a floating offshore environment due to the sensitivities of the components in HVDC converter stations. Semi-submersible platforms may offer more stability against ocean movements than barge concepts and are therefore more suitable for hosting HVDC topsides. There are numerous designs and initiatives in progress to create scalable floating offshore wind substation platform solutions for both HVAC and HVDC systems.

There has also been progress in developing offshore subsea substations for deep-water applications as an alternative option to floating substations, which aggregate the turbine array cables and then export the wind power from the seafloor, eliminating the requirement for dynamic export cables. These substations are under development and the technology may be available for procurement by 2024.[207] However, subsea substations have not yet been demonstrated in offshore wind applications.

Floating offshore substations are a key technology that OEMs are focusing on to enable floating offshore wind projects in deep waters. Some developers stated in interviews they were not concerned about the technological barriers to floating substations and expressed confidence that this technology gap would be overcome by the time they are needed for their projects.

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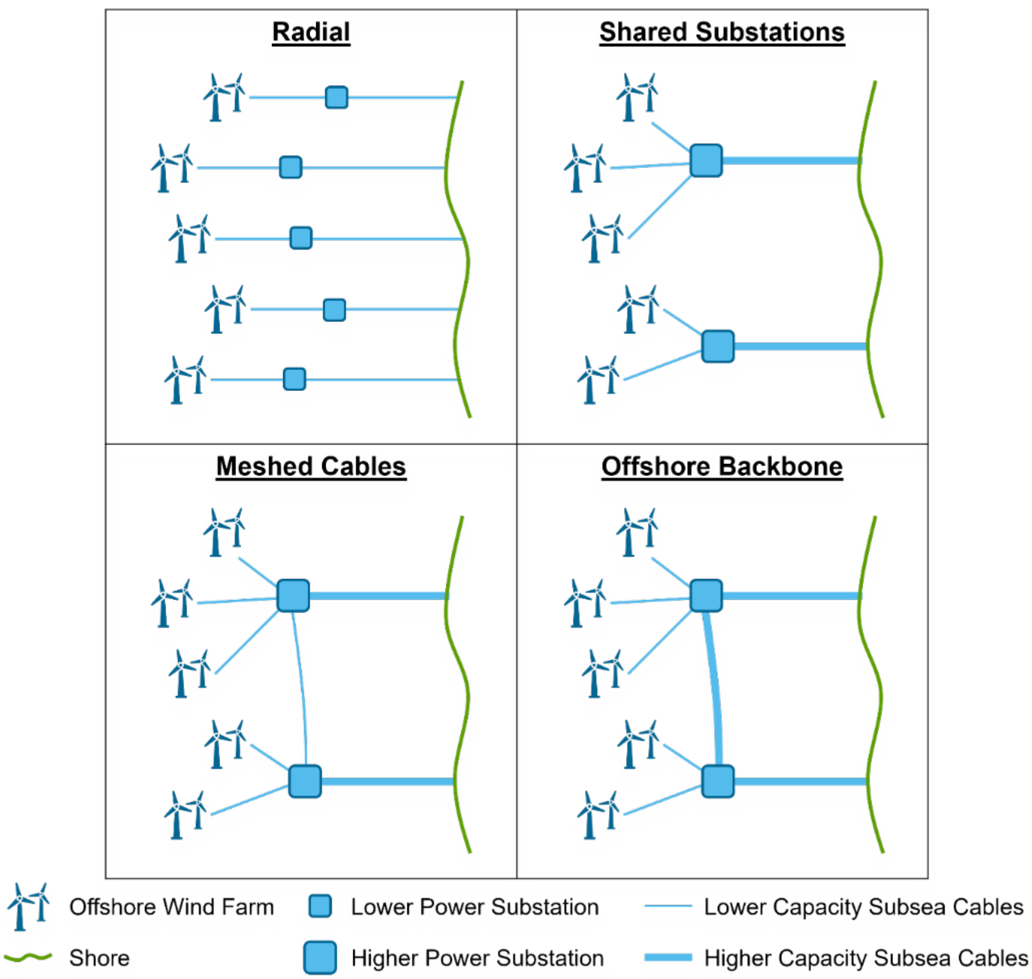
207 Aker Solutions is developing subsea substations and claim their technology will be available for procurement by 2024.

Offshore Wind Interconnection Concepts

As offshore wind developments expand globally, grid operators have explored concepts for interconnecting multiple wind projects or farms offshore with the onshore energy system. Most offshore wind projects to date are connected to shore radially using point-to-point transmission lines that export power directly from offshore to onshore substations. More networked interconnection concepts such as shared substations, meshed grids, and offshore backbones can increase reliability and redundancy, allow for increased offshore wind build-out and interconnection between different regions and markets, and provide onshore grid benefits. **Figure 8-3** shows four offshore wind farm interconnection concepts, increasing in degree of connectivity from radial, to shared substations, to meshed cables, to a complete offshore backbone with high-capacity cables connecting offshore substations. The California ISO has indicated that the early phases of offshore wind projects on the North Coast are expected to be radially connected to one or two onshore substations at Humboldt and Del Norte, in a variation of the shared substations concept.

Figure 8-3: Offshore Wind Offshore Wind Farm Interconnection Concepts



Source: Guidehouse Assessment. 2023

The offshore substations can be HVAC or HVDC, and meshing can be achieved for either type of system, or a combination of both. However, meshed AC systems face limitations for transmission distance and cable corridor capacity, and meshed DC systems face technology readiness bottlenecks for dynamic cables, DC gas-insulated switchgear, and DC circuit breakers. Many of the meshed grid concepts that have been investigated thus far, including the Meshed Ready concept in New York, are meshed on the AC side of transmission, and use HVDC export cables to bring the power to shore. The *Guidehouse Assessment* reviews three studies on meshed offshore grids for integration of offshore wind, in New York, New Jersey, and Great Britain.

Meshed and backbone systems provide more resilience and redundancy in the offshore transmission system, allowing for power to be evacuated via connected offshore substations in the case of an export cable failure or other fault.[208] Use of high-capacity DC export cables can maximize the potential of cable corridors and allow for continued expansion of offshore wind generation capacity. However, meshed systems require a higher upfront investment, strong policies on transmission development, and coordination among offshore wind and transmission developers. Additionally, many supporting systems and technologies for meshed grid systems are still in development. These include vendor- and technology-neutral requirements to allow for interoperability and compatibility between technologies, standardized communication protocols and a DC grid code, DC grid protection and fault clearing strategies, and HVDC circuit breakers.

HVDC circuit breakers are a key emerging technology that will be necessary for meshed DC grids and multi-terminal DC links. Existing point-to-point HVDC connections do not have protection schemes in place, so any HVDC fault takes out the entire HVDC link and the fault is isolated by the HVAC breakers on each side of the converters. Implementing a DC grid protection scheme requires use of a combination of DC circuit breakers, full-bridge converters, or other fault current limiters. DC circuit breakers are switching devices that interrupt the flow of normal and abnormal direct current.[209] DC circuit breakers are a relatively new technology that differs from their AC counterparts. They have been demonstrated in Europe but have not yet been used at the transmission level and are not yet commercially available.

The lack of availability of DC circuit breakers and their large size are two major challenges for meshed grids and offshore DC applications. Policy direction can facilitate the development of

208 Using shared substations helps avoid crowding cable corridors, but both radial and shared substation configurations offer little resilience in the case of a cable failure, as the failure of a single cable can put an entire wind farm offline, or multiple wind farms in the case of an export cable failing in a shared substation configuration.

209 Because DC transmission does not have natural zero current crossings like AC, DC circuit breakers are necessary to allow healthy branches of an HVDC system to remain in service after a fault in the larger system. Full-bridge converters can control the voltage down to zero to isolate a fault but cannot act as a circuit breaker.

meshed interconnection strategies to reduce financial risk for new offshore wind development, increase overall system reliability, and enable the offshore wind market to grow.

Transmission Technology Findings

Through literature review and interviews with developers, the Guidehouse Assessment identified the following key technology gaps and pain points for the development of California's first round of offshore wind area development and for long-term offshore wind build-out.[210]

- Technologies needed to enable transmission of floating, deep-water offshore wind projects are still emerging. These include dynamic and higher capacity export cables and floating substations.
    - Dynamic cables are not yet available at the level of capacity or voltage rating necessary to support California offshore wind. Dynamic cabling technology exists for lower voltage HVAC applications, but HVDC dynamic cables do not yet exist in any form.
    - There is limited precedence for floating substations. Existing offshore wind substations thus far have all been fixed bottom, with the exception of one floating offshore substation that was demonstrated but decommissioned in 2021.
- Supply chain constraints and availability of key technologies at scale are key considerations for developers. Developers expressed confidence in the technological feasibility of offshore wind transmission technologies, but anticipated supply chain challenges as demand for transmission technologies ramps up.
- Developers identified onshore grid constraints that present challenges to the interconnection of the first round of offshore wind build-out in California. Specifically, developers singled out transmission constraints and uncertainties in the Humboldt and Morro Bay WEAs.
- Developers strongly encouraged proactive, state-led planning for long-term offshore transmission needs. Developers were generally in favor of meshed grids as a long-term transmission strategy. However, a meshed system requires collaborative and centralized planning, and developers stressed the need and opportunity for a central transmission solution led by the state, rather than a piecemeal approach as has been the case on the East Coast.

210 Pain points are specific problems, obstacles, or complications faced by current or prospective customers that make things difficult in the marketplace.

The Existing North Coast Transmission System

Having sufficient transmission is critical to delivering offshore wind energy generation to Californians. The challenge in developing transmission to deliver wind resources from the North Coast is that the existing system serves only relatively small local loads and does not have an interconnection to the major existing transmission paths in California that run North and South through the state. The following section discusses the existing transmission systems, as well as options to upgrade and associated costs.

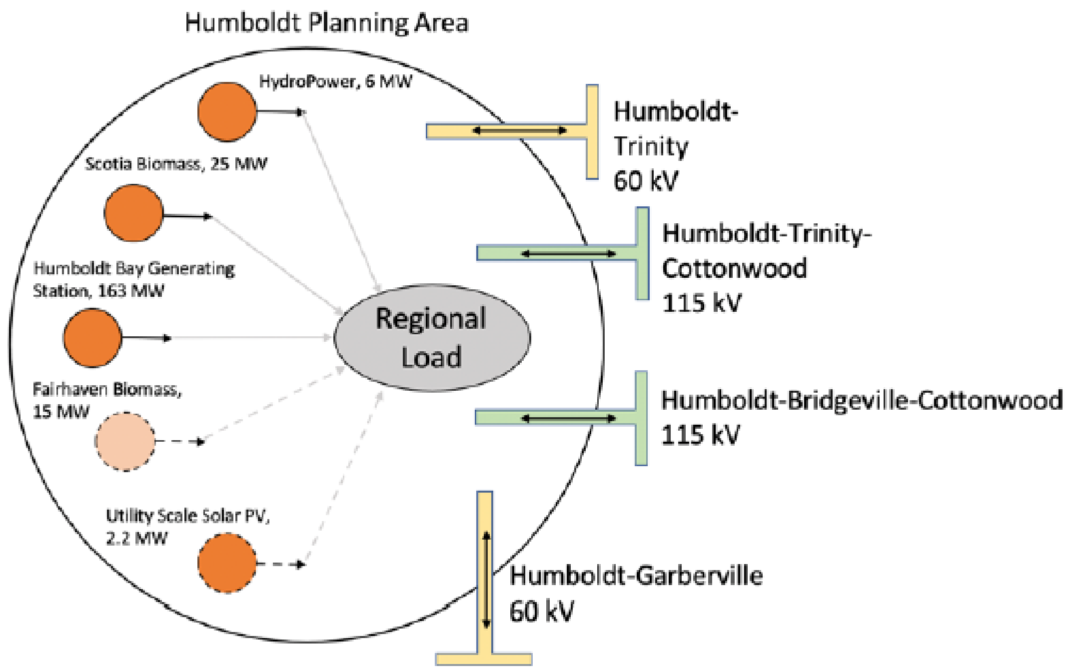
The existing transmission system onshore from the Humboldt WEA is constrained and will not be able to accommodate large amounts of offshore wind energy coming into and out of the area. The current system consists of 60 kV and 115 kV transmission facilities and multiple generation sources that include natural gas, biomass, solar, and hydroelectric power plants, shown in **Figure 8-4**.[211] There are four, 80 to 100 miles long transmission circuits; two 115 kV circuits and one 60 kV circuit that run along an east-west corridor from the Cottonwood substation and one 60 kV circuit runs north-south from the Mendocino substation.[212] A study by Schatz Energy Research Center (Schatz) concluded that one or more small commercial wind projects that are scaled to match local loads and transmission capacity would require only modest investments in new transmission infrastructure. Detailed analysis indicated the largest wind projects that could be connected with full capacity deliverability without requiring upgrades to the existing transmission system is approximately 30 MW.[213] The study concluded that the largest energy-only project that could be connected to the regional electrical grid without requiring transmission system upgrades is on the order of 174 MW. Wind energy capacity beyond the 30 MW size with full capacity deliverability would require transmission upgrades.

211 Jacobson, Arne, Jim Zoellick, Zach Alva, Charles Chamberlin, Greg Chapman, Andrew Harris, Amin Younes, et al. March 2022. *Transmission Alternatives for California North Coast Offshore Wind, Volume 1: Executive Summary.* OCS Study BOEM 2022-016. Available at http://schatzcenter.org/pubs/2022-OSW-R1.pdf.

212 The power plants in the region, including the Humboldt Bay Generation Station and other local power plants, serve the regional load of about 90-100 MW.

213 Full capacity deliverability means the transmission system must be capable of accepting the full output that the power plant is expected to deliver at all times. Energy-only deliverability means the full output of the power plant cannot be accommodated and as a result output from the plant must be curtailed.

Figure 8-4: Simplified Schematic of Humboldt's Transmission System



Source: Jacobson et al. 2022

Schatz provided estimates of transmission upgrade costs for offshore wind projects in the Humboldt WEA with full deliverability of 144 MW ranging from $170 to $240 million; 288 MW at $330 million; and 480 MW ranging from $590 to $1,120 million.[214] Another study estimated upgrade costs ranging from $365 million for the low estimate of a 48 MW wind project up to $5,000 million for a 1,836 MW wind project.[215]

Other areas off California's northern coast from Mendocino north to the Oregon border have strong wind speeds that offer substantial opportunity for developing offshore wind. A recent study of offshore wind compared wind resources and power generation of hypothetical wind projects in the Cape Mendocino area, Crescent City area, and Humboldt.[216] The preliminary

214 Jacobson, Arne, Jim Zoellick, Zach Alva, Charles Chamberlin, Greg Chapman, Andrew Harris, Amin Younes, et al (Schatz Energy Research Center). March 2022. *Transmission Alternatives for California North Coast Offshore Wind, Volume 1: Executive Summary.* OCS Study BOEM 2022-016. Available at http://schatzcenter.org/pubs/2022-OSW-R1.pdf.

215 Severy, Mark, Zachary Alva, Gregory Chapman, Maia Cheli, Tanya Garcia, Christina Ortega, Nicole Salas, et al. (Schatz Energy Research Center). September 2020. *California North Coast Offshore Wind Studies: Interconnection Feasibility Study Report*. Available at http://schatzcenter.org/pubs/2020-OSW-R4.pdf.

216 Chapman, Gregory, Ian Guerrero, Arne Jacobson, Nicole Salas, Amin Younes, and Jim Zoellick (Schatz Energy Research Center). May 2021. *Del Norte County Offshore Wind Preliminary Feasibility Assessment: Final Report*.

analysis, showed that the area offshore Cape Mendocino had the most powerful wind on average, providing 10 to 11 percent more energy than the Humboldt WEA and 5 percent more than the Crescent City area. The study assessed the compatibility of offshore wind in these areas with regional electric load. It suggests that within existing transmission constraints a significant fraction of energy from a theoretical 48 MW wind projects could be used within Del Norte County, at a scale of 144 MW most of the generation would be exported, and at even larger scales most of the generation would be curtailed.

The transmission system in Del Norte County is also limited as it was designed to serve a relatively low regional electricity load.[217] The main interconnection in the area is provided by two 115 kV lines running northeast into Oregon, as part of the PacifiCorp transmission network. These lines connect to 500 kV lines in Grants Pass, Oregon. According to the study PacifiCorp described the transmission as a fairly weak system with relatively light loads at the end of a radial transmission path.[218] The study suggests that an interconnection at Crescent City might accommodate an offshore wind project to about 110 MW peak capacity. For larger wind projects significant transmission upgrades are needed. The study notes that this transmission system is not within the California ISO balancing area and using any portion of the Pacific Power transmission, even portions located on the California side of the border, would prevent power from being delivered into the California ISO.[219] The study indicates building transmission infrastructure to enable interconnection at a point in the California ISO would likely add substantial expense and may require and undersea cable, but further study of interconnection options is needed. An economically viable offshore wind project likely needs access to wholesale electricity markets and the study suggests opportunities are more favorable in the California ISO balancing area.

A concept level assessment of an approximately 1,800 MW high voltage direct current (HVDC) transmission cable from Humboldt Bay to deliver offshore wind to load centers in the San Francisco Bay area was conducted in 2020 to present options and document routing hazards

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Available at https://www.ccharbor.com/files/e947de255/HSU+Schatz+Center+Offshore+Wind+Study+May-31-2021.pdf.

217 Ibid. The peak load in Crescent City is just under 40 MW in summer and under 60 MW in winter, with the light load periods typically less than half the peaks.

218 PacifiCorp indicates that significant generation interconnection at the transmission level could cause voltage stability issues.

219 PacifiCorp's transmission system is managed by Pacific Power and markets transmission services using an Open Access Same-Time Information System (OASIS). To deliver power into the California ISO they must pay an import transmission access charge, increasing costs of offshore wind generated electricity.

and constraints.[220] The use of HVDC, rather than HVAC transmission, was assumed as it will likely be the preferred option to minimize electrical losses, as the distance between the two points is on the order of 250 miles.[221] In addition to the cable system, an HVDC converter station is needed at each end of the transmission cable to convert the power for use in the standard AC grid system. The study notes that while there aren't technical limits to the length of HVDC line, with technology available at the time the cables could only be deployed as links, rather than a network of cables. In fact, long-distance HVDC has been used to move power north and south on the U.S. West Coast, from Canada to California since the 1970s.[222]

North Coast Transmission Alternatives and Costs

As previously mentioned, the Northern California coastal loads are relatively small with limited transmission infrastructure to serve local needs. As a result, significant transmission system upgrades will be required to export gigawatts (GWs) of offshore wind energy from the Humboldt area to major load centers in the state. To assess viable transmission alternatives that could feasibly interconnect gigawatt-scale offshore wind energy projects off the coast of California and Oregon, the Schatz Energy Research Center (Schatz) was contracted by the CEC, with grant funding from the Department of Defense, to conduct a transmission assessment, referred to as the Schatz Study.[223] Schatz has been engaged in planning and feasibility studies related to offshore wind development and transmission since 2019.[224] A focus for this study is mapping and analyzing transmission alternatives considering constraints for military testing, training, and operations to avoid and prevent encroachment of incompatible development from renewable energy projects. The goal of the current Schatz Study is to explore a broad range of possible transmission solutions, rather than identify an optimal transmission solution.

The Schatz Study assesses multiple offshore wind geographic locations and various transmission solutions for regional offshore wind development ranging from 7.2 GW to 25.8

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220 Porter, Aaron, and Shane Phillips (The Mott MacDonald Group). September 2020. *California North Coast Offshore Wind Studies: Subsea Transmission Cable Conceptual Assessment*. Schatz Energy Research Center. Available at http://schatzcenter.org/pubs/2020-OSW-R5.pdf.

221 Electric power can be transmitted through high voltage alternating current (HVAC) or high voltage direct current (HVDC) transmission lines. In HVAC systems transformers are used to step-up or down the voltage for delivery from generators to end-users and voltage in the lines fluctuates. The voltage in HVDC systems does not fluctuate or require intermediate substations. The HVDC system allows for flow control and involves fewer losses.

222 The Pacific Intertie DC lines carry up to 3,100 MW of electricity and from the Celilo substation, near The Dalles Dam in Oregon, to Sylmar, California, near Los Angeles.

223 Zoellick, James, Greyson Adams, Ahmed Mustafa, Aubryn Cooperman, et al. 2023. *Northern California and Southern Oregon Offshore Wind Transmission Study*. Schatz Energy Research Center. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=252604.

224 Previous Schatz Energy Research Center studies are available at http://schatzcenter.org/publications/.

GW within the study area. The five offshore wind study areas examined within the scope of the study area, from north to south, the Coos Bay Call Area, the Brookings Call Area, the Del Norte planning area, the Humboldt WEA, and the Cape Mendocino planning area.[225]

To determine the generation potential of the offshore wind study areas, Schatz identified potential restrictions for each study area beyond military mission compatibility. These restrictions include seafloor conditions, seismic conditions, ecological habitat, migratory species protections, species of special concern, shipping lanes, fishing grounds, and technical feasibility.[226] Schatz assumed the Humboldt WEA does not have identified restrictions in the study and is assumed to be fully developable. The Del Norte and Cape Mendocino planning areas have significant restrictions and are assumed to be only 50 percent and 20 percent developable areas, respectively. An overview of these restrictions and developable areas can be found in **Table 8-3.**

Table 8-3: Restrictions and Developable Areas

California Offshore Wind Study Area	Unrestricted Area (square mile)	Developable Area (square mile)	Developable Area (percent)	Current Possible Restrictions
Del Norte	1,061	531	50%	PAC-PARS,[227] Coral and Sea Sponge restrictions
Humboldt	206	206	100%	n/a
Cape Mendocino	2,399	480	20%	PAC-PARS, Mendocino Ridge Fish Habitat Conservation Area, undersea canyon restrictions

Source: CEC based on Schatz Study. 2023

225 Both the Del Norte and Mendocino potential areas are not delineated by BOEM but were identified in AB 525 Workshop: Identifying Additional Suitable Sea Space and Assessing Impacts and Mitigations for Offshore Wind Energy Development available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250471.

226 Zoellick, James, Greyson Adams, Ahmed Mustafa, Aubryn Cooperman, et al. 2023. *Northern California and Southern Oregon Offshore Wind Transmission Study*. Schatz Energy Research Center. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=252604.

227 The Pacific Port Access Route Study (PAC-PARS) is a comprehensive evaluation of maritime traffic patterns along the U.S. Pacific Coast being conducted by the U.S. Coast Guard (USCG). The USCG published the study draft in August 2022 and received public comments thru October 2022, the final report is forthcoming. The restrictions for the offshore wind areas are based on the draft PAC-PARS study.

The Pacific Coast Port Access Route Study Draft Report is available at https://www.navcen.uscg.gov/sites/default/files/pdf/PARS/PAC_PARS_22/Draft%20PAC-PARS.pdf.

Schatz then combined these restrictions and applied a power density factor (MW per square mile) to identify scaled development scenarios for potential offshore wind generation.[228] As shown in **Table 8-4**, the scenarios assume differing levels of offshore wind development in various study areas. For California, the low scenario includes 2.1 GW of development in the Del Norte planning area, 2.0 GW in the Humboldt planning area, and no development in the Cape Mendocino planning area. The mid scenario includes two variations: 1) 6.7 GW in the Del Norte planning area, 2.6 GW in the Humboldt WEA, and no development in the Cape Mendocino planning area; and 2) 4.6 GW in the Del Norte planning area, 2.6 GW in the Humboldt WEA, and 2.1 GW in the Cape Mendocino planning area. The high scenario includes 7.0 GW in the Del Norte planning area, 2.7 GW in the Humboldt WEA, and 6.3 GW in the Cape Mendocino planning area. A map of the offshore wind study areas is shown in **Figure 8-5**.

