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E2 economic benefit analysis of OSW development in California

Additional submitted attachment is included below.

Natural Resources Defense Council
Julia de Lamare (jdelamare@nrdc.org)

February 23, 2023

California Energy Commission

Re: Docket # 17-MISC-01 – Resubmission – Preliminary Assessment of Economic Benefits of Offshore Wind - Related to Seaport Investments and Workforce Development

On December 22, 2022, NRDC submitted a report commissioned by E2 (Environmental Entrepreneurs) presenting an economic benefit analysis of offshore wind development in California. The analysis demonstrates that policies that harness offshore wind resources will drive a sustainable, resilient offshore wind industry with significant economic benefit to California.

The report is hereby resubmitted as it needed an amendment on page 4 to clarify that a two-phase development of offshore areas in Morro Bay and Humboldt Bay would lead to a conservative estimate of nearly 169,000 construction ***job-years*** and about 5,750 annual operations and maintenance jobs, with upwards of $15 billion in local wages.

The total economic benefit to California would be $45 billion. This includes more than $1.8 billion in state and local tax revenue generated from the two locations, and more than $75 million in annual state and local tax revenues stemming from the operation and maintenance of the sites.

There will be additional economic benefits if there is additional development beyond the 10 GW target by 2040 analyzed in this report. Given California's higher offshore wind planning goals, the state can expect significantly more jobs created that would scale with the amount of total offshore wind developed in California.

NRDC supports responsible offshore wind development, which offers California a great opportunity to fight climate change, reduce air pollution, and improve reliability. We appreciate CEC's work to comply with AB 525 and commend the Commission for the Preliminary Assessment of Economic Benefits of Offshore Wind - Related to Seaport Investments and Workforce Development. Thank you for the opportunity to comment on AB 525.

California's Offshore Wind Opportunity

Creating jobs by developing a new clean energy resource, and capitalizing on robust job creation potential

February 2023
E2R: 22-10-B

About E2

E2 (Environmental Entrepreneurs) is a national, nonpartisan group of business leaders, investors, and professionals from every sector of the economy who advocate for smart policies that are good for the economy and good for the environment. E2 members have founded or funded more than 2,500 companies, created more than 600,000 jobs, and manage more than $100 billion in venture and private equity capital.

E2 releases more than a dozen clean energy employment reports annually—including Clean Jobs America—with state-specific reports covering more than 20 states every year.

For more information, see www.e2.org or follow us on Twitter at @e2org.

1. OVERVIEW

About one third of the energy powering California's electric grid currently comes from nonhydroelectric renewable resources.[1] Yet in barely more than two decades, California will be legally required to generate *all* its electricity from clean, carbon-free energy.[2] Adding more solar, onshore wind, and geothermal energy, coupled with robust energy efficiency gains, will help close this gap; but to power its economy from 100 percent clean, renewable energy by 2045, California must develop and invest in new technologies and manufacturing capabilities.

Within the wind industry, an increasingly important market segment is quickly developing for *floating offshore wind*. This technology, which is not yet developed at a major commercial scale anywhere in the world, uses mooring systems and dynamic electrical cables to create new wind power generation opportunities in deep water like the Pacific Ocean off California's coast, where the more conventional method of fixing turbines directly to the seafloor is technically infeasible.

California and federal lawmakers have an opportunity to hasten the development—and scale the deployment—of this valuable new technology by enacting appropriate policies now. This is especially urgent on the heels of President Joe Biden signing into law the Inflation Reduction Act (IRA) of 2022. This bill includes full-value tax incentives for the manufacturing and deployment of technologies like offshore wind in the U.S. The IRA also includes billions of dollars for the U.S. Department of Energy (DOE) to help scale up technologies like floating offshore wind.

The Biden administration has set its sights on leading the global community in the development of floating offshore wind, and in September 2022 committed to develop 15 gigawatts (GW) of floating offshore wind power by 2035, which is an expansion of the White House's existing goal of 30 GW of offshore wind by the end of the decade.[3]

To ensure this clean energy resource remains a sustainable, economically valuable asset for decades to come, lawmakers must ensure offshore wind is developed responsibly and in a way that protects the biodiversity of local marine ecosystems. Over the next 20 years, adaptive management of the state's marine and coastal ecosystem resources will be crucial. By developing California's offshore wind resources responsibly from the outset, legal action that would otherwise hinder development and impede critical climate mitigation can be minimized.