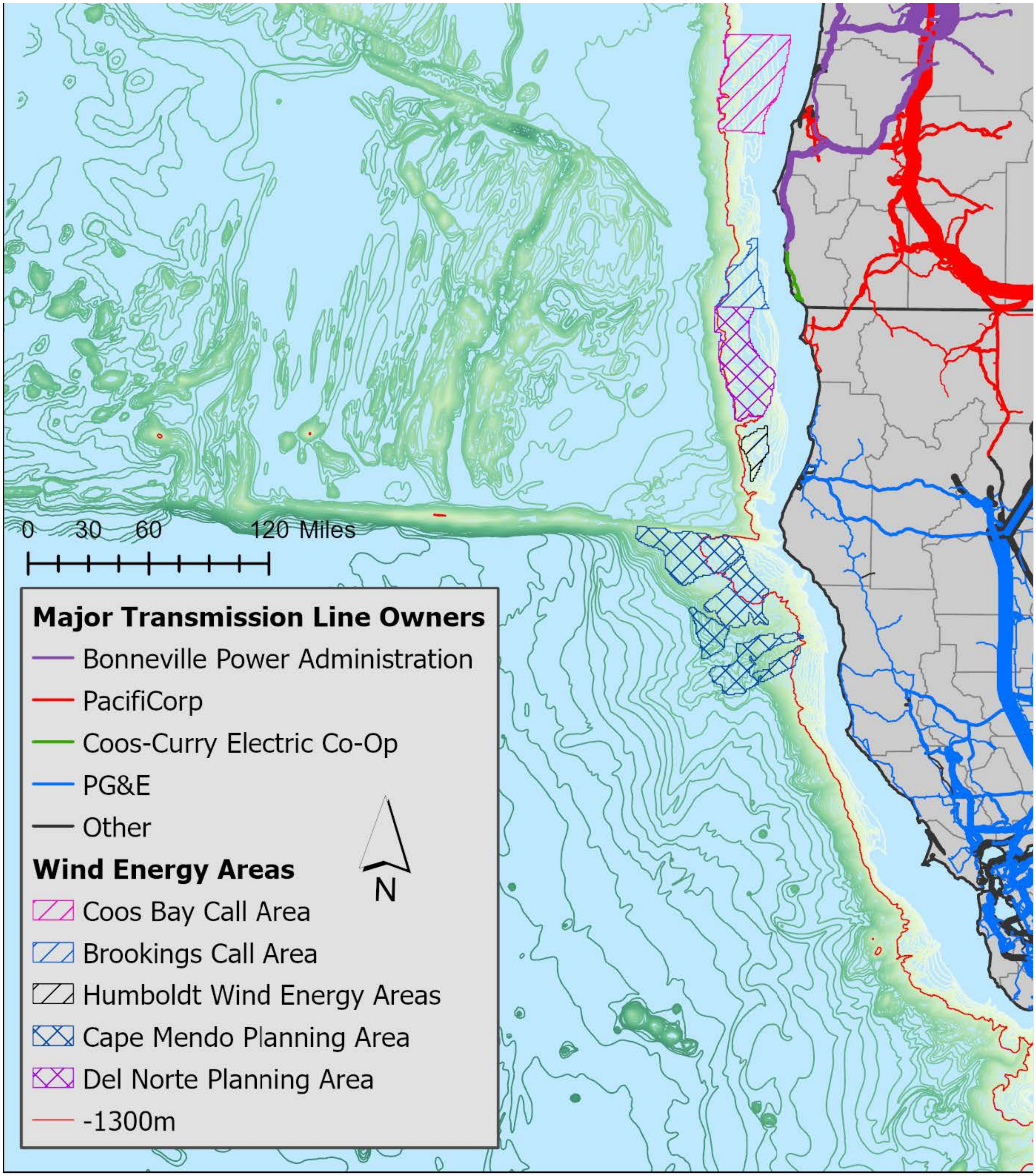
228 Schatz worked with project partners, national laboratories, industry professionals, as well as utility and agency staff to determine a viable industry power density of 13.1 MW per square mile. The estimated power density assumes 15 MW turbines and would vary based on actual turbine layouts.

Table 8-4: Offshore Wind Development Scenarios

Development Scenario	Wind Area	Nameplate GW Output Capacity	Total OR (GW)	Total CA (GW)	Total OR + CA (GW)
Low	Coos Bay	1.3	3.1		7.2
	Brookings	1.8			
	Del Norte	2.1		4.1	
	Humboldt	2.0			
	Cape Mendocino	0.0			
Mid	Coos Bay	1.3	3.1		12.4
	Brookings	1.8			
	Del Norte	6.7		9.3	
	Humboldt	2.6			
	Cape Mendocino	0.0			
Mid	Coos Bay	1.3	3.1		12.4
	Brookings	1.8			
	Del Norte	4.6		9.3	
	Humboldt	2.6			
	Cape Mendocino	2.1			
High	Coos Bay	3.9	9.8		25.8
	Brookings	5.9			
	Del Norte	7.0		16.0	
	Humboldt	2.7			
	Cape Mendocino	6.3			

Source: Schatz Study. 2023

Figure 8-5: Map of the Offshore Wind Areas Studied



Source: Schatz Study. 2023

Schatz Regional Transmission Alternatives

The transmission alternatives below were selected to capture a range of technologies and to illustrate the amounts of potential transmission needed to meet different levels of offshore wind development. When developing offshore wind energy generation adjacent to the constrained and remote load centers on the North Coast, it is crucial to explore a range of both overland and subsea transmission options. All transmission line routes proposed are for planning purposes only and generally follow existing rights-of-way.

Schatz created 10 transmission alternatives specific to the Northern California and Southern Oregon transmission systems. The different transmission alternatives include overland transmission, subsea transmission, HVAC, and HVDC options. To conduct the transmission analysis, Schatz used the Western Electricity Coordinating Council (WECC) year 2032 anchor data set and followed standard transmission planning methodologies to meet North American Electric Reliability Corporation (NERC) Reliability Standards, WECC Regional Criteria, [229] and California ISO Planning Standards.[230]

Schatz then conducted a steady-state power flow reliability analysis (using the summer peak case) and a production cost study. Schatz also assessed the cost and benefits of each alternative, and performed a high-level feasibility assessment exploring the potential siting and environmental challenges that might be encountered.

While the study examines transmission alternatives for developing offshore wind resources in both Northern California and Southern Oregon, this section focuses on transmission alternatives explored for the North Coast of California. Of the 10 transmission alternatives, five are explored in more detail in this chapter: two low development alternatives, two mid development alternatives, and one high development alternative.

Transmission Alternative 7.2a

The first alternative, Alternative 7.2a, is a low development scenario that uses an offshore wind HVAC radial interconnection layout and excludes the Cape Mendocino planning area. Partial buildouts of the Humboldt WEA, Del Norte planning area, Brookings and Coos Bay Call Areas are included. In this development scenario, the Humboldt WEA generates 2.0 GW and the Del Norte planning area generates 2.1 GW for a total of 4.1 GW of offshore wind energy generated off the Northern California coast. The remaining 3.1 GW of offshore wind are generated in the Oregon Call Areas. **Figure 8-6** shows an interconnection map for Alternative 7.2a.

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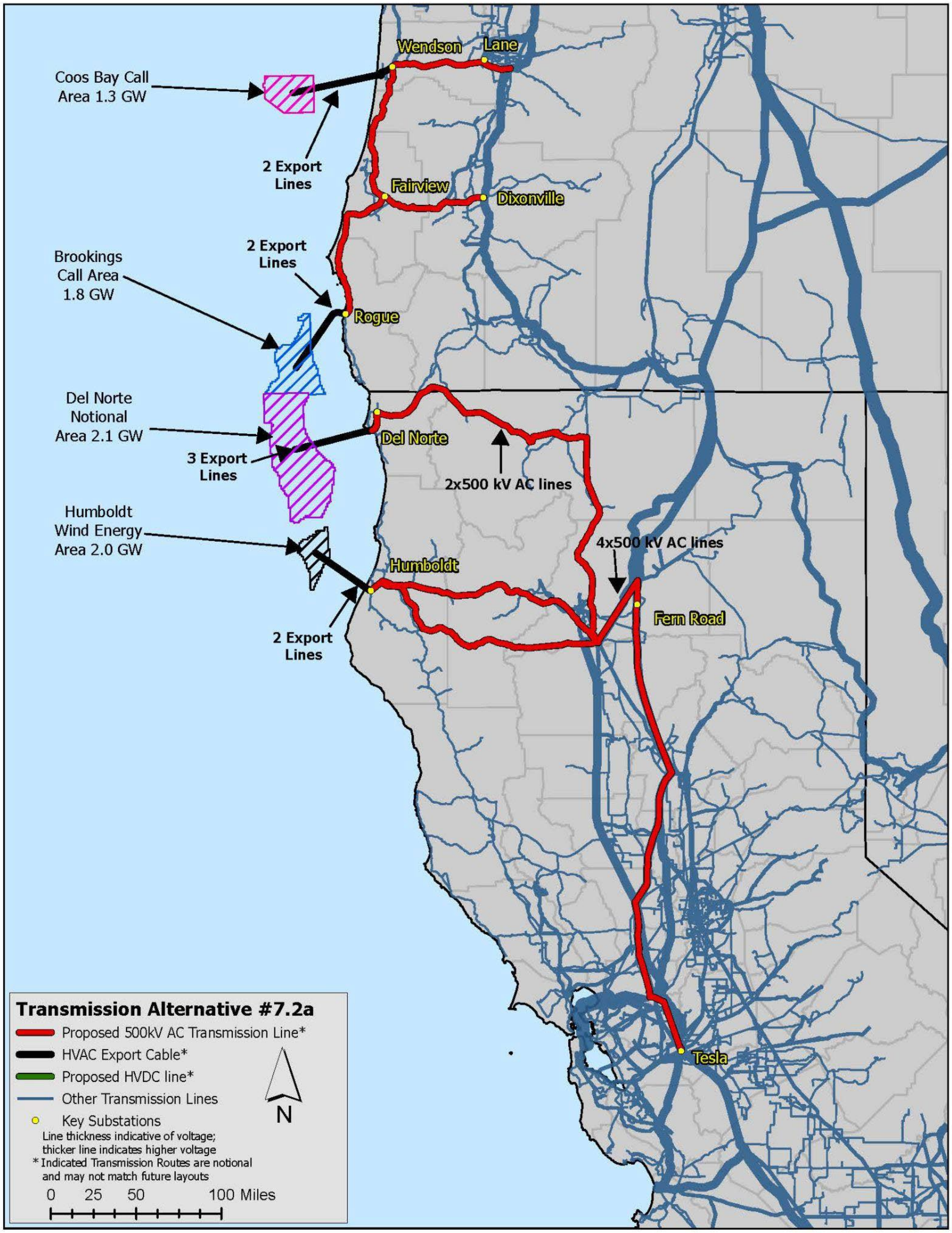
229 Current NERC Reliability Standards are available at https://www.nerc.com/pa/Stand/Pages/default.aspx. Current WECC Regional Criteria are available at https://www.wecc.org/Standards/Pages/default.aspx.

230 Current California ISO Planning Standards are available at https://www.caiso.com/Pages/documentsbygroup.aspx?GroupID=D507226B-5552-4919-B133-FB0C126D8147.

Figure 8-6: North Coast Transmission Alternative 7.2a (Low Scenario – 500 kV AC Layout)



Source: Schatz Study. 2023

For this transmission alternative 7.2a, the Oregon and California transmission systems are separated along state boundaries.[231] For the California grid, electricity from the Del Norte planning area would come ashore via three HVAC export cables to a new Del Norte 500 kV substation. Similarly, electricity from the Humboldt WEA would come ashore via two HVAC export cables to a new Humboldt 500 kV substation. Two 500 kV transmission lines would interconnect the Del Norte substation to the existing Fern Road substation; two 500 kV transmission lines would interconnect the new Humboldt substation to the Fern Road substation. The cost of this alternative is estimated at approximately $7.51 billion, with the California portion estimated at $5.09 billion. The feasibility assessment for this alternative indicates a high level of difficulty to develop the northernmost 500 kV transmission pathway interconnecting the new Del Norte substation to the Fern Road substation.[232]

Transmission Alternative 7.2b

Alternative 7.2b is similar to 7.2a in that it is also a low development scenario that maintains the same offshore wind generation assumptions and intrastate grid separation, and also excludes the Cape Mendocino planning area. However, Alternative 7.2b uses radial connections via 500 kV AC export cables between the proposed offshore wind projects and nearby onshore substations. For the California grid, electricity would come ashore via HVAC export cables and be provided to local communities via new 500 kV substations onshore in Humboldt and Del Norte. To avoid the restrictive Del Norte transmission pathway to the Fern Road substation noted in Alternative 7.2a above, the Del Norte substation would route electricity to and from the Humboldt substation via onshore HVDC conversion stations and dual HVDC subsea cables. To interconnect the new Del Norte and Humboldt substations, HVDC cables would originate onshore, travel offshore in the Pacific Ocean, and then return onshore.[233] The Humboldt substation would also connect a single 500 kV transmission line to the Fern Road substation. Additionally, the Humboldt substation would route electricity to the Collinsville 500 kV substation via an onshore HVDC conversion station and an overland HVDC transmission line. The cost of this alternative is estimated to be $10.13 billion, with the California portion estimated at $7.25 billion. The feasibility assessment for this alternative indicates varying degrees of development difficulty (from low to high) along the different transmission pathways while avoiding the most restrictive transmission pathways. **Figure 8-7** shows an interconnection map for Alternative 7.2b.

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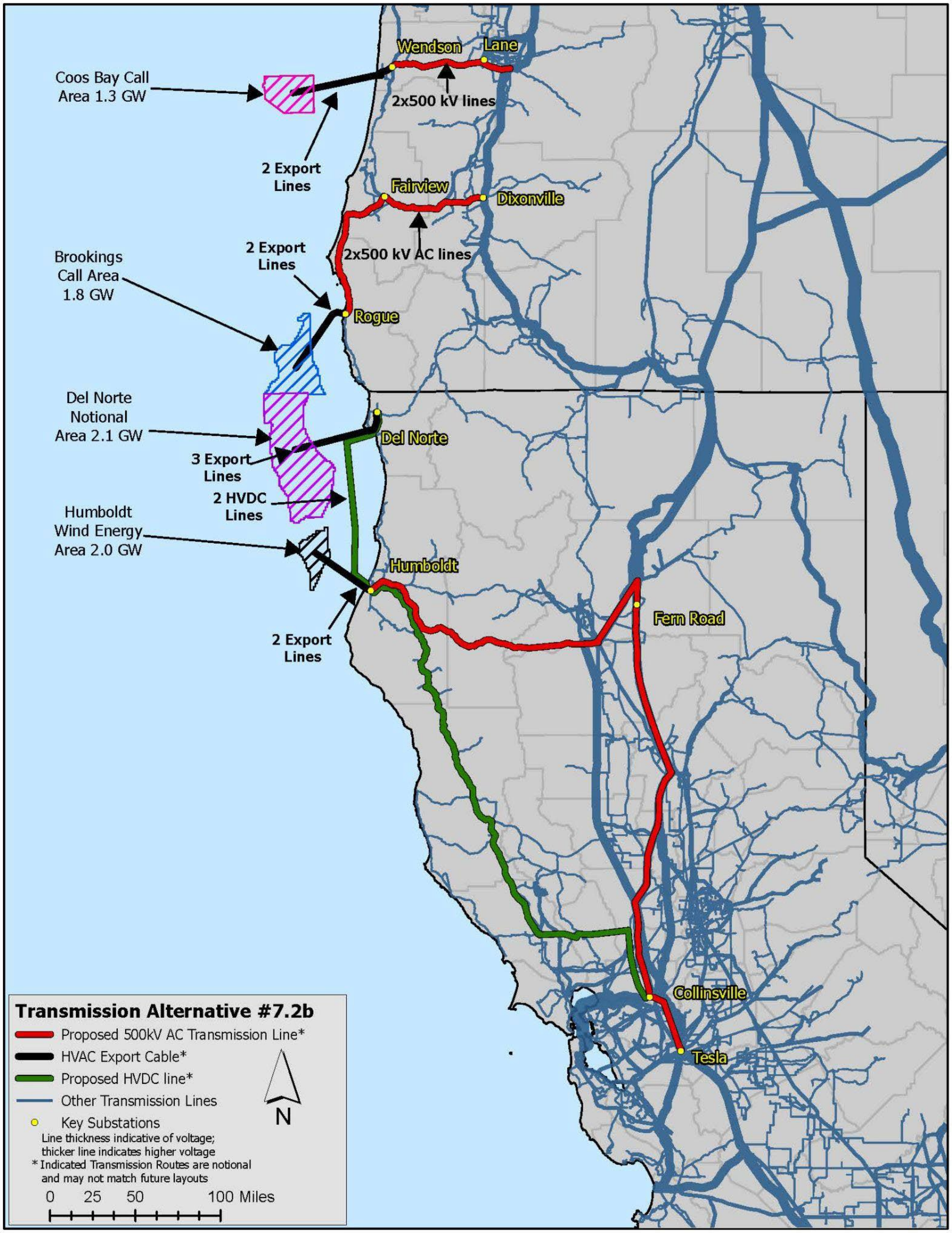
231 Currently the PG&E electric service area and the California ISO balancing area exclude Del Norte county. Coastal Del Norte electric service is provided by Pacific Power, an Oregon investor-owned electric utility, and regulated by the Oregon Public Utility Commission.

232 The transmission pathway from Del Norte to Fern Road would traverse the Redwood National and State Parks as well as the Klamath National Forest which presents significant environmental permitting challenges.

233 An overland HVDC interconnection between Del Norte and Humboldt substations is viewed as having insurmountable challenges due to the geographic areas.

Figure 8-7: North Coast Transmission Alternative 7.2b (Low Scenario – HVAC and HVDC Lines with HVDC Conversion Stations)



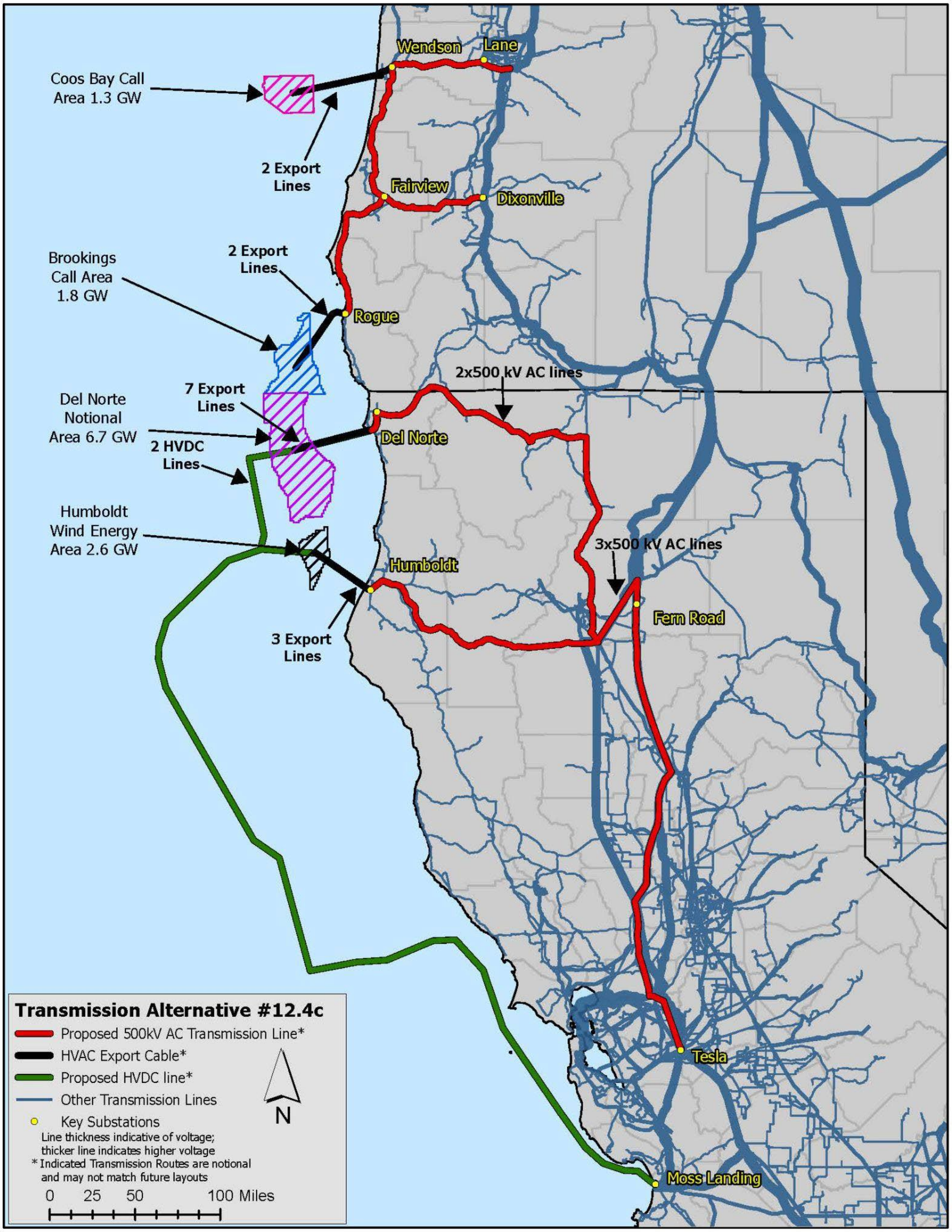
Source: Schatz Study. 2023

Transmission Alternative 12.4c

Alternative 12.4c is a mid-range development scenario that excludes the Cape Mendocino planning area. The scenario includes nearly full buildouts of the Humboldt WEA and Del Norte planning area, along with partial buildouts of the Brookings and Coos Bay Call Areas. The Humboldt WEA generates 2.6 GW and the Del Norte planning area generates 6.7 GW, for a total of 9.3 GW of offshore wind energy generated off the Northern California coast. The remaining 3.1 GW are generated in the Oregon Call Areas.

For Alternative 12.4c, the Oregon and California transmission systems are separated along both offshore and onshore state boundaries. For the California grid, a combination of existing and emerging technologies, such as floating offshore HVDC conversion stations, are used. Electricity from the Del Norte planning area would come ashore via seven HVAC export cables to a Del Norte 500 kV substation. Similarly, electricity from the Humboldt WEA would come ashore via three HVAC export cables to a Humboldt 500 kV substation. Two HVAC transmission lines would connect from the Del Norte substation to the Fern Road substation; one HVAC transmission line would interconnect the Humboldt substation to the Fern Road substation. The Del Norte planning area and Humboldt WEA would interconnect with floating HVDC conversion stations and HVDC export cables. Additionally, a long distance undersea HVDC cable would interconnect the Humboldt WEA to the existing Moss Landing substation. The cost of Alternative 12.4c is estimated to be $17.79 billion, with the California portion estimated at $15.10 billion. The feasibility assessment for Alternative 12.4c indicates the highest level of difficulty for development for the overland Del Norte to Fern Road pathway as well as the undersea pathway from south of Cape Mendocino to the Moss Landing substation. The difficulty of the remainder of the undersea pathway north of Cape Mendocino would be high, but less restrictive than the overland pathway from Del Norte to Fern Road substation. **Figure 8-8** shows an interconnection map for Alternative 12.4c.

Figure 8-8: North Coast Transmission Alternative 12.4c (Mid Scenario – Offshore HVDC Conversion Stations with Subsea Cable Plus HVAC)

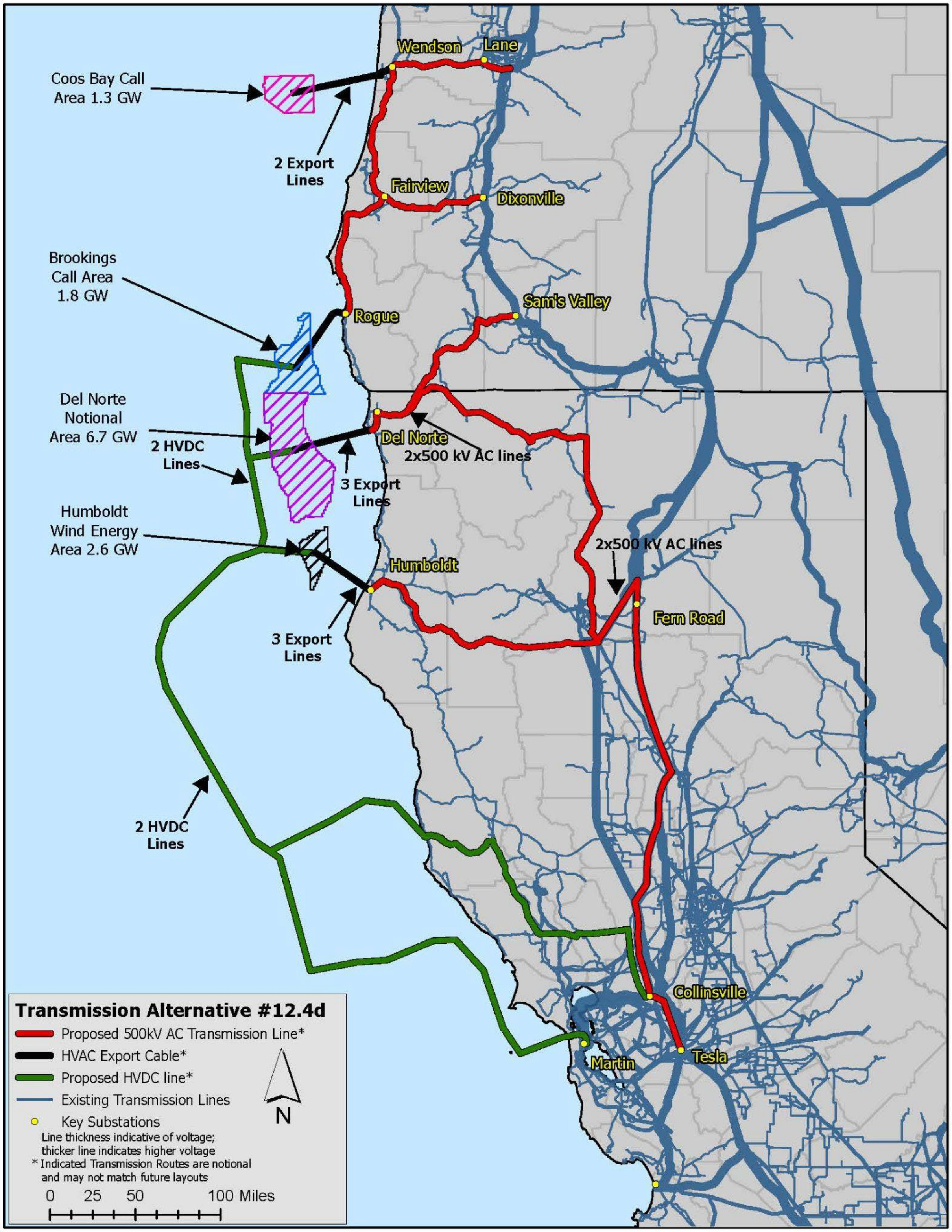


Source: Schatz Study. 2023

Transmission Alternative 12.4d

Alternative 12.4d is a mid-range development scenario that excludes the Cape Mendocino planning area, keeps the same generation assumptions as Alternative 12.4c, and includes a combination of existing and emerging technologies. Electricity from the Del Norte planning area would come ashore via a single HVAC export cable to a Del Norte 500 kV substation. Similarly, electricity from the Humboldt WEA would come ashore via three HVAC export cables to a Humboldt 500 kV substation. One HVAC transmission line would connect a Del Norte substation to the Fern Road substation; one HVAC transmission line would connect a Humboldt substation to the Fern Road substation. The California and Oregon transmission systems are connected via a 500 kV HVAC transmission line from a Del Norte substation to the existing Sams Valley 500 kV substation. The Del Norte planning area and Humboldt WEA would interconnect with floating HVDC conversion stations and HVDC export cables. Additionally, two long distance undersea HVDC export cables would interconnect the Humboldt WEA to the existing Collinsville substation and then to the San Francisco Bay Area. The cost of this alternative is estimated at $21.60 billion, with the California portion estimated at $17.88 billion. The feasibility assessment for this alternative indicates the highest level of difficulty for development of the overland Del Norte to Fern Road pathway, Del Norte to Sam’s Valley pathway, and the undersea pathway from south of Cape Mendocino to the Collinsville substation and San Francisco Bay area. High, but less restrictive, difficulties are indicated for the remainder of the undersea pathway north of Cape Mendocino. **Figure 8-9** shows an interconnection map for Alternative 12.4d.

Figure 8-9: North Coast Transmission Alternative 12.4d (Mid Scenario – Offshore HVDC Conversion Station with 2 Subsea Cables)



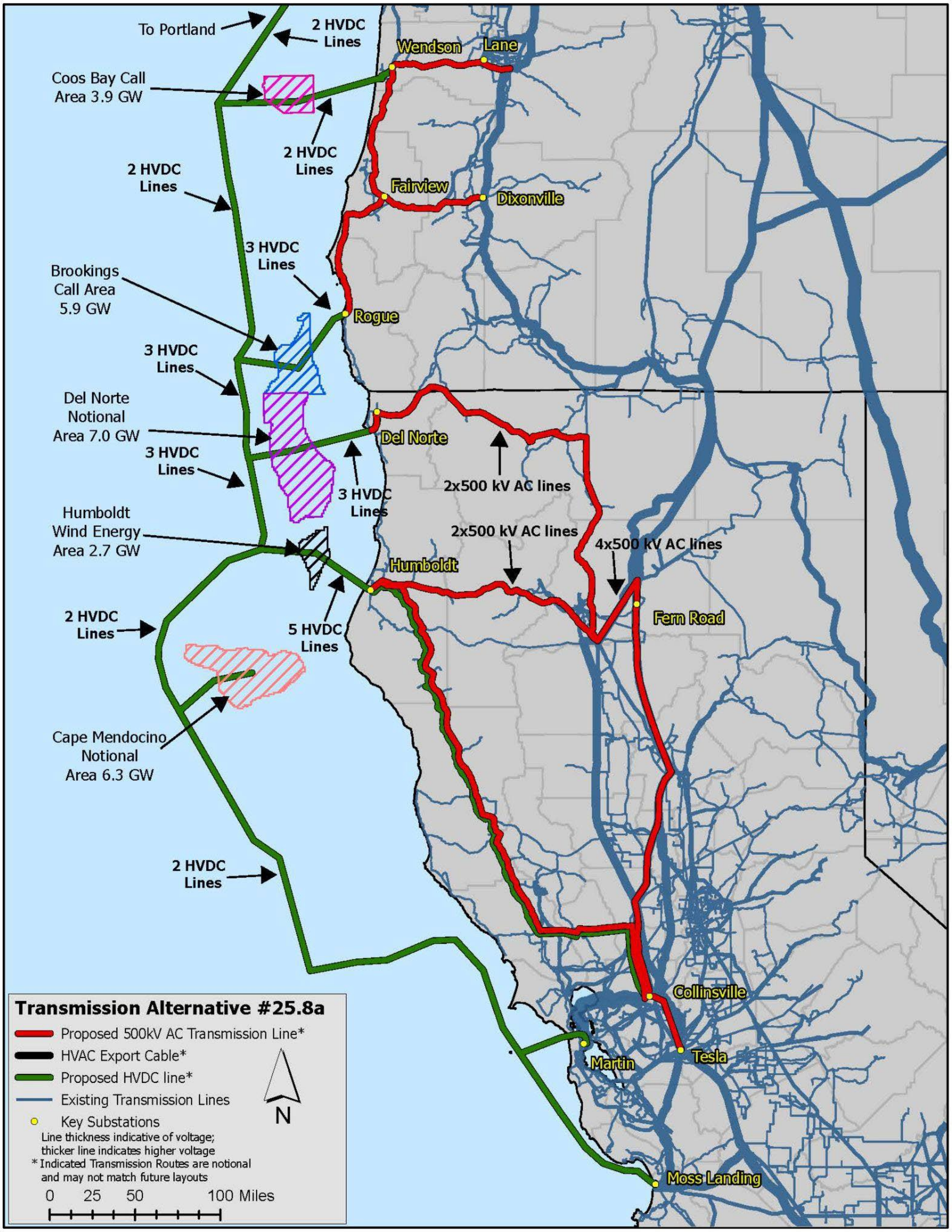
Source: Schatz Study. 2023

Transmission Alternative 25.8a

Alternative 25.8a is a high development scenario with the highest capacity of the alternatives and includes the Cape Mendocino planning area. It is the most technologically advanced alternative, using emerging technologies to create an HVDC backbone to interconnect much of the West Coast. It assumes full buildouts of the Cape Mendocino planning area, Humboldt WEA, Del Norte planning area, and the Brookings and Coos Bay Call Areas. The Cape Mendocino planning area generates 6.3 GW, the Humboldt WEA generates 2.7 GW, and the Del Norte planning area generates 7.0 GW, for a total of 16.4 GW generated off the Northern California coast. The remaining 9.8 GW are generated in the Oregon Call Areas.

For this transmission alternative, the Oregon and California transmission systems are separated onshore along state boundaries but are interconnected offshore between the Del Norte planning area and Brookings Call Area. Alternative 25.8a features the most robustly developed offshore network of the alternatives and makes use of HVDC infrastructure. An offshore HVDC backbone would interconnect all of the study areas and radial HVDC connections would connect to onshore substations. Electricity from the Del Norte planning area would come ashore via three HVDC export cables to a Del Norte 500 kV substation. Similarly, electricity from the Humboldt WEA would come ashore via five HVDC export cables to a Humboldt 500 kV substation. **Figure 8-10** shows an interconnection map for Alternative 25.8a.

Figure 8-10: North Coast Transmission Alternative 25.8a (High Scenario – HVDC Backbone California to Oregon)



Source: Schatz Study. 2023

Two HVAC transmission lines would use the pathway from a Del Norte substation to the Fern Road substation; two HVAC transmission lines would interconnect a Humboldt substation to the Fern Road substation. Additionally, a Humboldt substation would route electricity to a Collinsville 500 kV substation via an onshore HVDC conversion station and an overland HVDC transmission line as well as an additional HVAC transmission line (for grid redundancy). Two long-distance undersea HVDC export cables would interconnect the Cape Mendocino planning area the Martin substation in San Francisco Bay Area and further south to the existing Moss Landing substation. Two long distance undersea HVDC export cables would also interconnect the Coos Bay Call Area to the Portland area. The cost of Alternative 25.8a is estimated to be $41.35 billion, with the California portion estimated at $27.40 billion. The feasibility assessment for this alternative indicates the highest level of difficulty for development of the overland Del Norte to Fern Road pathway and the undersea pathway from south of Cape Mendocino to the San Francisco Bay area and the Moss Landing substation. High difficulty, but less restrictive, is indicated for the remainder of the undersea pathway north of Cape Mendocino to the Humboldt WEA.

While these North Coast transmission alternatives vary widely in the amount of offshore wind development capacity, the transmission system configuration, and technologies deployed, the alternatives are similar in many ways, as shown in **Table 8-5**. For the California transmission system, all the study alternatives rely on new substations in Humboldt and Del Norte to interconnect coastal communities with the adjacent offshore wind generation. These substations and higher voltage transmission lines would represent significant improvements to transmission system infrastructure and generate widespread resiliency for the North Coast of California. Taken together, these transmission alternatives uniformly demonstrate that significant investments in transmission are necessary to enable the deployment of offshore wind at scale. Interconnection schematics for the five transmission alternatives can be found in **Volume III, Appendix D**.

Phased Transmission Implementation

A full-scale buildout of California's offshore wind resource to meet the planning goals that grow from 2-5 GW by 2030 to 25 GW by 2045 will require a long-term planning approach. This lengthy timeline provides an opportunity for California to chart a *least regrets* pathway for transmission that includes short-term investments to achieve the 2030 goals while also allowing for a long-term phased progression of transmission development to meet the 2045 goals.

The Schatz Study was not originally envisioned to provide a least regrets phased planning framework. However, the study did discuss the benefits of a phased approach and examined transmission alternatives that would minimize the potential for stranded transmission investments.

Table 8-5: North Coast Transmission Alternative Comparison

Transmission Alternative	Development Scenario Level	Total Generation Capacity (GW)	Interstate Grid Connection	Technologies Utilized	Cost Estimate (Billions)
Alternative 7.2a	Low	7.2	No	• HVAC radial • Floating HVAC substations	$7.51
Alternative 7.2b	Low	7.2	No	• HVAC radial • Floating HVAC substations • HVDC subsea cables • Onshore HVDC transmission	$10.13
Alternative 12.4c	Mid	12.4	No	• HVAC radial • Floating HVAC substations • HVDC offshore backbone • Floating HVDC converter stations • HVDC long distance export cable	$17.79
Alternative 12.4d	Mid	12.4	Yes - overland and offshore	• HVAC radial • Floating HVAC substations • HVDC offshore backbone • Floating HVDC converter stations • HVDC long distance export cables	$21.60
Alternative 25.8a	High	25.8	Yes - offshore	• HVDC offshore backbone • HVDC offshore mesh network • Floating HVDC converter stations • Onshore HVDC transmission • HVDC long distance export cables	$41.35

Source: CEC. 2023

For example, one phased progression pathway could step from Alternative 7.2 (low) to Alternative 12.4c (mid) and culminate in Alternative 25.8a (high). Similarly, a second phased progression pathway could step from Alternative 7.2a (low) to Alternative 12.4d (mid) and culminate in Alternative 25.8a (high). Minor adaptations in the transmission alternatives, such as retaining radial HVAC cables throughout the process, may be necessary to achieve a phased progression pathway that minimizes the potential for stranded transmission investments.

Stakeholder support for a phased transmission planning approach for offshore wind has been raised at in-person outreach meetings and in comments written in response to the AB 525 transmission workshop.[234] Benefits identified include a more streamlined implementation of development, meeting the current needs of coastal communities while achieved the 2030 offshore wind goals, cost savings, and reduced environmental impacts. Based on the potential benefits of a phased transmission planning approach, additional studies could help inform these future transmission development decisions.

Environmental Analysis of Transmission Alternatives

As part of the Schatz Study, H.T. Harvey & Associates performed a high-level feasibility assessment exploring potential siting and environmental challenges that might be encountered along segments of the routes for the transmission alternatives.[235] Both terrestrial and subsea segments were evaluated based on potential environmental and permitting or regulatory constraints.

To evaluate the segments, H.T. Harvey & Associates used spatial databases to identify environmental concerns and key permitting or regulatory constraints associated with transmission infrastructure alternatives. The transmission infrastructure includes cable landings, subsea cable corridors, and transmission land corridors. The spatial databases cover three broad environmental categories, including special-status species, sensitive habitats, and land ownership/designations. Special-status species includes those listed in the Endangered Species Act (ESA), California ESA, and fully protected by the California Fish and Game Code. Sensitive habitats include sensitive land cover types, wetlands, waters, essential fish habitat, and biologically important areas. Land ownership designations includes National Forests, National Parks, Monuments, and Reservations, National Wildlife Refuges, Tribal Lands, State Parks, Wild and Scenic Rivers, Marine Protected Areas, and National Marine Sanctuaries. Based on the severity of the potential environmental interactions and ramifications for permitting, this information was used to screen, differentiate, and compare the feasibility of the

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234 American Clean Power - California, recommended a "planned and staged offshore wind development approach", in its docketed Public Comment in response to the AB 525 Workshop: Assessing Transmission Upgrades & Investments for Offshore Wind Development off the Coast of California.

The American Clean Power comment is available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250745&DocumentContentId=85559.

235 Zoellick, James, Greyson Adams, A. Mustafa, A. Cooperman, et al. 2023. *Northern California and Southern Oregon Offshore Wind Transmission Study.* Schatz Energy Research Center (H.T. Harvey & Associates). Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=252604

alternatives. Resulting feasibility rankings for the routing segments were rated as low, medium, high, or very high difficulty.

The Schatz transmission alternatives included 22 individual transmission segments, including 9 subsea and 13 terrestrial segments. After analyzing the intersections of spatial databases with the different transmission segments, each segment was ranked based on their environmental barriers. A detailed feasibility rating of each transmission alternative segment based on environmental barriers is presented in the H.T Harvey report. Of the 22 segments: 6 are ranked low, 7 are ranked medium, 6 are ranked high, and 3 are ranked very high, as shown in **Figure 8-11**.

Although terrestrial segments follow existing transmission routes, widening of rights-of-way may be necessary in some areas, which would potentially create greater environmental impacts.[236] Conversely, if reconductoring existing lines is possible rather than installing new parallel transmission lines, potentially fewer environmental impacts may occur. For the North Coast, redwood habitat type and northern spotted owl or marbled murrelet critical habitat intersect to create a very high degree of permitting difficulty for segment 3 in the map above.[237] This segment is included in the transmission alternatives 7.2a, 12.4c, 12.4d, and 25.8a.

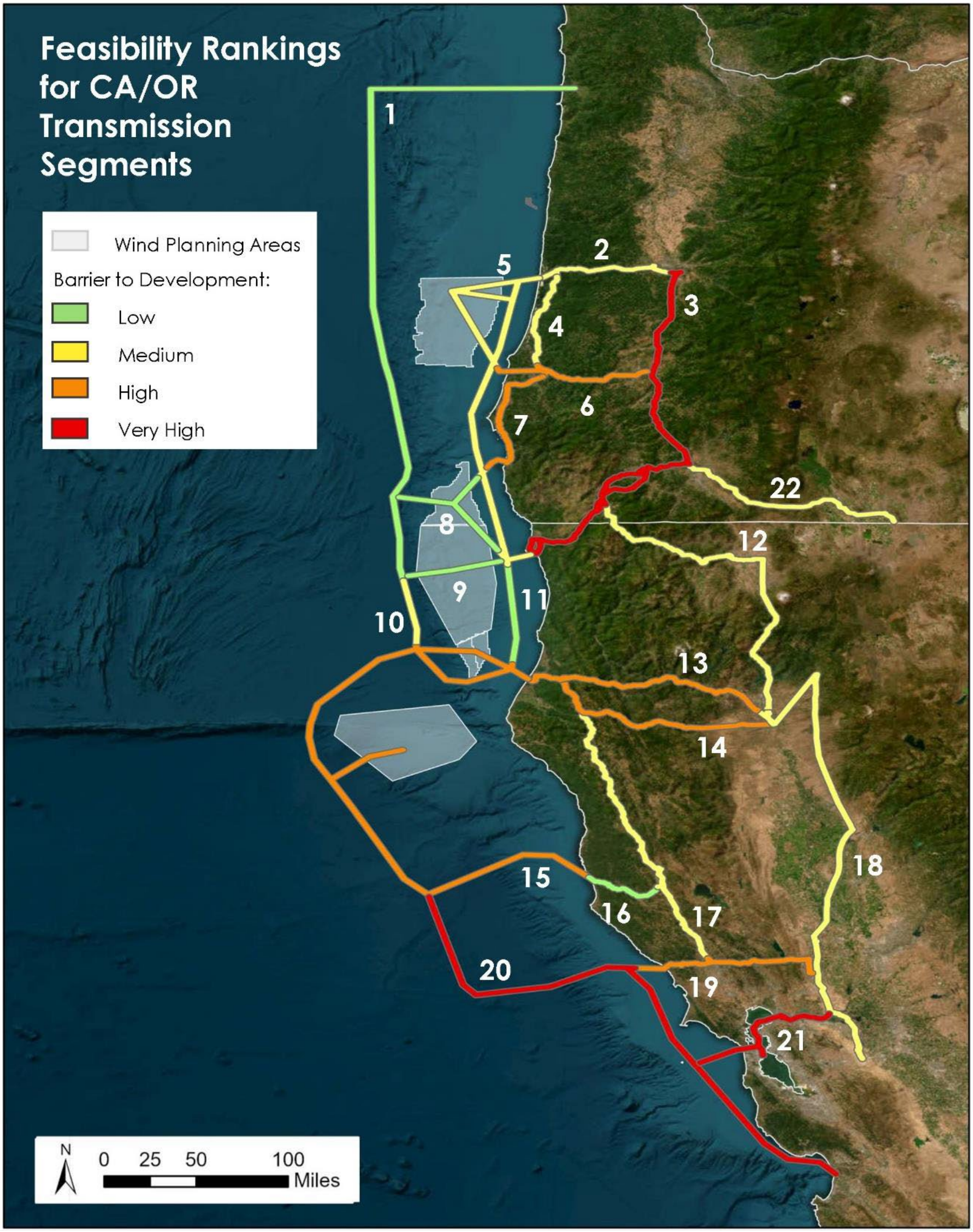
Many unknowns exist regarding the specific transmission infrastructure (towers, cables, and configurations) for the different transmission alternatives. Site specific information such as habitat characteristics and presence of listed species are also unknown. In addition, detailed surveys along terrestrial segments may be needed to confirm potential habitat characteristics and the presence of listed species and sensitive habitats.[238] Survey results would further inform the feasibility of transmission pathways and associated permitting requirements.

236 Ibid.

237 Ibid.

238 Ibid.

Figure 8-11: Feasibility Rankings for Transmission Alternatives



Source: H.T. Harvey & Associates. 2023

The Central Coast Existing Transmission System

Offshore wind feasibility has been studied in two Central Coast areas: Morro Bay and Diablo Canyon. In 2018, BOEM designated these two areas the Morro Bay Call Area and the Diablo Canyon Call Area. The Diablo Canyon Call Area is located within an area that was subsequently nominated to become a marine sanctuary, which would preclude any future offshore wind projects within the proposed sanctuary. NOAA has completed the public scoping period, and on August 24, 2023, the Biden-Harris Administration issued the draft proposal for the Chumash Heritage National Marine Sanctuary.[239] NOAA is seeking comment on the draft proposal. If the proposed sanctuary designation is approved, under current law BOEM would not have the authority to issue future leases within the Diablo Canyon Call Area.[240] The Morro Bay Call Area, however, which lies fully outside the proposed marine sanctuary boundaries, progressed to a WEA in 2021. The Morro Bay WEA is located roughly 20 miles offshore the Central California coastline and is approximately 376 square miles.[241] The Morro Bay WEA has a power generation capacity of 4.9 GW.[242] The Morro Bay WEA was subsequently separated into two plots that were included in BOEM's December 2022 competitive lease auction, with final leases signed in June 2023.

Unlike the North Coast, the Central Coast has a robust transmission system in place. Additionally, the retirement of power plants in the region presents an opportunity to repurpose the transmission to deliver offshore wind resources. The onshore Central Coast region adjacent to the Morro Bay WEA contains multiple large transmission lines and electric substations sufficient to supply local load centers. Two existing 500 kV and one 230 kV transmission lines connect the Diablo Canyon nuclear substation, and three 230 kV transmission lines connect the Morro Bay natural gas substation to the transmission system.

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239 In response to the Chumash Heritage National Marine Sanctuary nomination, NOAA has proposed a sanctuary designation that excludes any geographical overlap with the proposed Morro Bay Wind Energy Area for offshore wind development.

The Proposed Designation of Chumash Heritage National Marine Sanctuary is available at https://sanctuaries.noaa.gov/chumash-heritage/.

240 BOEM lacks the authority to lease within the boundaries of National Marine Sanctuaries.

Bureau of Ocean Energy Management. October 2018. *Commercial Leasing for Wind Power Development: Outer Continental Shelf Offshore California*. Notice. Available at https://www.regulations.gov/document/BOEM-2018-0045-0001.

241 Bureau of Ocean Energy Management. "Morro Bay Wind Energy Area." Available at https://www.boem.gov/renewable-energy/state-activities/morro-bay-wind-energy-area.

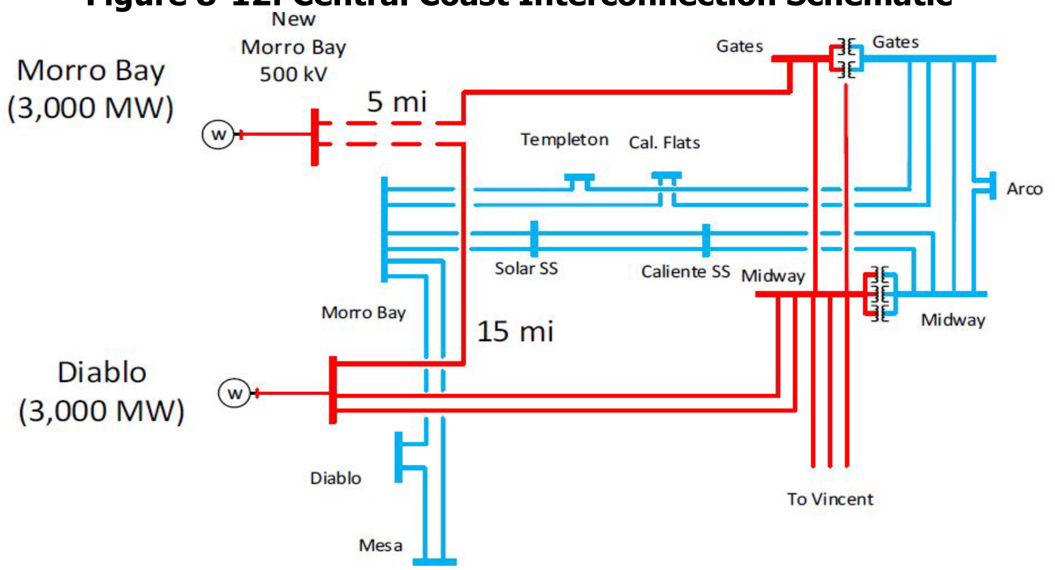
242 The installation nameplate capacity of a wind energy area will change based on inputs and assumptions. For example, a capacity of 4.9 GW is based on the Schatz Energy Research Center's reasonable industry power density of 13.1 MW/sq. mi which assumes 15 MW turbines. Older capacity estimates such as 2.9 GW listed by BOEM utilize a power density of 3 MW/sq. mi.

Transmission development necessary to accommodate Central Coast offshore wind are included in the California ISO 20 Year Transmission Outlook.[243]

Central Coast Options and Costs

The California ISO assumed that Central Coast offshore wind generation would interconnect to the Diablo 500 kV substation and the Morro Bay 500 kV substation, looping in the existing Diablo-Gates 500 kV line.[244] **Figure 8-12** shows the interconnection schematic. The California ISO estimates the cost of a 500 kV switching station at $110 million.[245]

Figure 8-12: Central Coast Interconnection Schematic



Source: California ISO. 2022

The California ISO has identified up to 3 GW of transmission availability that could be used for offshore wind resources even with Diablo Canyon still in operation, and up to 5 GW after the retirement of the Diablo Canyon Power Plant.[246] To meet the state's current offshore wind planning goals it will be necessary to explore the availability of transmission in the Morro Bay area to interconnect offshore wind generation prior to 2030. The following studies would inform transmission planning efforts:

243 California ISO. May 2022. *20-Year Transmission Outlook*. Available at http://www.caiso.com/InitiativeDocuments/20-YearTransmissionOutlook-May2022.pdf.

244 Ibid., p. 33.

245 Ibid., p. 57.

246 California ISO. May 2023. *2022-2023 Transmission Plan*. Available at https://www.caiso.com/Documents/ISO-Board-Approved-2022-2023-Transmission-Plan.pdf.

- Central Coast evaluation of transmission alternatives for offshore wind interconnection to meet the 2030 and 2045 offshore wind planning goals.
- Central Coast transmission system upgrades needed to support grid integration of offshore wind energy from the Morro Bay WEA.
- Central Coast phased grid integration evaluation to understand potential overgeneration issues that may arise when the Diablo Canyon Power Plant eventually closes.