Offshore wind will diversify California's renewable energy supply. This is critical to a stable electric grid and, crucially, can help the state achieve its long-term clean energy and climate ambitions in a least-cost manner. At the same time, floating offshore wind can create tens of thousands of new jobs for Californians, benefit underserved communities, and generate billions of dollars' worth of wages, investments, economic benefits and tax revenues at the state, local and federal levels.

Ultimately, enacting smart public policies can vault California into a global leadership position in the high-tech, fast-growing, job-creating floating offshore wind industry—but state policymakers need to act now.

The Resource, the Jobs and the Economic Value

According to the National Renewable Energy Laboratory (NREL), California's coast has a resource potential of at least 200 GW of offshore wind, and possibly as much as 400 GW.[4] At the state level, regulators at the California Energy Commission (CEC) are currently identifying achievable build-out targets for offshore wind over the next 20-plus years.

For the planning goals, the CEC established a preliminary planning goal range of 2 GW–5 GW of offshore wind for 2030, and a preliminary planning goal of 25 GW for 2045. They are accounting for transmission limitations, ecosystem impacts, and the need to develop a skilled and trained offshore wind workforce.

The two areas most likely to experience sizable investments in floating offshore wind in California by 2045 are located about 20 miles off the coast, in the waters of Morro Bay and Humboldt Bay. The U.S. Bureau of Ocean Energy Management (BOEM) held an offshore wind auction in December 2022 to secure rights to five lease areas in Morro Bay and Humboldt Bay. While more wind energy areas will be needed to meet the state's 25 GW goal by 2045, these Wind Energy Areas have the potential to produce over 4.6 GW of floating offshore wind energy.[5]

According to an analysis conducted by BW Research for E2, a two-phase development of these two offshore areas would lead to a conservative estimate of nearly 169,000 construction job-years and about 5,750 annual operations and maintenance jobs, with upwards of $15 billion in local wages.[6]

The total economic benefit to California would be $45 billion. This includes more than $1.8 billion in state and local tax revenue generated from the two locations, and more than $75 million in annual state and local tax revenues stemming from the operation and maintenance of the sites.

This data is detailed further on Pages 13-15.