DOE West Coast Transmission Study

Building upon other transmission assessments to date, such as the Schatz Study, a regional offshore wind transmission planning study is currently underway by the Pacific Northwest National Laboratory (PNNL). PNNL, in collaboration with NREL, will conduct the West Coast Offshore Wind Transmission Study (WOWT Study) to develop a coordinated and integrated plan for West Coast offshore wind transmission planning and development. The purpose of the WOWT Study is to identify pathways that enable onshore and offshore transmission access to offshore wind development from 2035 to 2050. The study will develop a nodal approach for the Western Interconnection that will integrate long-term offshore wind deployment along the West Coast with further deployment of clean energy resources, while considering near-term needs.[247] The study will also evaluate the cost and benefits of proactive and coordinated transmission planning, including to coastal communities. The study objectives are to quantify the changes to capital cost, production cost, emissions, resource adequacy, and resilience characteristics over time through cost-benefit analysis. Additional objectives include evaluating pathways under resilience events (such as wildfires, earthquakes, droughts, and heat domes) and assessing both the socioeconomic impacts and benefits to coastal communities as a function of cable routing, landfall, and points of interconnection options. This study is currently underway, and forthcoming results are expected in early 2025.

Transmission Technology and Alternatives Conclusions

Some of the transmission technologies needed to bring offshore wind energy to shore and interconnect with the larger bulk transmission system are still emerging. Continued research and development on dynamic cables, floating substations, direct current circuit breakers, and other technologies will be needed to meet California's long term offshore wind planning goals. In addition, innovative approaches such as networked or backbone systems needed to efficiently interconnect offshore wind projects will be required. As such, technologies and

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247 The Western Electricity Coordinating Council (WECC) is the regional entity responsible for ensuring a reliable Bulk Power System (BPS) in the geographic area known as the Western Interconnection. The WECC region contains 14 western US states, the provinces of Alberta and British Columbia, Canada, and the northern portion of Baja California, Mexico.

More information on the Western Electricity Coordinating Council is available at https://www.wecc.org/Pages/home.aspx.

configurations for interconnecting these projects are necessary to achieve efficiencies and minimize environmental impacts from multiple individual cables connecting to onshore facilities. Investigating the need for and design of these systems, along with regulatory guidance for ownership of network ready transmission projects, may be helpful to facilitate interconnection.

As the Schatz Study identified, large investments in transmission will be required to deliver offshore wind power to local communities and the larger grid to serve major load centers. This study identified a number of potential transmission pathways that will require additional detailed evaluation and corridor planning, as discussed in **Chapter 9**. Finally, exploring transmission alternatives that connect regionally can maximize the potential benefits of offshore wind across the Western Interconnection.

The Schatz Study also highlighted the importance of considering a phased approach to offshore wind transmission development for the North Coast. A phased transmission approach allows examination of both short term and long-term offshore wind development needs, costs, and benefits. This can avoid stranded transmission investments built for near term needs that must be removed and replaced in later stages of development. Phased transmission development and implementation can also reduce costs and environmental impacts, while helping the state achieve the offshore wind planning goals. In addition, transmission alternatives to support additional development on the Central Coast will need further study.

Transmission Technology and Alternatives Recommendations

The following recommendations support technology development and alternatives assessment to effectively plan for offshore wind transmission:

- Continue assessing transmission alternatives for the North and Central Coast offshore wind development to meet the offshore wind planning goals, including analyzing corridors, routes, and rights-of-way for promising transmission pathways, including land-based (overhead and underground, HVAC and HVDC) and subsea cable alternatives.
- Consider phased approaches to transmission development to examine both short-term and long-term offshore wind development needs, costs, and benefits that balance these factors.

CHAPTER 9: Transmission Planning and Interconnection

AB 525 finds that California must initiate long-term transmission and infrastructure planning for delivery of energy from offshore wind projects to meet the state's planning goals. As discussed in the previous chapter, transmission infrastructure is critical to delivering offshore wind resources to the state's electricity users. California has a robust transmission planning process for the transmission system operated by the California ISO, which covers the load of roughly 80 percent of the state including investor-owned utilities and other load serving entities. Publicly owned utilities, except for those that have joined the California ISO, independently plan the transmission systems they own and operate. Increasing amounts of offshore wind resources are being added to the resource portfolios developed by the CPUC in the Integrated Resource Planning (IRP) process and studied in the California ISO's Transmission Planning Process (TPP), as well as in the California ISO's *20-Year Transmission Outlook*.

Over the past several years, the CEC has worked with local, state, and federal agencies, Native American tribes, and many other stakeholders in a variety of landscape-planning like efforts using spatial and environmental and land-use data to identify and prioritize the best locations for renewable energy development and new or expanded transmission lines. These include the first and second Renewable Energy Transmission Initiatives (RETI) processes,[248], the Imperial Valley Study Group,[249] the Desert Renewable Energy Conservation Plan (DRECP),[250] and the stakeholder-led San Joaquin Valley Identification of Least-Conflict Lands study.[251] Targeted planning for offshore wind transmission may be necessary to ensure infrastructure is in place as offshore wind generation is brought on-line. The CEC is also exploring how it might apply additional corridor planning and the potential use of its corridor designation authority to facilitate offshore wind transmission development. Additional corridor efforts may expedite the siting, permitting, and development of transmission projects.

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248 CNRA, CEC, CPUC, BLM, and CAISO. February 2017. *Renewable Energy Transmission Initiative 2.0 Final Report*. TN 216198. Available at http://docketpublic.energy.ca.gov/PublicDocuments/15-RETI-02/TN216198_20170223T095548_RETI_20_Final_Plenary_Report.pdf.

249 More information on the Imperial Valley Study Group is available at *https://ceert.org/wp-content/uploads/PDFs/reports/2005-09-30_IVSG_REPORT.pdf.*

250 More information on the Desert Renewable Energy Conservation Plan is available at https://www.energy.ca.gov/programs-and-topics/programs/desert-renewable-energy-conservation-plan.

251 More information on the Joaquin Valley Identification of Least Conflict Lands Study is available at https://sjvp.databasin.org/pages/least-conflict.

Interconnection of new renewable generation and battery storage has become challenging in recent years as procurement of these resources has rapidly escalated to meet California's clean energy and climate goals. In addition, the permitting processes for transmission in the state depends on the type of transmission developer, with the CPUC having permitting jurisdiction over transmission projects in the California ISO footprint. The publicly owned utilities act as their own lead agency under California Environmental Quality Act (CEQA) and secure necessary permits from federal, state, and local agencies.

The planning, interconnection, and permitting processes for transmission infrastructure, including issues specific to offshore wind transmission are discussed in this chapter.

Transmission Planning

Ensuring that sufficient transmission is available when offshore wind projects are ready to come on-line requires robust planning. The state needs more specificity about the alternative transmission pathways, costs, rights-of-way, and environmental impacts before moving forward into investment and construction. The Schatz Study and updates to the California ISO's 20-Year Transmission Outlook provide a good starting point for the planning of offshore wind transmission. However, transmission planning including additional targeted analysis of transmission alternatives will be necessary to inform infrastructure decisions related to offshore wind.

The joint transmission planning of the CEC, CPUC, and California ISO was recently enhanced by the signing of a Memorandum of Understanding (MOU) in December 2022. Progress is being made both in the California ISO's annual TPP and their *20-Year Transmission Outlook*.[252] In May 2022, the California ISO *20-Year Transmission Outlook* identified a total of 10 GW of offshore wind development with 4 to 7 GW in the North Coast and 3 to 6 GW off the Central Coast. The *20-Year Transmission Outlook* also presented transmission development alternatives to accommodate resources identified in the SB 100 Starting Point scenario, which includes 10 GW of offshore wind.[253] Offshore wind continues to be included as a candidate resource in the CPUC's IRP modeling and load serving entities plans. In February 2023, the CPUC recommended a base case portfolio for the California ISO's 2023-2024 TPP that included 4.7 GW of offshore wind in 2035, and also transmitted to the California ISO an offshore wind sensitivity portfolio of 13.4 GW in 2035.[254] The objective of using the offshore wind sensitivity portfolio as a policy driven sensitivity for the 2023-2024 TPP is to refine and update transmission assumptions of offshore wind resource buildouts consistent with AB 525 policy

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252 California ISO. May 2022. *20 Year Transmission Outlook*. Available at http://www.caiso.com/InitiativeDocuments/Draft20-YearTransmissionOutlook.pdf.

253 Ibid., page 47.

254 CPUC Staff. February 2023. *Modeling Assumptions for the 2023-2024 Transmission Planning Process*. Available at https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan.

and changes in the resource potential.[255] For the 2022-2023 IRP, the CPUC identified a total offshore wind resource potential of 17.3 to 28.9 GW.[256] The offshore wind resource potential for the Diablo Canyon Call Area is set to zero, the Morro Bay WEA resource potential ranges from 2.9 to 4.9 GW, and the Humboldt WEA ranges from 1.6 to 2.7 GW. The resource potential at the Cape Mendocino Study Area ranges from 6.2 to 10.4 GW, and the Del Norte Study Area ranges from 6.6 to 11.0 GW.[257] The 2024 update of the 20-Year Outlook, which is currently underway, includes a total of 20 GW of offshore wind development with 14.6 GW in the North Coast and 5.4 GW in the Central Coast.

Between 2018 and 2021, the CEC, in collaboration with the CPUC, introduced new methods for land-use screening and resource mapping (resource-to-busbar mapping or busbar mapping) for analysis in California ISO's TPP. Busbar mapping is the process of refining the energy resource portfolios from the CPUC's IRP process, which are at a geographic scale too broad for transmission planning and must instead be mapped to the specific interconnection locations (or substations). The objective of introducing new methods for land-use screening was to incorporate additional statewide environmental information to better understand implications, from a landscape perspective, of mapped areas with renewable resource potential.

The other clean and renewable resources being included in the CPUC resource portfolio and California ISO Plan include well-known renewable technologies that exist today, are cost-effective, and are already in the development queue. There is less certainty surrounding offshore wind technology and some critical transmission technologies for offshore wind are still emerging and are not yet commercially available. This poses challenges to the transmission planning process, and new and innovative approaches may be needed to account for offshore wind resources.

Nevertheless, for California to take advantage of offshore wind resources, the state must also be prepared to begin planning in earnest for these resources. The state has engaged in previous planning activities, such as the Tehachapi Renewable Transmission Project, which was developed to access 4,500 MW of electricity from renewable resources that had no existing transmission access, including wind generation in the Tehachapi area. For offshore wind development on the North Coast, a similar planning approach may be needed to ensure transmission is available as large amounts of offshore wind generation comes online.

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255 Ibid.

256 California Public Utilities Commission. June 2023. *Inputs & Assumptions: 2022-2023 Integrated Resource Planning (IRP)*. Available at https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2023-irp-cycle-events-and-materials/draft_2023_i_and_a.pdf.

257 Ibid.

Transmission Landscape and Corridor Planning

California faces near-term challenges in ensuring adequate investments in bulk transmission capacity to meet its growing electricity needs and the state's renewable and zero carbon electricity goals. Over the years, transmission development has been challenging, as transmission lines are long linear facilities that cross many land use types and jurisdictions, with concerns over impacts voiced by many stakeholders. Senate Bill 2431 (Garamendi, Chapter 1457, Statutes of 1988) enacted state transmission siting policies, known as the Garamendi Principles, which encourage the efficient use of the transmission system and rights-of-way.[258] The CEC has implemented the Garamendi Principles in multiple transmission planning efforts over the years, including the RETI, DRECP, and other planning efforts.

RETI was the first large-scale planning process that brought together environmental, developer, ratepayer, public-owned utilities, investor-owned utilities, tribal, and other interests in a stakeholder-driven consensus process. The process identified Competitive Renewable Energy Zones (CREZs) to help guide potentially suitable renewable development in California, and identify and map environmentally sensitive areas that could be adversely affected. In addition, RETI also identified transmission corridors to facilitate the development of transmission projects and expedite the siting and permitting of transmission lines.

As discussed further in **Volume II, Chapter 10**, in 2008, the Renewable Energy Action Team (REAT) was established to expedite the development of renewable energy resources in California's desert region to help meet the state's renewable energy goals. The CEC signed a memorandum of understanding (MOU) with the CDFW, the U.S. Bureau of Land Management (BLM), and the U. S. Fish and Wildlife Services (USFWS) to formalize the REAT. The agencies worked closely with local agencies, conservation and environmental groups, the public, tribes, and other interested stakeholders to develop the DRECP, a landscape-scale, multi-agency, science-based renewable energy and conservation plan covering 22.5 million acres in California's desert. The DRECP identified the most appropriate areas for renewable energy development and related transmission projects while conserving important biological and natural resources.

Landscape-scale planning efforts in California have proven successful in guiding responsible energy infrastructure development and will continue to be an important tool to help meet the state's climate reduction goals and renewable energy mandates. Over the past several years,

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258 The Garamendi Principles include, in order of preferred use: Encouraging the use of existing rights-of-way by upgrading existing transmission facilities where technically and economically justifiable; When constructing new transmission lines is required, encourage expansion of existing rights-of-way when technically and economically feasible; Provide for the creation of new rights-of-way when justified by environmental, technical, or economic reasons as determined by the appropriate licensing agency; and where there is a need to construct additional transmission capacity, seek agreement among all interested utilities on the efficient use of that capacity, thus recognizing the importance of coordinated transmission planning to improve the system efficiency and the environmental performance of the system.

the CEC has worked with local, state, and federal agencies, Native American tribes, and many other stakeholders in a variety of landscape-planning efforts to identify and prioritize the best locations for renewable energy development and new or expanded transmission lines throughout the state. A landscape-scale approach takes into consideration a wide range of potential constraints and conflicts, including but not limited to environmental sensitivities, habitats, existing land uses, tribal cultural resources, agricultural areas, transmission corridors, and military operating areas. By locating renewable projects in preferred areas near existing transmission infrastructure, potential environmental impacts, and permitting costs and timelines can be reduced, resulting in better and more timely projects.

CEC Corridor Designation Authority

Senate Bill 1059 (Escutia and Morrow, Chapter 638, Statutes of 2006) authorizes the CEC to designate suitable transmission corridor zones for high-voltage electric transmission lines to ensure reliable and efficient electricity delivery. It requires the CEC, as lead agency under CEQA, to prepare a Programmatic Environmental Impact Report to ensure that use of a corridor for a transmission line would not result in significant unmitigated environmental impacts. The CEC must work with cities, counties, state and federal agencies, and California Native American tribes to identify and designate transmission corridor zones on its own motion or by application of a transmission developer. The designation of a transmission corridor zone serves to identify a feasible corridor where one or more electric transmission lines can be built, consistent with the state's needs and objectives. It also requires cities and counties to consider designated corridor zones when making land use decisions that could affect corridor viability.

Interregional Transmission Planning

There is also a need for more inter-regional transmission to accommodate offshore wind development as Oregon and Washington begin planning for potential offshore wind. An inter-regional approach to offshore wind transmission development could provide economic advantages by leveraging existing transmission assets and provide other key benefits in terms of increased resilience and reliability for the Western transmission grid. As such, in addition to planning for transmission upgrades in California, the state will need to conduct regional transmission planning and coordinate with regional and state transmission planning entities in the West to maximize offshore wind benefits and ensure the state can meet its offshore wind planning goals.

Transmission Interconnection Issues

Coordinated planning efforts between the CEC, CPUC and California ISO have identified the need for large amounts of new zero carbon generation and storage over the next 20 years and beyond to achieve California's clean energy and climate goals. Current forecasts have identified a need for about 5,000 MW of new zero carbon generation and 2,000 MW of new storage to be interconnected every year until 2045 in the California ISO footprint. That is more than double what the California ISO averaged between 2017 and 2022. The latest Cluster 15 queue includes 541 separate interconnection requests, which total 354 GW of new capacity.

This is in addition to the existing 187 GW of requests through Cluster 14, exceeding California's most aggressive development goals.[259]

This high volume of interconnection requests creates interconnection issues, as there are so many developers seeking to interconnect that the California ISO is unable to provide a timely, meaningful analysis of what is required to interconnect them all. The project developers are struggling because they are unable to get information on interconnection costs without going through the interconnection process. They readily admit to submitting multiple interconnection requests for the same project, which further complicates the interconnection queue. The California ISO is in the process of significantly reforming the interconnection structure to advance viable projects and clear the interconnection queue of excess interconnection requests.

Regulating Interconnection

Developers of generation projects seeking to connect to the grid must apply to the transmission operator and undergo a system impact study before they can build or participate in wholesale electricity markets. The Federal Energy Regulatory Commission (FERC) regulates transmission lines used in interstate commerce by utilities and regional grid operators, such as the California ISO, and establishes standardized rules and processes for interconnecting generators or other resources such as storage. In general, this process establishes the required technical aspects and equipment, as well as what new transmission upgrades may be needed to connect a project to the system and then estimates and assigns the costs of that equipment. The lists of projects in this process are known as "interconnection queues".

Interconnection issues are a growing concern, not only in California, but nationally. In the last decade the amount of renewable resources seeking interconnection in the U.S. has rapidly increased, and is expected to continue at unprecedented levels to achieve decarbonization goals across the country.[260] As a result, on a national scale interconnection queues have grown and delays in many areas of the country have hampered getting projects on-line.[261] At the same time, the number of projects that have reached commercial operations is small. A recent study of regional grid operators and utilities serving roughly 85 percent of U.S. load

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259 Mills, Danielle (California ISO). June 2023. "Working with stakeholders to find the right improvements on interconnections." Available at http://www.caiso.com/about/Pages/Blog/Posts/Working-with-stakeholders-to-find-the-right-improvements-on-interconnections.aspx.

260 Rand, Joseph, Ryan Wiser, Will Gorman, Dev Millstein, Joaquim Seel, Seongeung Jeong, and Dana Robson. April 2021. *Queued Up: Characteristics of Power Plants Seeking Transmission Interconnection As of the End of 2021*. Lawrence Berkeley National Laboratory. DE-AC02-05CH11231. Available at https://www.energy.gov/eere/analysis/queued-characteristics-power-plants-seeking-transmission-interconnection-end-2021.

261 Ibid. As of the end of 2021 there were over 8,100 projects seeking grin interconnection across the U.S., representing over 1,000 GW of generation, of which over 90 percent are solar or wind projects, and an estimate 427 of storage.

concluded that only 23 percent of projects that requested interconnection between 2000 and 2016 have come online, while the remainder have been withdrawn from queues.[262] Completion rates for solar and wind are even lower, at 20 and 16 percent respectively.[263]

Concerns over large interconnection queue backlogs across the country, along with the concern that project proponents may be filing multiple applications for the same projects to gain less costly interconnections, prompted FERC to initiate interconnection reforms in the summer of 2022. California has also experienced large increases in the number of interconnection requests. In addition, primarily due to California being at the forefront in renewable resource development, the California ISO has already initiated a number of interconnection enhancements. A recent interconnection study concluded that California policies include best practices that improve queue management and the ability to connect new resources relative to other areas of the U.S.[264] It notes that the state can do more to bring renewable resources, including offshore wind resources, into commercial operation. The following discusses interconnection processes and process improvements that may impact offshore wind development.

California ISO Interconnection Process Enhancements

As noted above, FERC has primary jurisdiction over the California ISO grid and has established standard generation interconnection procedures and agreements. The California ISO implements its interconnection process through tariffs approved by FERC. Projects located in the California ISO balancing authority area either connect to an ISO-controlled high voltage transmission line or to lower-voltage power or distribution lines controlled by a member utility. Projects that interconnect to lower-voltage distribution systems must follow the interconnection processes established by the investor-owned or publicly owned utilities responsible for those systems.

FERC's existing framework for interconnection is based on a first-come, first-served interconnection study process, in which each individual project submits an application. With the influx of renewable projects over the last several years, including solar, wind and more recently storage resources, the California ISO has already implemented a number of enhancements, through FERC-approved tariffs, to create a more efficient process. Probably the most important of these is the creation of *cluster studies* that looks at groupings of interconnection applications, rather than analyzing each application on a stand-alone basis.

262 Ibid.

263 Ibid.

264 Gramlich, Rob, Michael Goggin, Jay Caspary, and Jesse Schneider (Grid Strategies, LLC.). October 2021. *Resolving Interconnection Queue Logjams: Lessons for CAISO from the US and Abroad*. Available at https://gridprogress.files.wordpress.com/2021/12/resolving-interconnection-queue-logjams-lessons-for-caiso-from-the-us-and-abroad-1.pdf.

The California ISO first shifted to a clustering approach in 2008 to address the large number of interconnection applications and expected delays in processing them.[265] The California ISO noted that delays were inevitable, because data dependencies inherent in a serial study approach, resulting in later-queued projects being dependent on the effects of earlier-queued projects.[266] Also, when a higher queued project drops out, all projects with lower queue positions generally need to be restudied, which takes additional time and changes the scope and cost of transmission upgrades to restudied projects. The California ISO argued to FERC that the interconnection requests were coming in faster than the California ISO could process them. A FERC order at the time specifically noted that the queueing backlog within the California ISO was creating additional challenges to meeting the state's renewable portfolio standard.[267] The California ISO initiated cluster studies that identify: the interconnection facilities and network upgrades necessary to integrate the new cluster of resources seeking interconnection; estimate the costs of upgrades; and allocate those costs among interconnection customers sharing upgrades.

Prior to changes implemented in 2021, the California ISO's cluster study process proved to be an effective way to manage a large number of simultaneous interconnection requests. The interconnection process started annually with an open application window in April and a two-year study process that included a Phase I and Phase II study.

Additional reforms were implemented in 2021 with the dramatic increase in the numbers of interconnections applications as developers added larger amounts of renewables and zero carbon resources to meet the state's accelerated climate and clean energy goals. In the last decade, the California ISO received an annual average of 113 queue cluster interconnection requests.[268] In 2021, the California ISO received 373 interconnection requests in what is referred to as the cluster 14 *supercluster*. To accommodate the supercluster, the California ISO expanded its study timelines and altered the study process. The California ISO extended the overall study process by about a year, estimating that preserving all the current rules and procedures would require more than 30 months to complete the studies and would indefinitely delay the next opportunity for a queue cluster window.[269] The extension resulted in firm deadlines for the California ISO to complete the studies. Changes were made to the way

265 Order Conditionally Approving Tariff Amendment. 124 FERC ¶ 61,292, Docket No. ER08-1317. (September 26, 2008). Available at https://elibrary.ferc.gov/eLibrary/filedownload?fileid=11815618.

266 Ibid.

267 Reform of Generator Interconnection Procedures and Agreements. 122 FERC ¶ 61,252, Docket No. RM17-8-000. (April 19, 2018). Available at https://www.ferc.gov/sites/default/files/2020-06/Order-845.pdf.

268 Millar, Neil (California ISO). July 2021. "Memo to California ISO Board of Governors Re: Decision on Cluster 14 Interconnection Process." Available at https://www.caiso.com/Documents/Decision-Cluster-14-Interconnection-Procedures_Memo-July-2021.pdf.

269 Ibid.

interconnection Phase I and Phase II studies were performed to produce more meaningful results and the way costs and refunds were treated. Several interconnection issues were addressed in a second phase of enhancements that were approved by the California ISO Board of Governors on October 25, 2022.[270]

Additional Interconnection Process Enhancements

In December 2022, a joint MOU was signed by the CPUC, the CEC, and the California ISO.[271] The MOU tightens linkages between electricity and transmission planning, interconnection queuing, and resource procurement to meet California's reliability needs and clean energy policies. Under the MOU, the CPUC will continue to provide resource planning information to the California ISO for use in developing its transmission plan, initiating the resulting transmission projects, and communicating to the electricity industry specific geographic zones the California ISO is targeting for transmission projects, along with capacity being made available in each of those zones.[272] To address the accelerating requests for renewable interconnection, the California ISO is adopting this more proactive approach to transmission planning and has acknowledged the need for additional interconnection process improvements to accompany the new planning approach.

In early 2023, the California ISO introduced the 2023 Interconnection Process Enhancements using two tracks: Track 1 is focused on immediate adjustments to the Cluster 15 study schedule; and Track 2 is focused on targeted modifications to the interconnection and queue management processes.[273] The immediate changes for Track 1 delay the Cluster 15 schedule

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270 Emmert, Robert, Deb Le Vine, Steve Rutty, and Linda Wright (California ISO). September 2022. *Interconnection Process Enhancements 2021, Phase 2: Longer Term Enhancements Final Proposal*. Available at http://www.caiso.com/InitiativeDocuments/FinalProposal-InterconnectionProcessEnhancements2021Phase2.pdf.

Millar, Neil (California ISO). October 2022. "Memo to California ISO Board of Governors Re: Decision on interconnection process enhancements – phase 2." Available at http://www.caiso.com/Documents/DecisiononInterconnectionProcessEnhancementsPhase2-Memo-Oct2022.pdf.

271 The 2022 MOU supersedes the previous 2010 MOU between the CPUC, CEC, and California ISO. The Memorandum of Understanding between the CPUC, CEC, and California ISO is available at http://www.caiso.com/Documents/ISO-CEC-and-CPUC-Memorandum-of-Understanding-Dec-2022.pdf.

272 Emmert, Robert and Jeff Billinton (California ISO). April 2023. *2023 Interconnection Process Enhancements: Track 1 Final Proposal.* Available at http://www.caiso.com/InitiativeDocuments/Final-Proposal-Interconnecton-Process-Enhancements-2023-Track1-Apr13-2023.pdf.

273 Ibid.

to allow for the Cluster 14 Phase II study to be completed, before addressing the 541 interconnection requests in Cluster 15.[274]

The current planning and interconnection processes have yet to substantially address the transmission needs for offshore wind but are not anticipated to delay offshore wind projects already in the queue. In Track 1, the California ISO has anticipated no impacts from the North Coast or Central Coast offshore wind projects. North Coast offshore wind is not included in Cluster 15 as it requires policy-driven transmission projects approved through the California ISO's TPP. This must happen before Generator Interconnection Deliverability Allocation Procedure (GIDAP) studies can be completed, which at the earliest will be in March 2024.[275] The Central Coast offshore wind projects in Cluster 13 and 14 will not be delayed as a result of the Track 1 Interconnection Process Enhancements.[276]

Transmission Interconnection Priority Zones

Track 2 of the 2023 Interconnection Process Enhancements focuses on targeted modifications to the interconnection process to be in place when Cluster 15 studies resume. These modifications include: redesigning parameters or objectives such as transmission interconnection zones; limiting the volume of interconnection requests; aligning interconnection and load serving entities resource procurement; and enhancing post-study queue management.[277] One of the foundational changes to the interconnection process the California ISO has proposed is to prioritize interconnection in certain zones. The overarching intention of these zone designations is to limit the capacity studied in each transmission zone relative to the size of the available transmission capacity.

Transmission interconnection zones were identified in the California ISO 2022-2023 Transmission Plan, as shown in **Figure 9-1**. Zones where available transmission capacity exists, or new transmission has been approved, would be given priority for interconnection. Alternately, zones that currently lack capacity or do not have future TPP projects approved

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274 From Cluster 5 to Cluster 13, the annual average queue interconnection requests was 113. Cluster 14, known as a "supercluster" was 341.

Millar, Neil (California ISO). July 2021. "Memo to California ISO Board of Governors Re: Decision on Cluster 14 Interconnection Process." Available at https://www.caiso.com/Documents/Decision-Cluster-14-Interconnection-Procedures_Memo-July-2021.pdf.

275 Emmert, Robert and Jeff Billinton (California ISO). April 2023. *2023 Interconnection Process Enhancements: Track 1 Final Proposal.* Available at http://www.caiso.com/InitiativeDocuments/Final-Proposal-Interconnecton-Process-Enhancements-2023-Track1-Apr13-2023.pdf.

276 Ibid.

277 Emmert, Robert, Jeff Billinton, Jason Foster, and Danielle Mills (California ISO). May 2023. *2023 Interconnection Process Enhancements: Track 2 Discussion Paper*. Available at http://www.caiso.com/InitiativeDocuments/Discussion-Paper-Interconnection-Process-Enhancements-2023-Track%202-May312023.pdf.

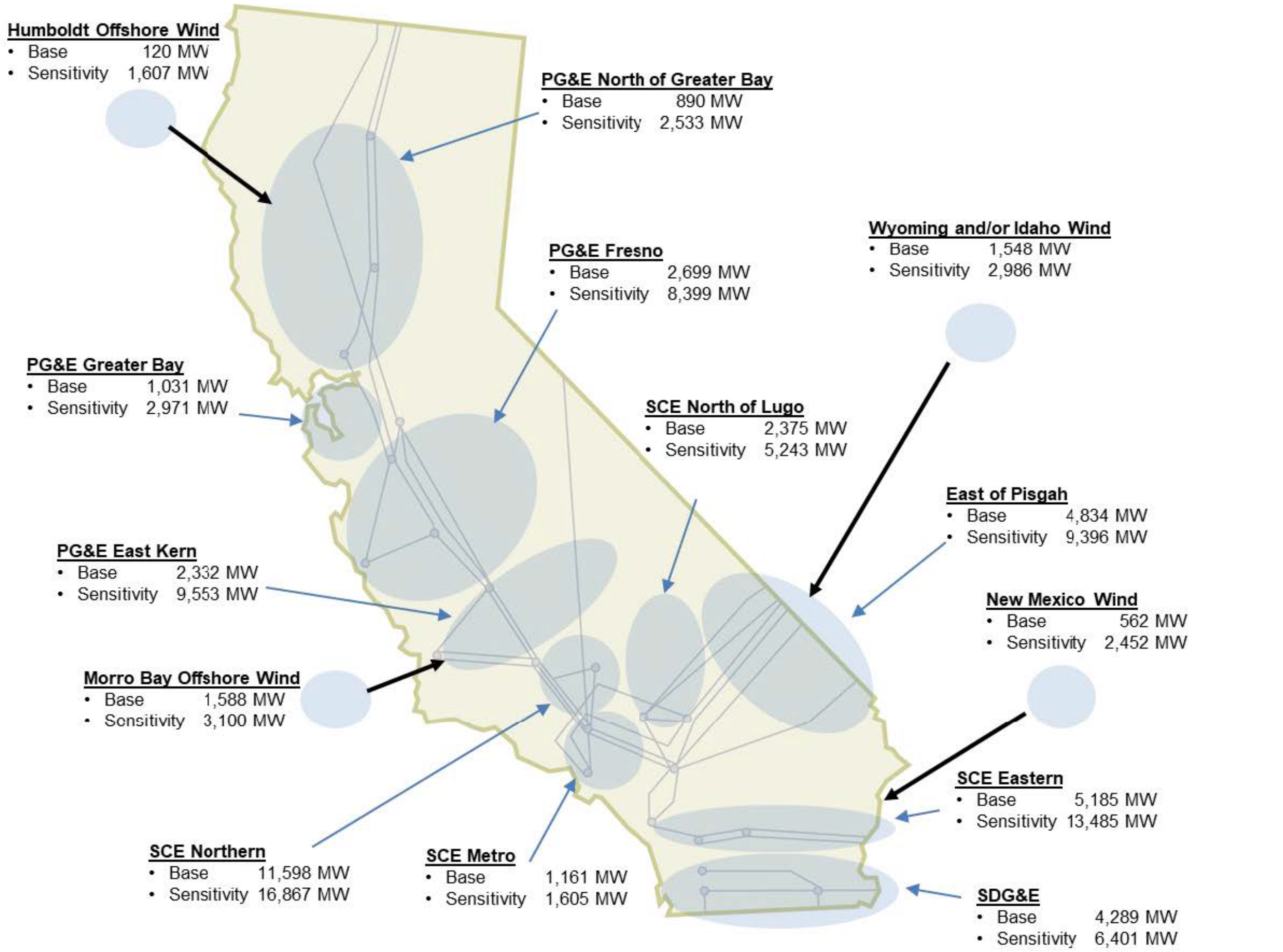
would be given lower priority or not be studied at all.[278] Prioritizing projects with available transmission is largely incompatible with location-constrained renewable resources, such as solar, onshore wind, and offshore wind in California because they are highly location specific. Battery storage projects that provide a uniform resource to the grid regardless of location could optimize locations within a priority zone to advance its interconnection study timeline.

In contrast, California's offshore wind energy areas are optimized based on average wind speeds and constrained by several variables such as water depth, navigation channels, and sensitive habitats. Offshore wind developers do not have the ability to relocate their projects and as a result face increased uncertainty surrounding interconnection study timelines. Increased interconnection uncertainty, coupled with high upfront capital costs for offshore wind projects, sends an adverse market signal to offshore wind developers.

The California ISO has a stakeholder process underway to help resolve some of these issues and expects to have a board-approved solution in place by February 2024. Comments in response to the Track 2 proposal suggest that the California ISO should shift its planning focus to geographic zones where new generation resources are expected to be, such as areas conducive to solar and wind, rather than studying projects in zones where transmission upgrades are not necessary for capacity expansion. Assuming the California ISO issues are resolved, there are still supply chain issues for basic interconnection equipment that will need to be addressed. In addition, major new transmission projects to bring remote, carbon free generation to customers will still face long permitting and evaluation timelines.

278 Ibid.

Figure 9-1: California ISO Transmission Zone Map



Source: California ISO. 2022-2023 Transmission Plan

Concepts for Offshore Wind Transmission Development in the U.S. and Globally

A study of interconnection practices in the U.S. and globally for the California ISO indicates that California, through the coordinated efforts of the California ISO, CPUC and CEC, has been using better long-term queue management practices than other regions.[279] The study notes that the California ISO proactively plans transmission for the future resource mix, which the study authors believe is the most important feature to have in place. California transmission planning at least intends to consider future generation needs by accounting for policy driven

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279 Gramlich, Rob, Michael Goggin, Jay Caspary, and Jesse Schneider (Grid Strategies, LLC.). October 2021. *Resolving Interconnection Queue Logjams: Lessons for CAISO from the US and Abroad*. Available at https://gridprogress.files.wordpress.com/2021/12/resolving-interconnection-queue-logjams-lessons-for-caiso-from-the-us-and-abroad-1.pdf.

transmission, in addition to reliability and economic-driven projects. The study also points to the benefit of California planning for a set of transmission projects for Tehachapi that enabled 4,350 MW of new wind energy while expanding needed north-south capacity. The study suggests that in the longer term, the California ISO, CPUC, and CEC will need to work on the intersection and interaction between resource adequacy, transmission planning, and interconnection. Contributions to resource adequacy from geographically remote and diverse resources should be incorporated into both the California ISO transmission planning and the CPUC resource adequacy and integrated resource planning processes. Transmission and generation should be co-optimized with a broader set of benefits, beyond just production cost, and those benefits should be included in the economic valuation of future resources.

Offshore wind developers, regional transmission organizations (RTOs), independent system operators (ISO) and utilities on the East Coast have generally pursued transmission development on a project-by-project basis, which may not be optimal for expanded development.[280] Efforts are underway on the East Coast, such as at the ISO New England, to consider and analyze transmission for multiple offshore wind projects.[281] A European study confirms that there is significant benefit to an integrated approach for interconnecting offshore wind projects, including approximately 18 percent savings in capital and operating expenditures by 2050.[282] Additional environmental and social benefits include a reduction of about 50 percent in new electricity infrastructure assets, including cables and onshore landing points.[283] The study notes that the majority of the technology required for the integrated design is available now or will be by 2030. However, a key component to release the full benefits of an integrated solution are HVDC circuit breakers. The study calls for a targeted innovation strategy in the United Kingdom, along with support for early commercial use to help progress HVDC circuit breakers achieve commercial availability.

280 Bothwell, Cynthia, Melinda Marquis, Jessica Lau, Jian Fu, and Liz Hartman. October 2021. *Atlantic Offshore Wind Transmission Literature Review and Gaps Analysis*. Office of Energy Efficiency & Renewable Energy (EERE) Wind Energy Technologies Office. DESC0014664. Available at https://www.energy.gov/sites/default/files/2021-10/atlantic-offshore-wind-transmission-literature-review-gaps-analysis.pdf.

281 Chadalavada, Vamsi (ISO New England). February 2021. *ISO New England's Approach to Future Grid Studies: Supporting New England's transition to a clean energy future*. NEPOOL Participants Committee Working Session. Available at https://www.iso-ne.com/static-assets/documents/2021/02/npc-20210218-chadalavada-presentation-r.pdf.

282 National Grid ESO. December 2020. *Offshore Coordination Phase 1 Final Report*. Available at https://www.nationalgrideso.com/document/183031/download.

283 Ibid.

In 2021, New Jersey established a State Agreement Approach (SAA) competitive transmission solicitation process to enhance the state's offshore wind program.[284] By increasing competition, the state hopes to drive down costs, provide savings for consumers, reduce risk, spur innovation, and significantly reduce the environmental footprint of new transmission lines.[285] Since November 2020, the New Jersey Board of Public Utilities has been working collaboratively with the Pennsylvania-New Jersey-Maryland Interconnection (PJM Interconnection) to incorporate New Jersey's offshore wind goals into the regional transmission planning process. Under the SAA, the close of the application window starts a multi-month evaluation process in which New Jersey Board of Public Utilities and PJM review all proposals to determine which, if any, are best suited for New Jersey's needs and represent the best value for New Jersey consumers.

Several studies suggest that comprehensive, proactive transmission analysis is needed to support offshore wind development. A recent DOE study recommends minimum criteria for comprehensive analysis, including understanding the underlying design assumptions.[286] Essential information includes identification of viable offshore wind generation locations, with the BOEM lease areas as a starting point. The DOE study calls for identification of viable landing points where offshore cables meet land, viable cable routes from offshore wind projects to landing points, and potential points of interconnection to the existing transmission system, whether to existing facilities or new facilities. It also notes the importance of determining the feasibility, compatibility, and cost-effectiveness of transmission technologies to interconnect offshore wind projects, such as HVAC or HVDC.

The DOE study also suggests that system impact analyses consistently evaluate relative feasibility, cost, reliability, and resilience of different land-based and offshore transmission options including:[287]

- Assessment of generation coincident with load to capture interdependencies, variability, and uncertainty.
- Co-optimization of transmission with generation and storage technologies to meet state policy goals while ensuring reliability and resiliency.

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284 Hart, Andrea (New Jersey Board of Public Utilities). May 2023. *Assessing Transmission Upgrades and Investments for Offshore Wind Development off the Coast of California.* TN 250371. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250371&DocumentContentId=85115.

285 National Grid ESO. December 2020. *Offshore Coordination Phase 1 Final Report*. Available at https://www.nationalgrideso.com/document/183031/download.

286 Bothwell, Cynthia, Melinda Marquis, Jessica Lau, Jian Fu, and Liz Hartman. October 2021. *Atlantic Offshore Wind Transmission Literature Review and Gaps Analysis*. Office of Energy Efficiency & Renewable Energy (EERE) Wind Energy Technologies Office. DESC0014664. Available at https://www.energy.gov/sites/default/files/2021-10/atlantic-offshore-wind-transmission-literature-review-gaps-analysis.pdf.

287 Ibid.

- Sub hourly economic analysis and production simulation modeling to assess curtailment, congestion, and emissions.
- Transmission contingency and dynamic stability analysis.[288]
- Resilience analysis that considers potential weather events, wildfire impacts, and common-mode failure scenarios caused by independencies.

The DOE study notes that some nonutility analyses suggest that planned offshore wind transmission meshed networks and backbones may be more economic, increase reliability and resilience, and reduce environmental impacts compared to project-by-project radial connections. However, they caution that these are high-level economic comparisons that have yet to be validated with sufficient data and modeling. The DOE study further notes that even if optimal from an economic or technical perspective, the studies may not fully consider the risks and costs that offshore wind energy developers face by waiting for shared infrastructure to be in place. DOE notes that other studies suggest that the benefits of shared transmission may be minimal and not achievable in some regions and recommend additional analysis to better understand and support infrastructure decisions.

The DOE study also notes that most wind energy and transmission planning studies in the Atlantic have been for a single state or Regional Transmission Organization (RTO) or ISO, with study years and deployment scenarios that assume each state has a claim on certain offshore resources. The studies also do not necessarily align with the national offshore wind goals, creating a gap in understanding the implications of how offshore wind transmission will be used by various states. Multistate and multiregional coordination to meet national offshore wind goals has not yet been considered, or is only beginning to be considered, in traditional planning processes. Some optimizations of generation and transmission, using meshed or backbone designs, have not been widely or deeply studied and as a result traditional transmission planning processes may miss innovative opportunities. Shared transmission or right-of-way may minimize costs and impacts. In addition, some innovative technologies may not yet be mature or even tested; assuming their availability may be infeasible or considerably more costly due to crucial constraints or impacts. The study suggests that the benefits of offshore wind can be accelerated and maximized if stakeholders, developers, states, utilities, and regulators coordinate to identify and analyze all options, weigh all benefits, and identify chronological development opportunities across regions for 2030 and 2050.

Transmission and Cost Allocation Policies in Other Jurisdictions

This section discusses the benefits and challenges facing meshed grid systems and other innovative interconnection options for offshore wind and addresses technical case studies evaluating offshore transmission concepts from New York, New Jersey, and Great Britain. The

288 Transmission contingency analysis is conducted to identify system upgrades that maintain transmission facility thermal and voltage limits, promote efficient flow, and maintain reliability according to industry reliability standards. Dynamic stability analysis considers angular stability, control interaction, and voltage and frequency response following a contingency event.

East Coast states of New York and New Jersey serve as examples for evaluating policy, financing, and solicitation options for the development of offshore wind transmission and interconnection infrastructure.

New York Procurement Options for Transmission and Interconnection

The New York State Energy Research and Development Authority (NYSERDA) assessed alternatives for addressing policy issues broadly applicable to deployment of offshore wind, including options for procurement of transmission and interconnection infrastructure.[289]

NYSERDA considered the following transmission and interconnection procurement options:

- **Option 1 – Developer Owned:** A single solicitation process would be used to procure both generation and transmission and interconnection assets. The winning bidder would own and operate both.
- **Option 2 – Independently Owned:** The offshore wind generation facility and the transmission and interconnection infrastructure would each be procured separately. The winning bidders of the generation and transmission and interconnection procurement processes – which could but would not necessarily be the same entity – would own and operate the assets.
- **Option 3 – Regulated Asset:** The transmission and interconnection assets would be owned and operated as regulated assets, with the intention to leverage the potentially lower cost of finance associated with rate-based assets.

Advantages, disadvantages, and other important considerations for each transmission and interconnection option are summarized in **Table 10-1**, and more details can be found in Chapter 5 of the NYSERDA Offshore Wind Policy Options Paper.

NYSERDA also took a phased approach to offshore wind procurement and focused its discussion of transmission and interconnection options on the first phase of procurement in 2018 and 2019, which encompassed a single wind energy area with 1,000 MW of capacity. Due to the limited nature of Phase I, NYSERDA considered direct radial connections only for Phase I transmission and integration development, with the expectation that procurement options would expand in Phase II to include backbone structures that could facilitate the interconnection of multiple future projects.

After evaluating the three transmission and interconnection procurement options, NYSERDA concluded that Option 1 (Developer Owned) is the most familiar and would face few implementation challenges. Additionally, under Option 1, construction timing risk and energy delivery risk would be placed with the offshore wind project developer, which is the entity that is best positioned to control these risks. While Option 1 could result in higher costs than

289 New York State Energy Research and Development Authority. January 2018. *Offshore Wind Policy Options Paper*. Available at https://www.nyserda.ny.gov/-/media/Project/Nyserda/Files/Publications/Research/Biomass-Solar-Wind/Master-Plan/Offshore-Wind-Policy-Options-Paper.pdf.

Option 3 (Regulated Asset), NYSERDA estimated the cost difference to be relatively small. Option 2 (Independently Owned) is untested and would be more complex to implement than Option 1, but could be suitable for Phase I transmission and interconnection development. Options 2 or 3 would more easily enable development of networked or backbone transmission and interconnection projects, which are less important for Phase I but will become more important in Phase II.

California could assess similar transmission and interconnection infrastructure procurement options as New York. California could also consider a similar phased approach to transmission and interconnection development, where the first phase may be geared more towards radial connections to serve the initial round of offshore wind generation. Subsequent phases could be geared towards networked transmission and interconnection infrastructure that can serve multiple projects.

Table 9-1: NYSERDA Transmission and Interconnection Procurement Options

	Advantages	Disadvantages	Other Considerations
Option 1 – **Developer Owned**	• Reduced construction timing risk • More control over delivery risk • Minimized administrative and contractual complexities	• Somewhat higher financing costs, compared to T&I development as a regulated asset (Option 3) • Scope of T&I infrastructure likely tailored to specific generation project, and "backbone" approach may be more difficult to implement	
Option 2 – **Independently Owned**	• Allows more easily for scaled economies with backbone and oversized structures, compared to Option 1 • Maximizes competitive benefits and reduces T&I project costs by conducting a separate procurement process for T&I infrastructure	• Structure is untested; could be complex to implement separate procurement and contracting processes for generation and T&I • Increased construction timing mismatch risk if the procurement results in different owners of generation and T&I facilities	• Need to determine how delivery risk would be allocated between the generation and T&I asset owners • Need to determine how the costs of the winning T&I bid would be funded (e.g., through load serving entity compliance obligations, or ratepayer charges)
Option 3 – **Regulated Asset**	• T&I assets developed as regulated assets are expected to have lower costs of finance compared to market-rate procurement options • Allows more easily for scale economies through the	• Many implementation issues: regulated asset approach generally applied for network-type assets, not direct radial connections; Public Service Commission's (PSC) jurisdiction in federal waters is unclear • Construction timing risk	• Structure pursued by many European countries, where the onshore transmission system operator and offshore transmission owner are responsible for extending the transmission system offshore to connect

	Advantages	Disadvantages	Other Considerations
	development of a "backbone" network or shared radial structure	• Planning and construction through the New York ISO Public Policy Transmission Planning Process is untested and could be difficult • PSC needs to determine extent the owner of regulated offshore wind T&I asset is subject to liability for failure to deliver energy (otherwise, generation owner fully exposed to delivery risk)	with the offshore substation and operating it for the lifetime of the asset • T&I assets could be utility-owned and cost of T&I would be borne by ratepayers through transmission chargers

Source: Guidehouse Assessment. 2023

New York Offshore Wind Integration Study

The New York Power Grid Study, entitled the *Offshore Wind Integration Study*, assesses the onshore grid, environmental and permitting challenges for transmission cable routing, and offshore transmission strategies.[290] The technical aspects of the offshore transmission strategies assessment are detailed in the Guidehouse Assessment. The following section provides more detail regarding the onshore grid and transmission cable routing assessments, as well as additional context around the offshore transmission assessment.

These three assessments were conducted partially in parallel and partially in sequence to inform and guide one another more effectively. The onshore grid assessment started with a screening of existing substations using reliability security analysis and production cost modeling. Then, two alternative injection splits between the New York City and Long Island regions were assessed to identify the configuration that would minimize onshore transmission system upgrades and minimize offshore wind curtailment.

A transmission cable routing feasibility assessment was conducted to evaluate the environmental and permitting challenges of routing transmission cables from potential offshore lease areas to the substations identified in the onshore grid assessment. The assessment identified several potential constraints that may be overcome with suitable planning and outreach efforts, and identified the number of cables or cable circuits that could be accommodated in the illustrative routes.

Five illustrative offshore wind build-out scenarios were considered in the offshore transmission assessment to capture uncertainties around the future development of offshore wind projects, including their locations and area sizes. For each scenario, five offshore transmission

290 DNV GL Energy Insights USA, PowerGEM LLC, and WSP Global Inc. December 2020. , *New York Power Grid Study, Appendix D: Offshore Wind Integration Study*. New York State Energy Research and Development Authority. 147290A. Available at https://www.nyserda.ny.gov/-/media/Project/Nyserda/Files/Publications/NY-Power-Grid/Appendix-D.pdf.

connection concepts (radial, split, shared substation, meshed, and backbone) were developed. Preliminary analysis of the scenarios found that the relative benefits and cost comparisons of the five connection concepts were consistent in each of the build-out scenarios. This suggests that a single representative build-out scenario could be used for detailed analysis to determine relative performance of the different connection concepts. The offshore transmission assessment also found the following:

- Networked connection concepts (such as substation sharing, meshed, and backbone) should encompass at least three offshore wind projects with a minimum aggregate rating of approximately 3 GW to be economically justifiable.
- Uncertainty related to the availability of wind energy areas makes it challenging to pivot from radial connection concepts to networked concepts.
- Close coordination with BOEM is needed to make more wind energy areas available and will foster more competitive offshore wind procurements and facilitate the potential development of networked offshore transmission systems.

Ultimately, the radial, meshed, and backbone connection concepts were shortlisted for detailed analysis of levelized transmission cost of electricity and availability.[291] Radial and meshed connection concepts resulted in lower levelized transmission cost of electricity than the backbone concept, and the meshed concept resulted in higher availability and operational benefits among the three shortlisted connection concepts.

California could perform similar technical assessments for offshore wind integration:

- **Onshore grid assessment:** Identify suitable onshore substations and offshore wind injection splits between substations to minimize onshore transmission system upgrades and minimize offshore wind curtailment.
- **Transmission cable routing feasibility assessment:** Determine transmission cable routing feasibility and associated environmental and permitting challenges.
- **Offshore transmission assessment:** Evaluate offshore wind connection concepts (radial and networked concepts) for several offshore wind build-out scenarios and perform detailed analysis for a selection of connection concepts within one representative offshore wind build-out scenario.

New Jersey State Agreement Approach for Offshore Wind Transmission

As previously mentioned, the State Agreement Approach (SAA) was initiated by the New Jersey Board of Public Utilities (NJBPU) at the direction of the New Jersey Legislature and the New Jersey Governor's Energy Master Plan. The SAA is designed to identify transmission solutions to support New Jersey's long-term offshore wind capacity goals of 7,500 MW by 2035

291 Levelized cost of transmission is the cost of transferring offshore wind energy for each delivered megawatt-hour of energy to the onshore grid.

and 11,000 MW by 2040.[292] The NJBPU asked the PJM Interconnection to incorporate the state's offshore wind goals into the regional transmission planning process, creating the SAA, a competitive transmission solicitation process. The SAA is outlined in Section 4.3 of the Guidehouse Assessment, and the following section provides more detail into the process and benefits of the SAA in New Jersey.