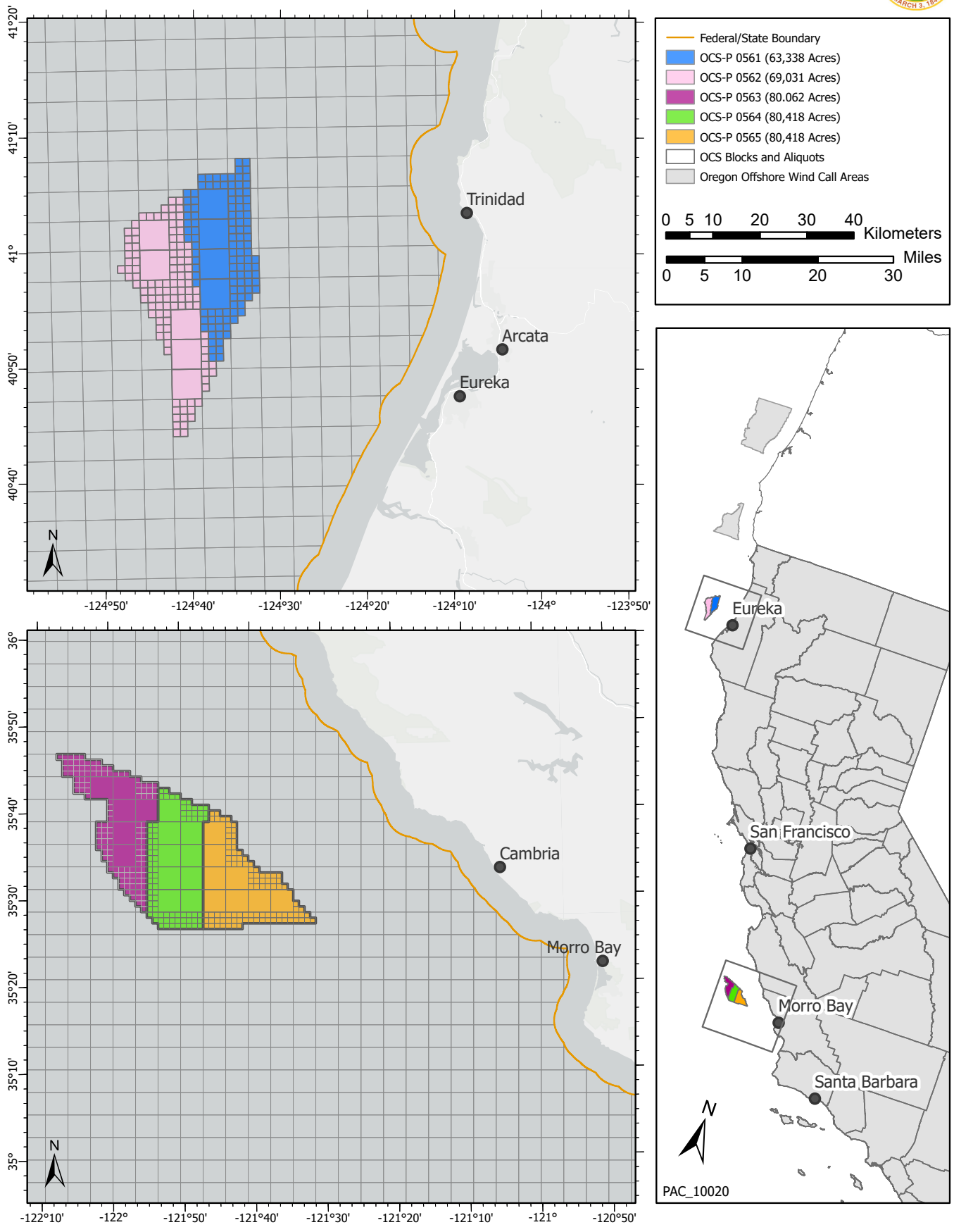
While this analysis models the economic benefits of a 10 GW build-out by 2040, it does not suggest a target for the CEC to consider—it simply uses the 10 GW number used in the SB 100 CPUC modeling. The economic benefits demonstrated by this analysis provide an illustrative snapshot of the potential from a specific level of development that might occur off the California coast over the next 20 years. There will be additional economic benefits if there is additional development beyond the GW targets analyzed in this report. A recent report released by the CEC established a preliminary planning goal range of 2 GW–5 GW of offshore wind for 2030, and a preliminary planning goal of 25 GW for 2045.[7] These preliminary goals will guide the development of the strategic plan for offshore wind in California, which is due on June 30, 2023, pursuant to AB 525, and will be revised as part of completing the strategic plan and as more information becomes available.

Multiple regions off California's coast are under consideration for offshore wind development, but the data generated by this analysis focuses on just the economic impact from the potential development of the Morro Bay and Humboldt Bay locations, as these locations were recently proposed by the Biden Administration for the first-ever California offshore wind lease sales.