In the first SAA solicitation, PJM Interconnection and NJBPU solicited four types of offshore wind related transmission proposals:

- **Option 1a:** proposals for required upgrades to the existing PJM grid to interconnect the additional offshore wind generation reliably
- **Option 1b:** proposals for new onshore transmission facilities that would extend the existing PJM grid towards the shore
- **Option 2:** proposals for new transmission facilities, from the onshore transmission facilities to the offshore wind generation projects in the various wind lease areas
- **Option 3:** proposals for transmission links between the offshore substations of Option 2 transmission links

The first SAA solicitation closed in September 2021 and received 80 proposals from 13 developers. NJBPU then had the option to award SAA proposals that would:

- Reduce the costs that need to be recovered from New Jersey ratepayers for PJM system upgrades by about $1 billion to reach 7,500 MW of offshore wind generation by 2035. Additional savings would likely be available through a future SAA to address the incremental transmission needs associated with the state's new 11,000 MW offshore wind goal.
- Reduce interconnection-related schedule and cost uncertainties for offshore wind generators, which will serve to increase competition in New Jersey's future offshore wind solicitations.
- Allow the state to more completely use the capability at the points of interconnection created by the coordinated system upgrades developed through the SAA solicitation and preserve attractive points of interconnection to enable future procurements beyond the 7,500 MW addressed by this SAA.
- Allow for pre-building of transmission infrastructure that significantly reduces the onshore environmental impacts and community disruptions from the construction of offshore wind transmission facilities that to support the state's offshore wind goals.

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292 Pfeifenberger, Johannes, J. Michael Hagerty, Joe DeLosa, Steven Herling, Mark Kalpin, Douglas Sullivan, Carson Peacock, Evan Bennett, and Ethan Snyder (The Brattle Group). October 2022. *New Jersey State Agreement Approach for Offshore Wind Transmission: Evaluation Report.* Available at https://www.brattle.com/wp-content/uploads/2022/10/New-Jersey-State-Agreement-Approach-for-Offshore-Wind-Transmission-Evaluation-Report.pdf.

- Maximize the availability of federal tax credits for offshore wind generation interconnection facilities, which offer approximately $2.2 billion in benefits to New Jersey electricity customers for achieving the 7,500 MW goal.
- Use the more attractive cost-control commitments, development schedule incentives, and operational incentives for offshore transmission facilities procured through future solicitations to mitigate risks for New Jersey electricity customers.

NJBPU then developed a baseline scenario, in which the SAA was absent, to compare costs with submitted proposals. The baseline scenario estimated $1.5 billion in PJM Interconnection network upgrades and $5.1 billion spent by developers for onshore and offshore transmission facilities to interconnect to the grid, resulting in a total baseline of $6.7 billion net tax credits (in 2021 dollars). In this baseline scenario, developers received cost recovery through offshore wind renewable energy certificate procurements.

To assess the various proposals, the SAA evaluation team developed different scenarios with the unique set of points of interconnection and injection amounts proposed by bidders. The transmission costs were estimated both in total capital costs for each scenario and the levelized cost of transmission per MW-hour. To meet the 2035 offshore wind goal, the SAA found the cost of the scenarios to range from $5.7 to $9.4 billion. These cost scenarios directly compare to the $6.7 billion baseline scenario cost. The SAA evaluation team, in collaboration with NJBPU, selected five options that would allow NJBPU to consolidate the remaining offshore wind projects to achieve the 2035 offshore wind goal in one or two onshore corridors, reducing community and environmental impacts. The SAA is estimated to save ratepayers approximately $900 million for the first solicitation, and additional solicitations will continue to address transmission and cost allocation challenges in New Jersey.[293]

California could consider a similar competitive transmission solicitation process to develop a coordinated transmission solution to achieve its offshore wind goals, potentially in collaboration with the California ISO's transmission planning process. State agencies in California could also consider working together within the context of their individual mandates in a similar manner as in New Jersey to explore transmission options on the West Coast.

Transmission Permitting

Permitting of transmission infrastructure in the state generally depends on the type of entity developing the transmission infrastructure. In California, there are three types of transmission developers:

- Investor-owned utilities (IOUs), such as Pacific Gas & Electric, Southern California Edison, and San Diego Gas and Electric

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293 State of New Jersey Board of Public Utilities. April 2023. *In the Matter of the Second State Agreement Approach for Offshore Wind Transmission*. BPU Docket No. QO23030129. Available at https://www.nj.gov/bpu/pdf/boardorders/2023/20230426/8D%20ORDER%20OSW%202nd%20Transmission.pdf.

- Publicly owned utilities (POUs) such as Sacramento Municipal Utility District and Los Angeles Department of Water and Power, joint powers authorities (JPAs) such as the Transmission Agency of Northern California, other public agencies
- Merchant or nonutility, private developers

These developers go through different processes for planning and determining whether transmission upgrades or new transmission lines are needed, as well as for permitting and environmental reviews. California will need to examine its existing permitting and environmental review processes to streamline the development of transmission projects. A more detailed description of transmission permitting is included in **Volume III, Appendix D**.

Transmission Planning, Interconnection, and Permitting Conclusions

Proactive planning and innovative interconnection approaches will be needed to bring transmission projects online to meet the offshore wind planning goals. Landscape level planning for transmission can evaluate potential corridor options and associated environmental and land use conflicts not historically addressed in existing transmission planning processes. Conducting detailed routing studies, environmental permitting analyses, community engagement, and cost assessments can provide valuable input to the transmission planning processes and regulatory decisions. Eliminating duplication in need determinations and environmental reviews for transmission projects can help ensure they come online in a timely and efficient manner.

In addition to planning for bulk transmission, assessing the potential to provide reliability and resiliency to offshore wind host communities and other rural communities along transmission routes can help address equity issues. Further, examining the potential role of energy storage to complement new offshore wind transmission is important as it can relieve congestion, minimize curtailment, and optimize the use of offshore wind energy when it is most valuable.

Transmission Planning and Interconnection Recommendations

The following recommendations support planning and interconnection processes to bring transmission projects online in a timely manner to meet the offshore wind planning goals:

- Foster regional bulk transmission planning efforts to support offshore wind development along the West Coast to maximize the potential benefits throughout the Western Interconnection.
- Explore innovative approaches, such as networked or backbone systems, and implementation mechanisms, to efficiently bring offshore wind energy to shore to meet the offshore wind planning goals.
- Inform existing transmission planning processes by systematically identifying and prioritizing alternative points of interconnection that limit the number of landfall sites and minimize environmental impacts and long run costs.

CHAPTER 10: Offshore Wind Permitting

AB 525 directs the CEC to include a chapter in the strategic plan on permitting that includes the findings of the final permitting roadmap (*Permitting Roadmap*) the CEC adopted on May 10, 2023.[294] The *Permitting Roadmap* was also required by AB 525 and describes a coordinated, comprehensive, and efficient process for offshore wind permitting, including the following:

- A goal for the permitting time frame and milestones for a coordinated, comprehensive, and efficient permitting process.
- Description of local, state, and federal agency roles, responsibilities, and decision-making authority.
- Timing, sequence, and coordination with federal permitting agencies, and coordination between reviews under the California Environmental Quality Act (CEQA) and the federal National Environmental Policy Act (NEPA).

The *Permitting Roadmap* was developed in consultation with relevant local, state, and federal agencies, including the CCC, the CDFW, and the CSLC, California Native American tribes, and affected stakeholders.

The review process for any large infrastructure project, such as offshore wind, is complex. It involves numerous state, federal, and local agencies, with differing data and information requirements, timelines, and processes. These agencies have the responsibility to implement the various laws, ordinances, and regulations that ensure that environmental impacts from projects are assessed, avoided, minimized and mitigated, and important ecological and natural resources, commercial and recreational ocean uses, and community values are protected. Under current federal, state, and local project review processes, the environmental and permit reviews for offshore wind facilities could take more than 10 years to complete.

Each of the state agencies are expected to have responsibilities for permitting different aspects of offshore wind development, along with different application and review processes for projects within their jurisdictions. To ensure timely development of offshore wind resources, the state must have a coordinated, comprehensive, and efficient review and approval process for offshore wind energy projects and their associated infrastructure. Offshore wind planning and permitting processes should also be efficient and consistent to ensure timing certainty, predictability, and adequate opportunities for participation from all relevant agencies at the

294 Jones, Melissa, Kristy Chew, Eli Harland, and Jim Bartridge. April 2023. *Assembly Bill 525 Offshore Wind Energy Permitting Roadmap.* CEC-700-2023-004. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250155&DocumentContentId=84876.

local, state, and federal levels, California Native American tribes, developers, local and underserved communities, and stakeholders.

This chapter focuses on a preferred approach for coordinated, comprehensive, and efficient environmental review and permitting processes for offshore wind projects that includes timeframes and milestones.

Background

The *Permitting Roadmap* focused on defining agency roles, responsibilities, and decision-making authorities, as well as the timing, sequencing, and coordination of state project reviews with federal agency processes. The *Permitting Roadmap* identified the following six approaches, including three coordinated agency approaches, a consolidated permitting approach, and two approaches for coordinated environmental reviews for offshore wind projects.

Coordinated Agencies Approach

- **State and Federal agency coordination approach:** This approach could be patterned after the Renewable Energy Action Team (REAT) structure and process that was developed by state and federal agencies to improve permitting for large renewable energy projects in the California desert. Another variation for state and federal coordination could be patterned after the San Francisco Bay Restoration Regulatory Integration Team (BRRIT) approach that was created to more efficiently deploy habitat restoration projects in the San Francisco Bay Area.
- **One state agency coordinator approach:** In this approach, one state agency would be identified to serve as a lead coordinator (or project manager) for all state agencies while aligning information needs with the federal agencies and applicants.
- **A coordinated state application and permitting process:** This approach would coordinate each agency's review of application materials to allow concurrent project review, coordinated responses, and shared feedback and information requests from the relevant state and local agencies.

Consolidated Permitting Authority Approach

- **A consolidated permitting approach:** This approach would establish a single permitting agency with the authority to permit offshore wind-related infrastructure located within state-jurisdictional waters. All the actions and responsibilities of the state agencies related to offshore wind facilities would need to be considered in establishing a single state agency process.

Coordinated Environmental Review Approaches

- **Coordinated environmental review approach:** This approach includes a federal and state agency NEPA and CEQA review process and environmental documents to provide the required information and analyses needed by the permitting agencies to complete their environmental review obligations.

- **Programmatic environmental impact report approach:** In this approach, a programmatic environmental impact report would be developed to evaluate the general impacts, mitigation measures, and broad policies related to offshore wind development. Future project-specific environmental review documents could tier from the programmatic document.

The *Permitting Roadmap* identified coordinated permitting and environmental review as preferred approaches for further consideration. Implementing one or more of the coordinated approaches above would leverage existing expertise and staff resources housed in each state agency, while allowing for possible permitting process improvements and potential reductions in permitting timelines. This approach could reduce confusion for developers, promote agency coordination on overlapping areas of jurisdiction, and provide consistent state communication with the federal agencies. Similarly, coordinated environmental review approaches could avoid redundancy, improve efficiency and interagency cooperation, and be easier for applicants and the public to navigate. A programmatic environmental impact report could also reduce the time needed to prepare the environmental review documents required by CEQA for individual projects.

The report noted that a consolidated permitting approach, while offering some simplification of the permitting process, is likely to increase permitting delays and challenges and result in inefficient use of state funds due to the duplication of existing expertise and roles at existing agencies. Additionally, federal permitting requirements would continue to require state permitting agencies, such as the CCC, to have a role in the federal permitting process regardless of state permitting process consolidation.

Permitting Approaches

As noted in the *Permitting Roadmap*, the CEC has already identified a preference for the coordinated permitting approaches. The CEC conducted additional outreach with coordinating agencies, California Native American tribes and tribal governments, fisheries, and various stakeholders following adoption of the *Permitting Roadmap* to develop and gather input on the different permitting approaches. In addition, the CEC held stakeholder meetings and a workshop to engage in further discussion and vetting of the options. The CEC received valuable input that helped shape the discussion and recommendations in this chapter.

Several parties, including some tribes, environmental groups, and developers initially expressed support for a consolidated permitting approach by a single state agency for offshore wind-related infrastructure within state-jurisdictional waters. One of the primary benefits from their perspective was the ability to track and participate in one central permitting process, rather than multiple permitting processes. This was especially true for tribes, community organizations, and others with limited resources.

While this approach could simplify some aspects of offshore wind permitting, it also has significant drawbacks. For example, this approach would require one entity to develop the technical and regulatory expertise to carry out the unique and complex permitting requirements in the marine and coastal environment instead of relying on the existing expertise already present in the agencies currently operating in this space. This could be an inefficient use of state resources and could contribute to permitting delays. It could also provide an opening for legal challenges, which could introduce additional delays. This could also create confusion for stakeholders who are familiar with the current ocean planning and regulatory processes and have been interacting with those agencies for the last several years. The single agency approach may also be especially difficult to implement as it requires statutory changes to carefully integrate multiple permits and reviews in a seamless and sound process that creates efficiencies. Comments and stakeholder input over the last several months reinforced these concerns. For these reasons, a coordinated approach rather than a consolidated approach is more likely to streamline permitting while making best use of existing agency expertise. The CEC gathered additional information on the two primary coordination approaches, which are discussed below.

Overview of REAT Approach

The Renewable Energy Action Team (REAT) coordinated multi-agency permitting approach was initiated in 2008 through an executive order from then Governor Arnold Schwarzenegger.[295] The purpose was to accelerate renewable energy development in support of California's renewable energy goals and federal energy goals while also providing economic stimulus during the 2007-2008 recession. This coordinated approach was successfully deployed in California, resulting in the permitting of at least 8,000 MW of solar energy in the desert in about a one-year period. This significantly helped the state achieve its 33 percent RPS goal in 2018, two years ahead of the 2020 goal. By promptly permitting the projects, the REAT joint state and federal process allowed project developers to capture the majority of available federal loan guarantees and tax incentives from the American Recovery and Reinvestment Act that were available for projects.[296]

Today presents a similar situation with even more aggressive climate and renewable energy policies, along with ambitious offshore wind goals established by California and the Biden Administration. Offshore wind is a renewable energy technology that requires large areas controlled by the federal government to operate, in this case in federal waters off the California coast rather than on federal lands in the desert. The offshore wind projects entail a complex combination of issues, along with jurisdictions and needed permissions by numerous federal, state, and local agencies. Offshore wind projects in federal waters off California's

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295 Schwarzenegger, Arnold. November 2008. *Executive Order S-14-08*. Available at https://www.library.ca.gov/wp-content/uploads/GovernmentPublications/executive-order-proclamation/38-S-14-08.pdf.

296 Nelson, Martha (California Recording, LLC). *Workshop on Assembly Bill 525: Offshore Wind Energy Permitting Roadmap Transcript of Proceedings.* June 2023. TN 250758. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250758.

coast may also be able to benefit from federal funds made available by the Inflation Reduction Act and Infrastructure Investment and Jobs Act.[297]

State and federal agencies have the opportunity once again to join together and create a coordinated permitting process similar to the REAT for ocean energy projects. The REAT process served as a single point of contact for the state agencies that shared permitting responsibilities for the projects, for the federal agencies that had overlapping and complementary authorities for the projects, and for project developers to provide a conduit for information to the agencies. This provided clarity on the state processes involved, how state and federal processes were coordinated, and the respective responsibilities being executed under each process. Two entities were established to conduct these functions: the Renewable Energy Policy Group (REPG), consisting of executive level membership from the agencies, and the REAT, consisting of staff level members.

Under the REAT process, MOUs were implemented between the agencies to define roles, responsibilities, and expectations. The REAT developed integrated project timelines with state agencies attempting to complete their work within federal timelines. This allowed various permitting activities to be integrated so they could move more expeditiously, while also creating multiple touchpoints in the process to engage tribes, stakeholders and the public.

Another feature of the REAT process was using knowledgeable and experienced staff with clear decision-making authority and responsibility and with knowledge of which decisions need to be made at what level and when within each organization. To the extent feasible, the process relied on the same staff team from the agencies, so lessons learned from permitting, information collection, understanding of impacts, and developing mitigation strategies were immediately applied.

One of the primary benefits of the REAT process was the problem solving that it enabled. If problems were encountered or disagreements between agencies arose, or if staff resource constraints were identified, the REAT team would meet to resolve them. Through formal agreements, agencies would trade staff back and forth to complete the work and keep projects on track or amend schedules with project proponents as necessary. The REAT process also provided a forum to work through project-specific problems in real time in meetings. Agency staff could ask questions and get the answers they needed at the same time from project developers. In turn, the agencies could provide project developers with coordinated responses to minimize the conflicts or misunderstandings that could arise from multiple individual contacts between agencies and developers.

Another benefit of the REAT process was the development of a *best practices manual* for siting facilities in the desert that included information on facility design and environmental considerations. The manual identified how to analyze and characterize the types of

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297 Comay, Laura, Molly Sherlock, and Corrie Clark (Congressional Research Service). September 2022. "Offshore Wind Provisions in the Inflation Reduction Act." IN11980. Available at https://crsreports.congress.gov/product/pdf/IN/IN11980.

environmental effects, and identified survey protocols that allowed project developers to get a head start on developing permitting information the agencies would need for their reviews. The REAT process also offered pre-application meetings for the project developers with all agencies representatives together to explain the processes and information needs so expectations were clear.

Since 2016, California and BOEM have been working together in the BOEM-California Intergovernmental Renewable Energy Task Force.[298] The state agencies have coordinated their work in this forum, and as a result establishing a more formal entity such as a REAT for offshore wind projects would naturally build upon and recognize the agency coordination to date. A REAT structure would not change agency authorities or jurisdictions but would add an essential element of formal coordination. For offshore wind, BOEM's leasing process drives the permitting and environmental review processes, and the goal of a REAT approach would be for state processes to move in parallel with the federal process, rather than in a serial manner.

Overview of Bay Restoration Regulatory Integration Team Approach

The San Francisco Bay Restoration Regulatory Integration Team (BRRIT) is a team of seven state and federal agencies formed by the San Francisco Bay Restoration Authority to improve the permitting process for multi-benefit habitat restoration projects and associated flood management and public access infrastructure in the San Francisco Bay and shoreline.[299] A goal was established for recovering 100,000 acres of tidal wetlands in the San Francisco Bay working with the scientific community and the various stakeholders.[300] The importance of marshes in providing tidal wetlands ecosystem benefits has increased with accelerating climate change and sea level rise, adding to the pressure to get projects in place in a timely way. The BRRIT identified roadblocks that were preventing projects from moving as quickly and efficiently as desired.

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298 The California Intergovernmental Renewable Energy Task Force is a partnership of members of state agencies, local and federally recognized Tribal governments, and federal agencies.

More information on the California Intergovernmental Renewable Energy Task Force is available at https://www.boem.gov/renewable-energy/state-activities/california.

299 BRRIT consists of staff from the following state and federal regulatory agencies: the San Francisco Bay Regional Water Quality Control Board, California Department of Fish and Wildlife, San Francisco Bay Conservation and Development Commission, NOAA National Marine Fisheries Service, U.S. Army Corps of Engineers, and U.S. Fish and Wildlife Service.

More information on the San Francisco Bay Restoration Regulatory Integration Team (BRRIT) is available at https://www.sfbayrestore.org/san-francisco-bay-restoration-regulatory-integration-team-brrit.

300 Nelson, Martha (California Recording, LLC). *Workshop on Assembly Bill 525: Offshore Wind Energy Permitting Roadmap Transcript of Proceedings.* June 2023. TN 250758. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250758.

BRRIT consists of staff from state and federal regulatory agencies with jurisdiction over the projects. Together, these agencies implement a three-step process, which encompasses preapplication meetings with each other and applicants, post filing coordination with each other and continuing communication with applicants, and permit issuance. Projects are expected to participate in the BRRIT pre-application process prior to submitting permit applications to each individual BRRIT agency. Permit applications are subject to review under each individual agency's laws, policies, regulations, and permitting timelines. The San Francisco Bay Restoration Authority will regularly issue calls for projects to participate in the BRRIT pre-application and permitting process.

A policy and management committee (PMC) composed of agency managers coordinates with the BRRIT and participates on an ad hoc basis. The PMC has developed a Permit and Policy Improvement List identifying issues limiting the flexibility of design and/or permitting of multi-benefit restoration projects and is working to resolve these issues. The PMC will also review substantive issues raised by the BRRIT or others in project-specific cases and propose resolutions at a management or policy level where appropriate.

The key to successful permitting through the BRRIT is engaging in the pre-application process that the BRRIT provides, where applicants can receive early review and project input. Eligible projects are expected to engage with the BRRIT early and as often as needed through pre-application meetings. The BRRIT representatives work in close coordination to resolve issues identified during the pre-application process prior to the submittal of formal permit applications.

A representative from the BRRIT noted that several other factors contributed to the team's success, including adequate funding to provide a consistent pipeline for permitting efforts,[301] strong agency leadership support for the team, the ability to elevate issues that arise, and close collaboration between BRRIT members. In addition, the team was able to create identified efficiencies at the policy or management level and most importantly, dedicated staff time allowed early engagement in project planning and pre-application phases of a project, so that the project is fully formed upon application submittal.

Comments on Permitting Approaches

The CEC received comments on permitting issues earlier in the process which are discussed in the *Permitting Roadmap*. Some additional themes emerged from input and comments received in recent months, which are discussed below.

Offshore wind developers suggested that several elements are essential to an effective permitting process, including early and consistent engagement with reviewing agencies so the

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301 BRRIT identified what it would take to fund the seven state and federal agencies to provide a consistent, ongoing permitting effort with the California Coastal Commission starting a fundraising effort to secure $6 million to fund agency staff for 5 years.

agencies can provide clear guidelines and methodologies for collecting survey data and a checklist that describes the agencies' information needs and expectations.[302] They emphasized the importance of identifying a single agency or entity to coordinate agencies and that has the authority to require schedules for agency input and participation and provide for dispute resolution or other communication facilitation needs. Developers commented that state and federal permitting timelines need to be closely aligned and detailed schedules should be developed that include ongoing developer and agency engagement, coordinated agency reviews, appropriate sequencing, and milestones. They suggested development of an offshore wind permitting dashboard that shows milestones, public participation opportunities, and the status of the project in the review process. Developers suggested the dashboard should be maintained by the entity responsible for coordinating the agencies. They also stressed the importance of adequate long-term funding for agencies with permitting authority so they have the needed resources and staff to adequately review project applications in a timely manner.[303]

Offshore wind developers commented that the federal and state lead agencies should enter into a Memorandum of Understanding as soon as possible that establishes shared timelines; agency roles and jurisdictions; communication protocols; coordination and dispute resolution processes; agreements for alignment on project descriptions, data needs and survey requirements; consideration of feasible project alternatives; and the approach to cumulative impact analysis. They highlighted that the NEPA and CEQA lead agencies in a joint document approach will need to agree early-on to limit project alternatives and proposed mitigations according to NEPA and CEQA standards of feasibility and alignment with project objectives. They argued that without project alternatives and proposed mitigations early on, the joint document model creates a risk of greater complications and delays than having distinct NEPA and CEQA processes.[304]

Several environmental groups filed joint comments (*joint comments*) supporting a coordinated permitting process, noting concerns that a consolidated permitting process poses serious risks to the sustainability and efficiency of offshore wind development.[305] There was support for

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302 Nelson, Martha (California Recording, LLC). *Workshop on Assembly Bill 525: Offshore Wind Energy Permitting Roadmap Transcript of Proceedings.* June 2023. TN 250758. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250758.

303 Ibid.

304 Croll, Molly (American Clean Power Association). July 2023. "ACP-CA AB 525 Permitting Roadmap Workshop Comments." TN 251099. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=251099&DocumentContentId=86039.

305 Environmental groups represented in these joint comments include the Natural Resources Defense Council, Defenders of Wildlife, Environmental Defense Center, Environmental Protection Information Center, Humboldt Baykeeper, National Audubon Society, and Surfrider Foundation.

either the REAT or BRRIT approaches and the *joint comments* noted the importance of applying lessons learned from both approaches. They recommended that California offshore wind permitting agencies consider using BRRIT and REAT practices to navigate inter-agency dynamics and foster inter-agency coordination. The appointment of a lead to coordinate between all state agencies was viewed as a way to significantly streamline the permitting process, eliminate confusion, and maintain consistency in responding to information requests. The *joint comments* noted that a coordinated permitting application process would likely have environmental and economic benefits by facilitating a comprehensive and holistic review of all application materials by the state agencies.

However, the *joint comments* cautioned the CEC against recommending concurrent permitting, given that a more sequential permitting strategy would enhance the information available for later-stage permits. They emphasized that a focus on rapid permitting, although seemingly efficient, does not align with the broader timeframe of other crucial processes such as port and transmission development. The *joint comments* urged the CEC to adopt a rigorous and comprehensive permitting approach rather than hastily expediting the process.

The *joint comments* also stressed important lessons regarding timelines and adaptive management. They noted that agency staff involved in the REAT process reported that overly ambitious and unrealistic timelines were not helpful and sometimes reduced the quality of work that could be achieved. California should keep this in mind, as some AB 525 deadlines have already proved incompatible with the time required to properly conduct research, outreach, and planning. Regarding adaptive management, the BRRIT has incorporated lessons learned into annual reports to continuously improve permit review for multi-benefit restoration projects. California should similarly apply adaptive management strategies to offshore wind development, to enable the updating of regulatory policies as the climate evolves.