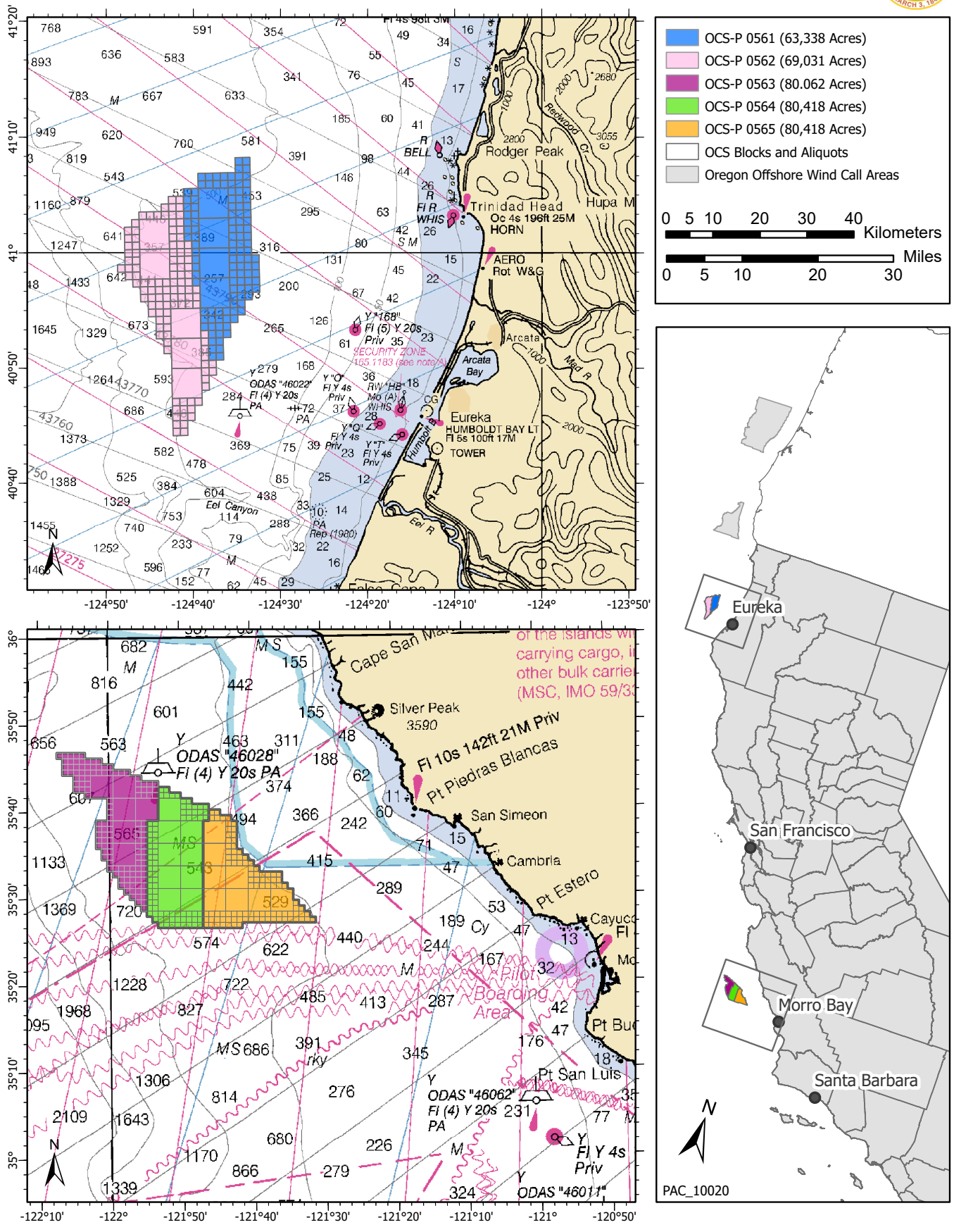
This study makes relatively conservative assumptions around the supply chain and statewide manufacturing opportunities associated with the nascent floating offshore wind energy industry. Those assumptions are quantified in Appendix A on Page 18, and, for example, assume that only 40 percent of the offshore wind turbines in the first development phase will be manufactured in California.

The assumptions in this analysis mean that with additional policies and public investments focused on expanding the statewide supply chain and manufacturing capacities for offshore wind, California could experience even greater economic and employment impacts from the development of offshore wind at Morro Bay and Humboldt Bay. Developing a robust in-state offshore wind innovation and manufacturing hub could also pay dividends as other regional and global locations with deep waters (i.e., Oregon) look to develop their offshore wind potential and turn to California for its established expertise and supply chains.

PACW-1 Final Lease Areas



PACW-1 Final Lease Areas



Policy Spotlight

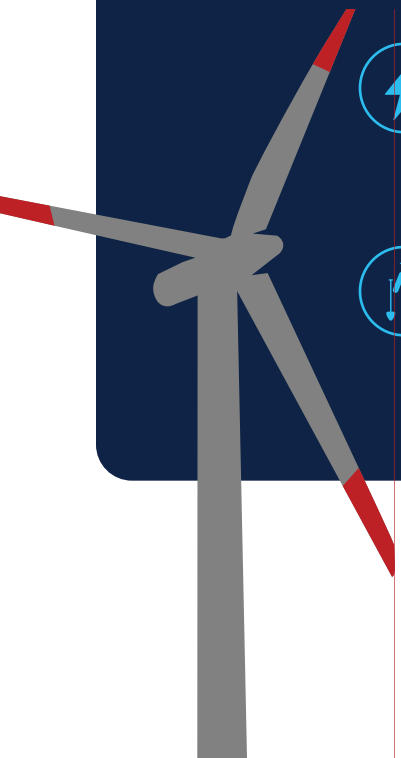
Several state and national-level policies intersect with or have the potential to boost California's floating offshore wind industry. A brief overview is below, with a more detailed policy analysis on Page 12:

// **AB 525 (Energy: offshore wind generation):** In addition to setting state offshore wind planning goals for 2030 and 2045, the CEC is directing state agencies to analyze the impacts of wind deployment, as well as to strategically plan for and address any barriers to development of an in-state offshore wind industry. By helping rapidly develop a component manufacturing base and floating offshore wind supply chain, an AB 525 report will help ensure environmentally responsible development that drives private investment, creates job opportunities and maximizes the opportunity to capitalize on export markets. Preliminary offshore wind planning goals were released in August 2022. These preliminary goals will guide the development of the strategic plan (due on June 30, 2023) and will be revised as part of completing the strategic plan and as more information becomes available.

// **California budget:** On September 6, 2022, Gov. Gavin Newsom signed into law 2023 state budget implementing language that includes $45 million to fund offshore wind activities. Led by the CEC, this will create an Offshore Wind Energy Deployment Facility Improvement Program, helping to advance California's offshore wind industrial capabilities.[8]

// **Federal drilling plan:** BOEM has the ability to permanently ban new offshore oil leases in its next five-year offshore plan, a draft of which was released on July 1, 2022. On October 2021, an oil spill off Huntington Beach jeopardized Orange County's coastal economy, which supports more than 57,000 jobs and is worth more than $4 billion.[9] Nationwide, activities like tourism, recreation and fishing support around 3.3 million coastal economy jobs and about $250 billion in GDP.[10] Offshore wind's economic and jobs benefits can be realized in California (and elsewhere around the country) without threatening high-value coastal economies with inevitable oil spills, underscoring the economic imperative for BOEM to enact the development ban now.

California offshore wind = jobs + economic development



DEVELOPING THE RESOURCE…

// **Develop 10 GW of floating offshore wind by 2045**

// **Off Humboldt and Morro bays**

CREATES JOBS…

// **169,000 construction job-years**

// **5,750 O&M jobs**

DRIVES ECONOMIC GROWTH…

// **Total economic benefit to California: $45 billion**

AND GENERATES TAX REVENUES

// **$1.8 billion+ in state & local tax revenue to build the two locations**

// **$75 million in annual state & local tax revenues from O&M at the sites**

2. JOBS IN FOCUS

Types of Jobs

A recent BW Research study of Maine's potential offshore wind industry mapped out 117 distinct occupations.[11] While California's floating offshore wind workforce needs will be somewhat different than Maine's fixed-bottom turbines, this provides an estimate of the number of types of jobs that will be needed.

Based on national estimates around employment opportunities in the development and operation of offshore wind projects, California's offshore wind jobs would likely be in construction and installation, support services, operation and maintenance, planning and development, and manufacturing and assembly.