Finally, the *joint comments* recommended the agencies prepare an MOU that defines the project's purpose, the responsibilities and roles of the different agencies, a process for resolving conflicts and amending the MOU, and plans for post-review agency collaboration. They also suggested that agencies and project developers agree on and publish a shared review timeline, rely on the same data in performing their respective analyses, and conduct in-depth resource analyses (such as quantification of potential impacts to threatened and endangered species) as early as possible, which can help determine a project's viability.[306]

Gutierrez, Irene, Andrea Folds, Pamela Flick, Linda Krop, Luis Neuner, Jennifer Kalt, Garry George, and Pete Stauffer. June 2023. "Energy Commission Report on AB 525 Offshore Wind Permitting Roadmap." TN 250472. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250472&DocumentContentId=85234.

306 Ibid.

Permit streamlining approaches like the Federal FAST-41 were also suggested during the workshop and in comments.[307] As described in the workshop, FAST-41 is intended to provide permitting predictability, enable and facilitate efficient issue resolution, provide transparency and accountability, and enable federal agency collaboration and coordination.[308]

FAST-41 projects use a Permitting Dashboard that provides information about the project, including project sponsor or developer, the lead agency, the relevant federal agencies, points of contact, and the status of the environmental review and federal permits.[309] An important part of the Permitting Dashboard is the development of a permitting timetable for each project. Project sponsors are consulted when creating or modifying the permitting timetable. FAST-41 funds are also available to federal, state, tribal, and local governments to support and facilitate timely and efficient permitting activities.

Environmental Review Approaches

As identified in the *Permitting Roadmap*, the preparation of joint documents under NEPA and CEQA could be considered to support the various state and federal permitting processes required for offshore wind energy projects. Both laws are intended to promote coordination, improve public understanding, and lead to more informed decisions.[310] They both encourage the development of joint documents, recognizing the efficiencies that can result from the preparation of a single document that will support multiple agencies' decisions. Joint documents have been commonly prepared for infrastructure projects when the project requires both state or local, and federal permits. The primary reasons for preparing joint environmental review documents are:

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307 Title 41 of the Fixing America's Surface Transportation Act (FAST-41) was signed into law on December 4, 2015. It was designed to improve the timeliness, predictability, and transparency of the Federal environmental review and authorization process for covered infrastructure projects. Projects that fall within one of 19 sectors that require authorization or environmental review by a Federal agency involving construction of infrastructure can apply for FAST-41 coverage, e.g., renewable or conventional energy production, electricity transmission, surface transportation, ports and waterways, water resource projects, and others.

308 The Federal Permitting Improvement Steering Council comprises representatives from the Department of Energy, Federal Energy Regulatory Commission, Nuclear Regulatory Commission, Department of Agriculture, Department of Commerce, Department of Defense, Army Corps of Engineers, Department of Homeland Security, Department of Housing and Urban Development, Department of Interior, Department of Transportation, Environmental Protection Agency, Advisory Council on Historic Preservation, Council of Environmental Quality, Office of Management and Budget, and General Services Administration.

309 Nelson, Martha (California Recording, LLC). *Workshop on Assembly Bill 525: Offshore Wind Energy Permitting Roadmap Transcript of Proceedings.* June 2023. TN 250758. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250758.

310 Sutley, Nancy and Ken Alex. February 2014. "Handbook on NEPA and CEQA: Integrating Federal and State Environmental Reviews." Letter. Available at https://ceq.doe.gov/docs/ceq-publications/NEPA_CEQA_Handbook_Letter_Feb_2014.pdf.

- **Efficiency:** Gathering information on the environmental baseline for analysis in both documents once instead of twice would be more efficient.
- **Consistency:** Analyzing the same information for both documents would likely yield more consistent impact conclusions and mitigation measures.
- **Simplicity and public accessibility:** It would be less confusing and time-consuming for the public and stakeholders to track, understand, participate in, and comment on one process and document rather than two.

Some issues with preparing joint documents that were identified include difficulties aligning schedules between the multiple processes and agencies, agreeing on an outline and terminology for the joint document, and the alignment of alternatives, impact descriptions, significance conclusions, and mitigation approaches. There are differences between the requirements of each statute that require careful coordination between the federal and state agencies. For example, the treatment of alternatives is more stringent under NEPA, and NEPA does not require the mitigation of impacts, while CEQA does. The differences between statutes could be addressed in a joint document by meeting the more demanding requirement. The agencies would also need to implement different requirements for consultation with Native American tribes. In addition, working with joint review panels for offshore wind projects may be cumbersome and time-consuming due to the large number of state and federal agencies involved (BOEM, NMFS, USFWS, CSLC, CCC, counties, etc.).[311]

Another approach to facilitating the permitting of complex regional projects is to develop programmatic environmental documents under both NEPA (Programmatic Environmental Impact Statements (PEIS)) and CEQA (Programmatic Environmental Impact Report (PEIR)). A PEIS or PEIR is an environmental document that broadly describes the effects of a series of related activities, such as a plan or program with multiple components.[312] It defines a range of actions or development components but does not usually support project specific approvals. It sets the stage for project specific actions that come later. Ideally, programmatic documents allow for more efficient permitting of individual projects by building on, but not repeating, the information contained in the original programmatic document. This process is called tiering, which can reduce the scope and complexity of subsequent project-specific environmental documents. BOEM has already committed to preparing a PEIS for offshore wind development off the California coast.

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311 California Energy Commission. June 2023. "AB 525 Permit Roadmap." Presentation by Susan Lee, Aspen Environmental Group. TN 250548. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250548&DocumentContentId=85324.

312 Under NEPA (40 CFR 1502.4[b]), a PEIS is prepared to consider broad federal actions such as the adoption of new agency programs or regulations… timed to coincide with meaningful points in agency planning and decision making. Under California Public Resources Code 15168, a PEIR may be prepared on a series of related actions that can be characterized as one large project.

Programmatic documents may also provide a more exhaustive consideration of effects and alternatives than would be practical in an EIR or EIS on an individual proposed action. Programmatic documents could also allow for consideration of cumulative impacts on a broad scale and broad policy alternatives and program-wide mitigation measures. They can also avoid duplicative consideration of basic policy considerations in subsequent project-specific documents.[313]

Programmatic documents can also evaluate the regional effects that include cumulative impacts and big picture regional alternatives. Specific to offshore wind projects, a programmatic document could help define a range of construction activities and facilities that may be developed, and a range of potential impacts and mitigation for anticipated impacts.

There is still significant uncertainty about the types of turbines, turbine platforms, cables, floating or fixed offshore substations that will be deployed, and broader questions about offshore wind development that require complex impact analysis due to the many potentially affected areas, such as:

- Offshore construction and operation of turbines, mooring cables, undersea transmission lines, offshore substations, vessel traffic, including for operations and maintenance
- Onshore construction of substations, transmission lines, and use of transportation corridors, and the development of manufacturing and operations and maintenance facilities
- Onshore and offshore construction of port facilities and harbors for staging, integration, and assembly of turbines, component manufacturing, and operation and maintenance of offshore wind projects.[314]

Programmatic documents can allow consideration of the many different aspects of offshore wind development. The mitigation measures developed programmatically could be incorporated into project specific documents, which could reduce impacts before consideration of the specifics of each project.

Finally, some of the same challenges with developing joint environmental documents can also occur with programmatic documents, such as aligning multiple agencies, authorities, and responsibilities.

Federal and State Efforts to Improve Clean Energy Infrastructure Permitting

Recent federal and state processes have been proposed or adopted to improve permitting and environmental review processes of new infrastructure, including clean energy infrastructure.

313 California Energy Commission. June 2023. "AB 525 Permit Roadmap." Presentation. TN 250548. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250548&DocumentContentId=85324.

314 Ibid.

On July 31, 2023, the White House Council on Environmental Quality (CEQ) proposed the *Bipartisan Permitting Reform Implementation Rule* to revise its regulations for implementing the procedural provisions of NEPA.[315] The proposed rule implements the Fiscal Responsibility Act of 2023 amendments to NEPA.[316] According to CEQ, the rule proposes revisions to provide for an effective environmental review process that promotes better decision making and ensures full and fair public involvement. It also provides for an efficient process and regulatory certainty, decision making grounded in science, including consideration of relevant environmental, climate change, and environmental justice effects. The public comment period on the proposed rule closed on September 29, 2023.

In 2022 and 2023, Governor Newsom signed a series of legislative bills aimed at supporting and expediting the projects necessary to achieve the state's ambitious climate and clean energy goals, including AB 205 (Committee on Budget, Chapter 61, Statutes of 2022) and SB 149 (Caballero, Chapter 60, Statutes of 2023), which makes the following changes:[317]

- **Opt-In Certification Process:** Authorizes the CEC to establish a new certification program for eligible renewable energy generation, nonfossil-fueled power plants, battery storage facilities, manufacturing and assembly, associated transmission lines, and related facilities to optionally seek certification from the CEC.
- **Environmental Leadership Development Projects:** Extends the sunset of the Leadership Act, which was most recently updated in SB 7 (Atkins, Chapter 19, Statutes of 2021). This bill extends the date by which an Environmental Leadership Development Project may be certified by the Governor, from January 1, 2024, to January 1, 2032. This bill extends the date a certified project must be approved by the lead agency from January 1, 2025, to January 1, 2034, and repeals these provisions on January 1, 2034.
- **Administrative Record:** Shortens the record by removing internal communications on nonsubstantive materials, for example meeting invitations. It allows a public agency to deny a request by a petitioner or plaintiff to prepare the record of proceedings. It also specifies that if a public agency denies a request by a petitioner or plaintiff to prepare the record of proceedings, the cost of preparing the record shall not be recoverable from the plaintiff or petitioner before, during, or after any litigation.

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315 Council on Environmental Quality. July 2023. "National Environmental Policy Act Implementing Regulations Revisions Phase 2." 88 Fed. Reg. 49,924. Available at https://www.federalregister.gov/d/2023-15405.

316 More information on H.R. 3746 – Fiscal Responsibility Act of 2023 is available at https://www.congress.gov/bill/118th-congress/house-bill/3746.

317 More information on SB 149 California Environmental Quality Act: judicial streamlining is available at https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202320240SB149.

- **Judicial Streamlining:** Allows specified energy, transportation, water, and semiconductor projects to be eligible for expedited judicial review under CEQA.

Comments on Environmental Review Approaches

Many stakeholders, tribes, and other commenters support the development of joint environmental documents under CEQA and NEPA and programmatic documents for offshore wind.

The *joint comments* supported the development of a joint NEPA and CEQA review process.[318] They believe a joint review process facilitates a more comprehensive evaluation of environmental impacts, leading to better-informed decisions. As previously noted in the discussion of permitting approaches above, the *joint comments* recommend preparing MOUs, agreement on shared timelines, relying on the same data for analysis, in-depth resource analysis, and post-review agency collaboration.[319] The *joint comments* also note that joint review documents must fully comply with and clearly distinguish between the requirements of both CEQA and NEPA. They suggest that any offshore wind project in California waters would need to thoroughly evaluate potential impacts, even if the impacts may not be as explicitly required under NEPA. Similarly, the purpose and need statement under NEPA and the project objectives requirement under CEQA may be similar, but their interpretation can differ significantly. It is essential for lead agencies to cooperatively review proposed project purpose and need statements, as well as project objectives statements.

The *joint comments* stated that a PEIR would facilitate a more comprehensive evaluation of environmental impacts, leading to better-informed decisions.[320] The *joint comments* also suggest that the programmatic approach offers valuable opportunities for early stakeholder engagement. In addition, a PEIR would enable a more comprehensive assessment of the cumulative impacts of multiple offshore wind projects and allow for the consideration of potential interactions and amplification effects between projects on ecosystems, wildlife, and coastal communities.[321] Overall, they believe that a holistic approach would minimize unintended consequences and provide a more complete understanding of the environmental

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318 Environmental groups represented in these joint comments include the Natural Resources Defense Council, Defenders of Wildlife, Environmental Defense Center, Environmental Protection Information Center, Humboldt Baykeeper, National Audubon Society, and Surfrider Foundation.

Gutierrez, Irene, Andrea Folds, Pamela Flick, Linda Krop, Luis Neuner, Jennifer Kalt, Garry George, and Pete Stauffer. June 2023. "Energy Commission Report on AB 525 Offshore Wind Permitting Roadmap." TN 250472. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250472&DocumentContentId=85234.

319 Ibid.

320 Ibid.

321 Ibid.

implications of offshore wind development, thereby enabling a more responsible and sustainable way of developing offshore wind.[322]

However, the *joint comments* advise against any process that requires or recommends tiered reviews because it may inadvertently restrict the flexibility needed to adapt to emerging risks and mitigation measures as offshore wind is developed.

One tribe's comment letter supports the preparation of PEIRs, as they would better account for the cumulative effects of individual offshore wind projects on the environment and could facilitate large-scale marine spatial planning on the North Coast.[323] Analyzing offshore wind projects at a programmatic level can consider the geospatial component of various uses and environmental needs at a planning stage where such uses and needs can be protected, rather than at the project stage when the location of an individual project has already been proposed. In addition, a PEIR "could provide a baseline understanding of environmental conditions, allowing the effects of individual projects assessed at the project EIR stage to be more accurately and comprehensively contextualized into a broader analysis of the impacts of offshore wind activities on the environment."[324]

Additionally, a tribe recommended the development of and support for additional options which specifically incorporate elements of the Bears Ears Intergovernmental Cooperative Agreement.[325] The agencies should also consider the many other co-stewardship agreements between federal agencies and tribes to allow for true co-stewardship of the tribe's offshore and coastal Ancestral Lands with respect to offshore wind energy projects. Lastly, the tribe recommended the development of a path for offshore wind permitting that is truly inclusive of tribes and tribal communities.[326]

Offshore wind developers commented that given the foundational nature of BOEM's PEIS for the first California lease areas and the bearing it will have on these projects, it is imperative that the state participate actively in the development of the BOEM PEIS and commit to the

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322 Ibid.

323 Joseph, James (Yurok Tribe). May 2023. "Comment on April 28 Permitting Roadmap." TN 250082. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250082&DocumentContentId=84800.

324 Ibid.

325 The Bears Ears Inter-Governmental Cooperative Agreement is an agreement between multiple Tribal Nations (whose representatives comprise the Bears Ears Commission - the Hopi Tribe, Navajo Nation, Ute Mountain Ute Tribe, Ute Indian Tribe of the Uintah and Ouray Reservation, and the Pueblo of Zuni) and the United Stated Department of the Interior, Bureau of Land Management and the United States Department of Agriculture, Forest Service for the Cooperative Management of the Federal Lands and Resources of the Bears Ears National Monument.

326 Ibid.

outcomes and decisions of that process.[327] Offshore wind developers commented that the state could participate in BOEM's PEIS in three possible ways: 1) participate as a cooperating agency on the PEIS developed by BOEM; 2) participate in development and review of a joint PEIR/PEIS process with BOEM; or 3) develop a PEIR separately from BOEM that is scoped to examine project components that occur within state waters and onshore.

Offshore wind developers urge that programmatic reviews enable efficient and expedited reviews of projects-specific permit applications and caution that delays in completing programmatic reviews could hold up the initiation of project-specific reviews and compromise the start of project construction. They also caution that identifying additional sea space for 2045 goals could complicate any programmatic document that is prepared specifically for the first five lease areas. Defining the project and scope of a programmatic review that is focused on advancing the first leases adds certainty and maintains forward progress toward developing the first leased areas.

Offshore Wind Coordinated Agency Permitting Approach

There are several potential elements of the proposed structure for a coordinated REAT permitting approach applied to the ocean and marine environment for offshore wind, referred to as the *Ocean REAT approach*. These include:

Creation of both an Ocean REPG and an Ocean REAT: The agencies would work with federal and local agencies to encourage participation and ensure coordination with the offshore wind science entity.

Define the structure and membership of the Ocean REPG and Ocean REAT:[328] This would include the BOEM and other federal agencies, the CCC, CSLC, CDFW, CEC, and other state and local agencies with a role in the planning, environmental review and permitting aspect of offshore wind off the coast of California. The structure should allow for flexibility so that entities with related responsibilities could participate as appropriate. This includes establishing the following two entities:

- **Ocean REPG:** The Ocean REPG should be composed of executives and principals from local, state, and federal entities with a role in the planning, environmental review and permitting aspects of offshore wind off the coast of California. They would meet to provide policy guidance and resolve potential issues, disputes, or conflicts that emerge.
- **Ocean REAT:** The Ocean REAT should be composed of staff from local, state, and federal entities with a role in the planning, environmental review and permitting

327 Croll, Molly (American Clean Power Association). July 2023. "ACP-CA AB 525 Permitting Roadmap Workshop Comments." TN 251099. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=251099&DocumentContentId=86039.

328 The REAT Agencies took coordinated action through two memoranda of understanding (one among the REAT Agencies and two signed by the Department of Interior and the State of California). The first MOU between the State of California and Department of Interior, was signed on October 12, 2009.

aspects. This interagency working group would coordinate with lessees from pre-filing through permitting.

Establishing timelines for completing environmental review and permitting: The Ocean REPG and Ocean REAT agencies would ensure a coordinated, comprehensive, and efficient process for offshore wind permitting by implementing a project-specific permitting schedule and creating a process for reviewing project documents and coordinating with lessees on information needs. They would identify opportunities for joint project-level environmental documents under NEPA and CEQA. They could also work with the CSLC, as CEQA lead agency, to establish a joint review panel to facilitate timely, collaborative, and comprehensive environmental review and agreement on impact analyses and mitigation measures during the administrative draft phase of the environmental review process.[329]

Proposed Ocean REAT Permitting Approach for Existing Leases

This section discusses the timeline and key activities that a coordinated agency approach could consider for an efficient permitting process for offshore wind facilities. The timeline is anchored to BOEM's four-phase process, as they have primary jurisdiction for permitting offshore facilities in the California lease areas. The four phases of a BOEM renewable energy project are: planning and analysis, leasing, site assessment, and construction and operations. BOEM has exclusive authority to grant leases and approve facility construction and operations plans (COP) for renewable energy development in federal waters under the Outer Continental Shelf Lands Act (OCSLA)[330] and its implementing regulations,[331] as detailed in the *Permitting Roadmap.*[332] The BOEM process is illustrated in **Figure 10-1** below.

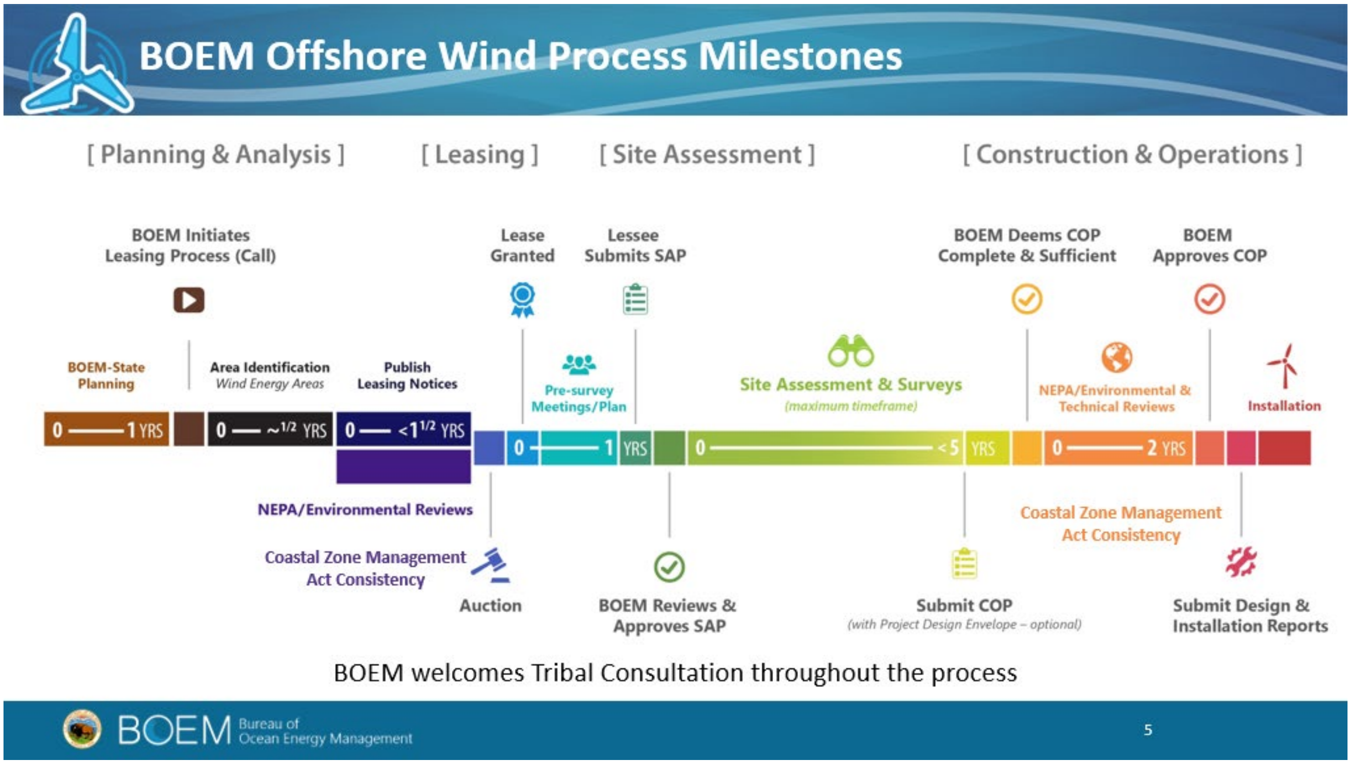
329 Senate Bill 286 (McGuire, Chapter 386, Statutes of 2023) designates the CSLC as lead agency under CEQA.

330 The Energy Policy Act of 2005 (EPAct) authorized BOEM to issue leases, easements and rights of way to allow for renewable energy development on the Outer Continental Shelf.

331 The Bureau of Ocean Energy Management's regulatory authority established in the Code of Federal Regulations is available at https://www.boem.gov/sites/default/files/uploadedFiles/30_CFR_585.pdf.

332 Jones, Melissa, Kristy Chew, Eli Harland, and Jim Bartridge. April 2023. *Assembly Bill 525 Offshore Wind Energy Permitting Roadmap.* CEC-700-2023-004. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250155&DocumentContentId=84876.

Figure 10-1: BOEM Four-Phase Process for Renewable Energy Projects on the Outer Continental Shelf



Source: BOEM

Anchoring the *Ocean REAT approach* to the BOEM process would allow California and BOEM to conduct joint reviews of individual offshore wind energy projects under federal and state law. The existing California offshore wind leases are currently in the site assessment phase of the BOEM process. NEPA and CEQA environmental review occur in the construction and operations phase of the BOEM process. Before a lessee can progress to the construction and operations phase, a COP must be submitted for the operation of an offshore wind energy project no later than six months before the completion of the five-year site assessment phase described above. As such, it may make sense for California to initiate the coordinated Ocean REAT approach before the construction and operations phase begins.

Once in the construction and operations phase, BOEM will conduct a NEPA review of the lessee's COP. BOEM will issue a Notice of Intent (NOI) if the COP meets BOEM's submittal requirements. The COP is an application submitted to BOEM for a permit to develop an offshore wind energy project. As described above, during the site assessment phase of a lease, offshore wind lessees will be studying their lease areas and designing their projects in preparation of their COP. A COP describes all proposed facilities and the installation and operational activities that a lessee will use for developing wind energy projects in the lease area and the proposed easement for a transmission route. BOEM conducts environmental and technical reviews of the COP to decide whether to approve, approve with modification, or disapprove it.

The construction and operations phase is also the time at which lessees will begin to secure some of the major permits and approvals from state and local governments, including Coastal Zone Management Act (CZMA) Consistency Certification. Several permits and approvals will first require the certification of an EIR by the CSLC as CEQA lead agency.[333]

Because a lessee must submit a COP to BOEM, it is important that the state is included early and often in the process to develop a COP, as once deemed complete, the NEPA process begins. On August 3, 2023, BOEM published updated guidelines for a Notice of Intent (NOI) checklist, which is based on BOEM's regulations and describes how BOEM will process incomplete COP submissions.[334] According to BOEM, the checklist is designed to provide clarity to lessees and establish a pre-application and pre-NOI process with lessees and cooperating agencies that will benefit all stakeholders. It is intended to improve the efficiency of proposed offshore wind project reviews by avoiding delays in conducting the NEPA analysis once the NOI has been published.[335] The *Ocean REAT approach* can coordinate with BOEM and lessees in BOEM's pre-application and pre-NOI process.

Phase 4 is also the point in the process where BOEM and the CSLC, along with other California agencies through the *Ocean REAT approach*, could conduct a coordinated NEPA and CEQA review of each COP. The *Permitting Roadmap* introduced the use of joint NEPA and CEQA reviews, and this approach was further explored at the June 2, 2023, workshop. As previously discussed, a coordinated NEPA and CEQA process could be more efficient. This could increase accessibility and transparency to the public and reduce the burden of engaging in separate federal EIS and state EIR processes. Additionally, a coordinated environmental review process could ensure that environmental impacts are analyzed consistently under NEPA and CEQA and that a single set of mitigation measures are applied to each project.

Ocean REAT Permitting Approach for Potential Future Development

The previous section addressed how the *Ocean REAT approach* could interact with the BOEM process for the current set of offshore wind leases that are in the site assessment phase. For potential future development, the *Ocean REAT approach* would also provide opportunities to coordinate with BOEM in the first two phases of their process: Phase 1 (Planning and Analysis) and Phase 2 (Leasing).

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333 The California Environmental Quality Act (CEQA) applies to all California public agencies that carry out or approve projects to inform decision makers and the public about the potential environmental impacts of proposed projects, and to reduce those environmental impacts to the extent feasible.

334 Guidance on Information Needed for Issuance of a Notice of Intent (NOI) Under the National Environmental Policy Act (NEPA) for a Construction and Operations Plan (NOI Checklist) is available at https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/FINAL%20BOEM%20NOI%20Checklist%20_August%202023.pdf.

335 Ibid.

In Phase 1, BOEM works through the BOEM-CA Intergovernmental Taskforce and public process to identify offshore Call Areas, take comments on Call Areas, and designate WEAs through environmental review under NEPA, including the CZMA Consistency Review by the CCC. Following the designation of WEAs, BOEM transitions into Phase 2 by publishing a proposed sale notice (PSN) for public comment and then a final sale notice (FSN) in the Federal Register. After the FSN, BOEM will hold a lease sale auction of the designated leasing areas and enter into leases with auction winners.

The Ocean REAT and REPG could play a key role in BOEM's planning and analysis and leasing phases to the extent it is consistent with existing law and would not supplant the BOEM-CA Intergovernmental Taskforce.

Programmatic Environmental Review

Many of the comments received on environmental review approaches support consideration of a programmatic environmental review of offshore wind development as it could be an important mechanism to help expedite comprehensive and timely permitting of offshore wind projects. As previously discussed, programmatic EIS and EIR documents can define a range of actions or potential development activities and conduct broad, regional environmental reviews that can be used for project-specific actions that occur later. Importantly, a programmatic EIS or EIR does not permit a specific action.

Following the New York Bight offshore wind lease sale auction, BOEM initiated a PEIS under NEPA for the six leases in the New York Bight area.[336] BOEM intends to complete this PEIS prior to individual lessees submitting a COP. The PEIS is intended to analyze the potential impacts, as well as the changes in those impacts that could result from adopting programmatic avoidance, minimization, mitigation, and monitoring measures for the New York Bight lease areas. BOEM has indicated that they plan to prepare a PEIS for the five PACW-1 lease areas off California, with the same objective of completing the PEIS ahead of the submittal of the individual COP.

The *Ocean REAT approach* could build on the years of collaboration between BOEM and California as BOEM develops a PEIS for the PACW-1 lease areas. To help facilitate a joint project-level NEPA and CEQA review of each offshore wind COP, the Ocean REAT could pursue a federal-state approach to BOEM's PEIS that satisfies federal and state laws and policies.

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336 More information on BOEM's New York Bight projects are available on https://www.boem.gov/renewable-energy/state-activities/new-york-bight.

Recommendations for Permitting

The following recommendations address the need for a coordinated, comprehensive, and efficient permitting and environmental review process:

- The state should consider developing and implementing a coordinated, comprehensive, and efficient process for permitting offshore wind and related projects based on the previously successful Renewable Energy Action Team (REAT) and Renewable Energy Policy Group (REPG) models developed in 2008 to permit utility-scale renewable energy projects in the California desert.
- The state should engage early and consistently with BOEM on its offshore wind programmatic environmental impact study to ensure the analysis is reflective of the state's priorities as it relates to data collection, analysis methodology, impact identification, and mitigation measures.

CHAPTER 11: Recommendations

Meeting California's energy and climate goals will require California to consider a diverse set of resources and strategies. Offshore wind presents an opportunity for California to continue advancing the state's clean energy and climate goals by diversifying the state's energy portfolio and supporting a reliable and resilient electric grid, while also creating economic development and workforce benefits.

Figure 11-1 shows a conceptual timeline for permitting and development of projects, ports, and transmission infrastructure needed to achieve the state's offshore wind planning goals. Achieving California's 2030 or 2045 offshore wind goals will require an unprecedented level of planning and policy development to effectively implement offshore wind and to protect the state's natural, cultural and economic resources. The buildout of offshore wind off California's coast will require extensive, sustained collaboration and coordination between multiple agencies and local jurisdictions, and increased efficiencies where feasible. The state must prioritize technology and infrastructure needs equally with the protection of the state's underserved communities, California Native American tribes, tribal cultural resources, and coastal resources, including marine wildlife, habitat, and commercially and recreationally important fisheries.

Implementing offshore wind generation in California will require time, effort, and funding. The pace of implementation will depend upon the feasibility and availability of resources. This strategic plan, with the below recommendations, provides direction and guidance for the development of offshore wind in a responsible and timely manner.

Figure 11-1: Conceptual Timeline to Achieve Offshore Wind Planning Goals

Conceptual Timeline to Achieve California's Offshore Wind Planning Goals																	
	State			BOEM	Offshore Wind (OSW) Leases			Ports and Waterfront Facilities						Transmission*			
Year	No Project Alternative Analysis	Programmatic Mitigation Analysis	Subsea Cable State Waters ROW	OSW PEIS	COP Dev	CEQA/ NEPA	Constr.	POLB 2	Humboldt	SF / Bay Area	Central Coast	POSD	Crescent City	500 kV AC to Fern Road Sub.	2nd 500 kV AC	HVDC #1	HVDC #2
1	Prepare No Project Alt Analysis	Prepare Programmatic Mitigation Analysis		PEIS for Existing Leases	SAP			CEQA/ NEPA	CEQA/ NEPA					Identify ROW Alternatives			
2			ID routes for existing leases		COP Surveys & Appl Prep for Existing Leases												
3																	
4		Establish Mitigation Banks	CEQA/NEPA & Permitting						Constr. 1 S&I					CEQA/NEPA & Permitting	Identify ROW Alternatives		
5										CEQA/ NEPA							
6			ID routes for future leases	PEIS for Future Leases	SAPs & COP Surveys & Appl Prep for Future Leases	CEQA/ NEPA Existing Leases		Constr. 2 S&I			Constr. 3 O&M						
7									Constr. 1 S&I					Construction	CEQA/NEPA & Permitting	Identify ROW Alternatives	
8			CEQA/ NEPA				Constr. of Existing Leases			Constr. 8 MF 1 Mooring/ Anchor 1 Cable Laydown		Constr. 1 MF					
9																	
10						CEQA/ NEPA Future Leases		Constr. 1 MF	Constr. 1 Mooring/ Anchor 1 Cable Laydown 6 O&M (O&M sites to be built as new projects come online)						Construction	CEQA/NEPA & Permitting	Identify ROW Alternatives
11																	
12								Constr. 2 MF									
13													Constr. 1 O&M			Construction	CEQA/NEPA & Permitting
14							Constr. of Future Leases										
15																	
16																	Construction
17																	
18																	
19																	
20																	
21																	
22																	
23																	

*CAISO 20 Year Outlook. Assumes 5.3 GW central coast (no improvements) and 14.4 GW northern CA coast.

Source: CEC and Aspen Environmental Group. 2023

Addressing Potential Impacts of Offshore Wind

Consistent with AB 525, the following recommendations address the potential impacts of offshore wind on coastal and marine resources, Native American tribes, fisheries, and national defense. Although not required by AB 525, recommendations to address the potential impacts of offshore wind on underserved communities are also included.

Marine Impacts

- Support comprehensive environmental research and monitoring that uses best available science and monitoring technologies, traditional ecological knowledge, and baseline and long-term monitoring to guide project siting, assess project-level and cumulative impacts during construction and ongoing operations, inform adaptative management strategies throughout the project lifecycle and future sea space planning and lease sales. This effort should incorporate scientific advice from academia, governments, tribes, nongovernmental organizations, the offshore wind industry, and other interested entities.
- Continue promoting coordination and collaboration among lessees on surveys, comprehensive monitoring plans, and project implementation to minimize environmental impacts, leverage resources, and increase efficiency.
- Develop a comprehensive mitigation framework that prioritizes avoidance and identifies strategies to minimize and offset impacts to marine life and habitats from offshore wind development and ongoing operations, including impacts from port development. Adaptive management strategies should also be identified to facilitate rapid response to unanticipated impacts.

Tribal Impacts

- The study, development, and operation of offshore wind related projects should include early, often, and meaningful consultations with California Native American tribes and collaborative development of appropriate avoidance, minimization, and mitigation strategies for impacts to tribal cultural resources, natural resources, cultural, social, economic, and other interests.
- Continue to study and develop public safety measures to reduce violent crime and sexual and gender-based violence particularly against Native American and other vulnerable populations.
- Encourage project proponents to contract with California Native American tribes for cultural and environmental monitoring pre, during, and post construction of offshore wind projects, port improvements, and expansion of transmission infrastructure.
- State and federal agencies should explore opportunities for increased tribal access and stewardship in state and federal waters.

Fisheries Impacts

- The latest commercial, recreational, subsistence, and cultural fishing data should be used to conduct analyses assessing spatial and temporal trends in fishing effort and value metrics in the offshore and nearshore environments, in consultation with California Native American tribes and the California Offshore Wind Fisheries Working Group. These efforts will inform deployment within existing lease areas and planning for port development and sea space for future offshore wind projects.
- Continue to support the California Offshore Wind Fisheries Working Group in developing a statewide strategy for avoidance, minimization, and mitigation of impacts to fishing and fisheries that prioritizes fisheries productivity, viability, long-term resilience, and safe navigation.
- Continue working with researchers, offshore wind leaseholders, tribes, and other state and federal agencies to develop a strategy to avoid, minimize, and mitigate impacts to ongoing fisheries surveys that inform fisheries management.

National Defense Impacts

- The state should continue to coordinate with the DOD to prevent potential offshore wind development from encroaching on military testing, training, and operations areas.

Underserved Communities Impacts[337]

- The study, development and operation of offshore wind related projects should include early regular, and meaningful community outreach and engagement with underserved communities, nongovernmental organizations, local governments, and other potentially impacted underserved groups.
- Offshore wind development and operation should avoid, minimize or mitigate impacts to underserved communities, including those in and around ports.
- Evaluate and identify ways to increase capacity for stakeholders to engage in the permitting, development and mitigation of offshore wind development.

Sea Space

The following recommendation encourages the identification of suitable sea space in a way that prioritizes least-conflict ocean areas:

- Continue suitable sea space identification, research, analysis and refinement, in coordination with BOEM, underserved and tribal communities, and stakeholders to inform the feasibility of offshore wind development that minimizes impacts to California's coast and ocean resources.

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337 Recommendations related to workforce development efforts for underserved communities can be found in the "Workforce Development" section.

Port Infrastructure Needs

The following recommendations will help to ensure adequate port infrastructure:

- Continue to support, in coordination with federal, tribal, and local governments, developers, and underserved and local communities a port development and readiness framework. This should include consideration of potential funding sources and strategies, as well as local content and prevailing wages, to identify port site developments needed for offshore wind project development and operations.
- A port development and readiness framework should continue to be coordinated with larger West Coast port network evaluation efforts and state and national supply chain development.
- Continue to collaborate with ports and harbor districts, tribal governments, underserved communities, local communities, port users and tenants, and developers to understand the unique challenges and opportunities of each port and harbor district and their potential role in supporting offshore wind development and operations.
- Continue to engage with industry leaders, developers, and supply chain entities to explore options to support local supply chain development.

Workforce Development

The following recommendations will help California develop an equitable, skilled, and trained workforce to support the offshore wind industry:

- Identify immediate and long-term workforce needs, understand diversity gaps, develop targeted and equitable hiring standards, establish training curriculum and programs, fund training and education centers, recruit entry-level as well as experienced workers, set local, tribal, and equitable hiring standards, and prioritize prevailing wage and union labor.
- Coordinate with local communities, tribes, workforce training centers, government agencies, community organizations, employers, high schools, community colleges, and universities to create career opportunities, workforce training, and economic development benefits.
- Support the development of project labor agreements that provide local and underserved communities and tribes with meaningful economic benefits from offshore wind development.

Transmission Technology and Alternatives

The following recommendations support technology development and alternatives assessment to effectively plan for offshore wind transmission:

- Continue assessing transmission alternatives for the North and Central Coast offshore wind development to meet the offshore wind planning goals, including analyzing corridors, routes, and rights-of-way for promising transmission pathways, including land-based (overhead and underground, HVAC and HVDC) and subsea cable alternatives.

- Consider phased approaches to transmission development to examine both short-term and long-term offshore wind development needs, costs, and benefits that balance these factors.

Transmission Planning and Interconnection

The following recommendations support planning and interconnection processes to bring transmission projects online in a timely manner to meet the offshore wind planning goals:

- Foster regional bulk transmission planning efforts to support offshore wind development along the West Coast to maximize the potential benefits throughout the Western Interconnection.
- Explore innovative approaches, such as networked or backbone systems, and implementation mechanisms, to efficiently bring offshore wind energy to shore to meet the offshore wind planning goals.
- Inform existing transmission planning processes by systematically identifying and prioritizing alternative points of interconnection that limit the number of landfall sites and minimize environmental impacts and long run costs.

Offshore Wind Permitting

The following recommendations address the need for a coordinated, comprehensive, and efficient permitting and environmental review process:

- The state should consider developing and implementing a coordinated, comprehensive, and efficient process for permitting offshore wind and related projects based on the previously successful Renewable Energy Action Team (REAT) and Renewable Energy Policy Group (REPG) models developed in 2008 to permit utility-scale renewable energy projects in the California desert.
- The state should engage early and consistently with BOEM on its offshore wind programmatic environmental impact study to ensure the analysis is reflective of the state’s priorities as it relates to data collection, analysis methodology, impact identification, and mitigation measures.

Appendix A: List of Acronyms

AB – Assembly Bill

AB 525 – Assembly Bill 525 (Chiu, Chapter 231, Statutes 2021)

AC – alternating current

BOEM – Bureau of Ocean Management

BSEE – Bureau of Safety and Environmental Enforcement

CARB – California Air Resources Board

California ISO – California Independent System Operator

CBA – Community Benefits Agreement

CCC – California Coastal Commission

CDFW – California Department of Fish and Wildlife

CEC – California Energy Commission

CEQA – California Environmental Quality Act

CFRA – California Fisherman's Resiliency Association

CNRA – California Natural Resources Agency

CPUC – California Public Utilities Commission

CSLC – California State Lands Commission

CZMA – Coastal Zone Management Act

DC – direct current

DOD – U.S. Department of Defense

DOE – U.S. Department of Energy

DOI – U.S. Department of Interior

EJ – environmental justice

EIR – Environmental Impact Report

EIS – Environmental Impact Study

FAA – Federal Aviation Administration

FAST Act – Fixing America's Surface Transportation Act

FERC – Federal Energy Regulatory Commission

FSN – Final Sale Notice

GDP – gross domestic product

GHG – greenhouse gas emissions

GO-Biz – Governor's Office of Business and Economic Development

GSP – gross state product

GW – gigawatt

HVAC – High Voltage Alternating Current

HVDC – High Voltage Direct Current

IOU – investor-owned utility

IRA – Inflation Reduction Act

IRP – Integrated Resource Plan

ISO – Independent System Operator

JPA – joint powers authorities

km – kilometers

kV – kilovolts

LCOE – levelized cost of energy

LSE – load serving entity

MOU – Memorandum of Understanding

MW – megawatt

NEPA – National Environmental Policy Act

nm – nautical miles

NMFS – National Marine Fisheries Service

NOAA – National Oceanic and Atmospheric Administration

NRDC – National Resource Defense Council

NREL – National Renewable Energy Laboratory

NYSERDA – New York State Energy Research and Development Authority

NRDC – Natural Resource Defense Council

OCS – Outer Continental Shelf

OEM – original equipment manufacturer

OPC – Ocean Protection Council

OPR – Governor's Office of Planning and Research

PAC-PARS – Pacific Coast Port Access Route Study

PACW-1 – Pacific Wind Lease Sale 1

PEIR – Programmatic Environmental Impact Report

PEIS – Programmatic Environmental Impact Statement

PG&E – Pacific Gas & Electric

PLA – Project Labor Agreement

PNNL – Pacific Northwest National Laboratory

POU – publicly owned utility

PSN – Proposed Sale Notice

REAT – Renewable Energy Action Team

RETI – Renewable Energy Transmission Initiative

SAP – Site assessment plan

SB – Senate Bill

SB 100 – Senate Bill 100 (De León, Chapter 312, Statutes of 2018)

SCE – Southern California Edison

TPP – Transmission Planning Process

USCG – U.S. Coast Guard

USFWS – U.S. Fish and Wildlife Service

WEA – Wind Energy Area

Appendix B: Glossary of Terms

Assembly Bill 525 (AB 525): (AB 525, Chiu, Chapter 231, Statutes of 2021) directs the California Energy Commission (CEC) to complete and submit a strategic plan for offshore wind development in federal waters off the California coast to the Natural Resources Agency and the relevant fiscal and policy committees of the Legislature.

Bureau of Ocean Energy Management (BOEM): The federal agency under the U.S. Department of Interior that manages development of U.S. Outer Continental Shelf energy and mineral resources. BOEM manages overall offshore wind processes which includes four phases: planning and analysis, leasing, site assessment, and construction and operation.

California Coastal Zone: A legislatively defined geographic region that establishes the area regulated under the Coastal Act encompassing the land and water areas along the length of the California coastline from the Oregon border to the border of Mexico, extending seaward to the state's outer limit of jurisdiction, including all offshore islands, and extending inland generally 1,000 yards from the mean high tide line of the sea.

California Independent System Operator (California ISO): The California ISO manages the flow of electricity on high-voltage power lines, operates a wholesale energy market, and oversees infrastructure planning.

Call Area: Areas with potential for commercial wind energy development that BOEM and the Intergovernmental Renewable Energy Task Force have proposed in a Call for Information and Nominations. BOEM considers public comments to delineate a Wind Energy Area within a Call Area.

Community Benefits Agreement (CBA): A legally binding agreement that has been negotiated and agreed upon between a developer and one or more communities, tribes, or stakeholder groups that are expected to be affected by the potential impacts resulting from lease development. A CBA is unique and tailored to the individual needs and circumstances of communities. BOEM has offered developers bid credits in previous offshore wind lease sales (such as the PACW-1) in exchange for a future executed CBA(s).

Community Choice Aggregator (CCA): Community choice aggregators can procure electricity on behalf of retail electricity customers within some geographic areas. CCAs may be run directly by a city or county government or by a third party through a contractual arrangement such as a joint powers agreement.

Community Workforce Agreement (CWA): Consists of a Project Labor Agreement that includes language to broaden access to good jobs in construction. These targeted or local hire provisions typically include requirements to hire a certain minimum percentage of workers from zip codes that are near the project and/or from economically disadvantaged or underserved communities.

Consistency Determinations (CDs): A consistency determination is submitted to the CCC when a federal agency activity affects the coastal zone. It is a project description and analysis of the activity's coastal zone effects based on the policies of the Coastal Act.

Construction and Operations Plan (COP): A COP is an application an offshore wind developer makes to the Bureau of Ocean Energy Management for a permit to develop offshore wind energy. Submission of a COP is required by 30 CFR part 585 for Outer Continental Shelf (OCS) renewable energy activities on a commercial lease. A COP describes construction, operations, and conceptual decommissioning plans under the commercial lease, including project easement.

CPUC Integrated Resource Planning (IRP): A planning proceeding to consider all the CPUC's electric procurement policies and programs and ensure California has a safe, reliable, and cost-effective electricity supply. The integrated resource planning process ensures that load-serving entities (LSEs) detail the procured and planned resources in their portfolios that allow the electricity sector to contribute to California's economywide greenhouse gas emissions reductions goals. Increasing amounts of offshore wind resources are being added to the resource portfolios developed by the CPUC in the IRP process.

Demand-side Resources: Demand-side resources serve resource adequacy needs by reducing load, which reduces the need for additional generation. Typically, these resources result from energy efficiency or demand response and load management.

Environmental Document: Reports required by the National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) that contain analyses of a project's environmental impacts that require discretionary approval by a government agency. Examples of environmental documents include environmental impact statements (EIS), environmental impact reports (EIR), environmental assessments (EA), initial studies, negative declarations, and more.

Floating Offshore Wind: Offshore wind turbines deployed in water depths that necessitate floating structures and are stabilized by moorings and anchors. Floating offshore wind technology allows for offshore wind to be deployed in deeper waters where fixed bottom offshore wind is not feasible. Due to the nearshore drop off of the Pacific Continental Shelf, floating offshore wind is the only feasible option for California.

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.

High Road Training Partnerships (HRTPs): HRTPs are industry-based, worker-focused training partnerships that build skills for California's high road employers – firms that compete based on quality of product and public entities that strive to provide a high level of service through innovation and investment in human capital.

Lease Holder (or Lessee): A developer that has been awarded a lease with rights to the renewable energy resources available within the designated lease area as detailed in the lease agreement with the Bureau of Ocean Energy Management. The lease holder may progress through the site assessment and constructions and operations phases.

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, LCOE is a measurement to assess and compare alternative methods of energy production.

Load Serving Entity: Load-Serving Entity is any company that sells or provides electricity to end users located in California, or that generates electricity at one site and consumes electricity at another site that is in California and that is owned or controlled by the company.

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).

Nacelle: A nacelle is a cover housing for all of the generating components in a wind turbine, including the generator, gearbox, drive train, and brake assembly.

Nameplate Capacity: The total manufacturer-rated capacities (or full-load sustained energy generation output) of equipment such as turbines, generators, condensers, transformers, and other system components. Offshore wind turbine nameplate capacities are rated in megawatts (MW).

Offshore Wind Energy: When offshore winds rotate the turbines, the rotor blades kinetic energy is converted into mechanical energy that powers a generator in the nacelle which produces electrical energy.

Offshore Wind Project (or Farm): A deployment of offshore wind turbines in a designated area intended to generate energy. Each offshore wind project is an independent entity within its lease area. A project (or farm) consists of the offshore wind turbines, array and export cables, and mooring systems. Offshore wind generated energy needs to be transformed at an offshore substation which may also be considered a part of the project.

Offshore Wind Turbine: (in report text sometimes referred to as turbine) A large utility-scale horizontal-axis wind turbine consisting of a tower, nacelle, hub, and rotor blades. Similar in design to terrestrial wind turbines, offshore wind turbines are located in waters with sufficient wind speeds. The size of the turbine (in hub height and rotor diameter) is proportional to the generation capacity.

Outer Continental Shelf (OCS): Includes the submerged lands between state jurisdiction to 200 nautical miles (nm) from shore. The OCS is the portion of the internationally recognized continental shelf of the U.S. which does not fall under the jurisdictions of the individual U.S. states.

Project Developer (Developer): A project developer is responsible for the development and management of the project, including activities required to secure financing and permits, determine the project's design and engineering aspects, and engage with partners, agencies, and stakeholders. An offshore wind developer is the owner and operator of an offshore wind project.

Project Labor Agreement (PLA): a pre-hire collective bargaining agreement with one or more labor unions setting the terms and protocols of project execution and worksite conditions and prohibiting work stoppages due to labor disputes. PLAs have become the industry norm and are used on almost all utility-scale renewable energy construction projects, even though they are not required by state law.

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. Offshore wind will require ports and waterfront facilities to support a range of activities, including construction and staging of floating platform foundations, manufacturing and storage of components, final assembly, and long-term operations and maintenance.

Project Phase(s): Offshore wind project activities can be categorized into chronological phases. Key offshore wind project workforce and supply chain development phases include supply chain and manufacturing, integration and assembly, and operations and maintenance. These project phases overlap with the BOEM renewable energy program phases: planning, leasing, site assessment, and construction and operations. Offshore wind developers incorporate both categories of project phases into a project timeline.

Publicly Owned Utilities (POUs): POUs are not-for-profit public agencies that supply and deliver electricity to their communities and are governed by locally elected officials, such as city council members or, for some agencies, regionally elected directors.

Renewable Energy Action Team (REAT): The REAT, formed in 2008, was a collection of state and federal agencies that came together to expedite the siting of renewable generation, primarily large solar facilities, and transmission projects in the California desert.

Site Assessment Plan (SAP): A plan that describes how a lessee intends to gather data to characterize the leased site, such as the construction or installation of meteorological buoys, device testing, and acquired easements.

Supply Chain: The sequence or system of organizations or operations that work together to design, produce, and deliver a product or service to a market. The offshore wind supply chain refers to the companies involved in the creation and implementation of offshore wind components.

Transmission Planning Process (TPP): Annual stakeholder process that provides a comprehensive evaluation of the California 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. Offshore wind projects are currently included within the scope of the TPP.

Wind Energy Area (WEA): An area delineated by BOEM that appears most suitable for wind energy development. A WEA is designated in anticipation of a future lease sale. WEA is also the term used to describe an existing or previously leased area.

Workforce: The workers needed to support a project or industry. The workforce for offshore wind consists of workers needed to perform all types of jobs related to the offshore wind ecosystem for all project phases.