More specific occupations could include welders, electricians, iron workers, engineers, crane workers, vessel mechanics and concrete laborers. Recent studies on the potential economic impacts of the emerging offshore wind industry emphasize considerable opportunities for shovel-ready jobs paying sustainable wages.[12]

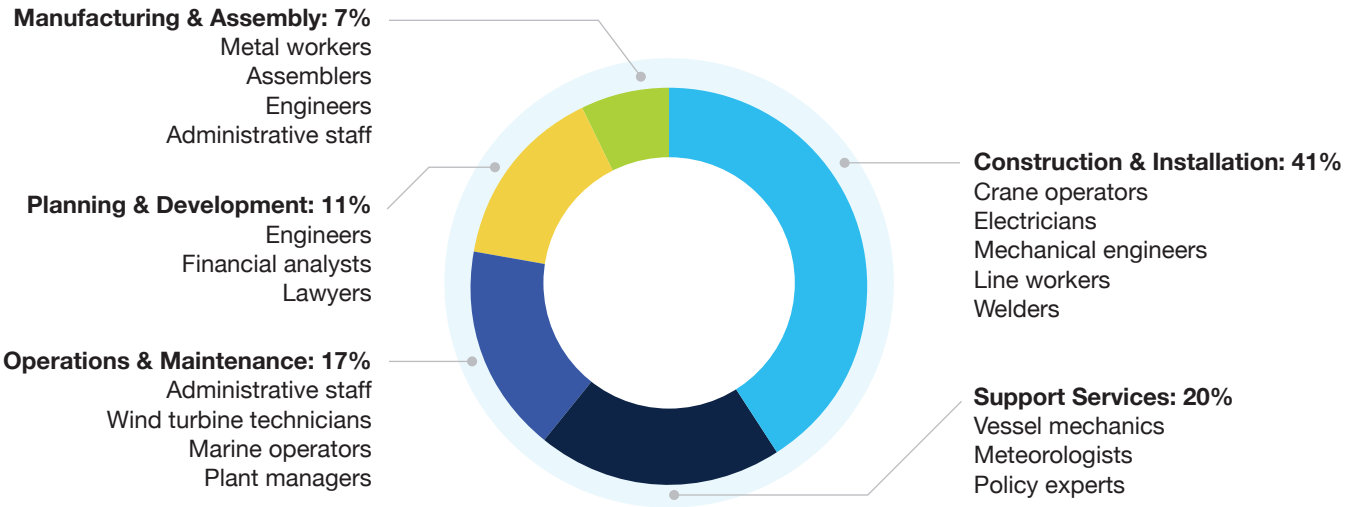
No matter what the jobs are, Project Labor Agreements (PLAs) can play a valuable role in increasing local hiring and investment opportunities. According to the AFL-CIO, PLAs are "collective bargaining agreements between building trade unions and contractors. They govern terms and conditions of employment for all craft workers—union and nonunion—on a construction project. They protect taxpayers by eliminating costly delays due to labor conflicts or shortages of skilled workers."[13]

PLAs can also be used to help ensure underserved communities have equitable access to job opportunities.

Port Infrastructure Jobs

The CEC is assessing requirements to identify and select potential ports. Before they can host projects essential to offshore wind development (i.e., assembling large floating turbines), Port Hueneme and the Port of Humboldt Bay would require site improvements. Renovating and revitalizing these and other ports to assist with the construction and development of California's proposed offshore wind projects could be a significant source of local employment, as the U.S. East Coast has already experienced.[14] To meet the 10 GW assumption for offshore wind development used in this study, expansion of port infrastructure is expected to generate approximately 10,000 one-time construction and development jobs in California. These jobs are included in our overall employment outputs for construction in Phase 1 and Phase 2.

Figure 1 // Direct U.S. Offshore Wind Opportunities



To meet the 10 GW assumption for offshore wind development used in this study, expansion of port infrastructure is expected to generate approximately 10,000 construction and development job-years in California.

Supply Chain Assumptions

The supply chain assumptions in this report follow conservative local content multipliers from NREL for the state of California and are derived from supply chain estimates for offshore wind projects in New York and New Jersey. The main assumption is that the local supply chain for Phase One in 2030 will be in the early stages of development, mainly for materials, components and maintenance activities. The projection for Phase One assumes that a large portion of the materials for turbine components come from out-of-state, and a smaller but still large portion of the labor for turbine components are not locally met. For Phase Two, the supply chain is assumed to be more developed and therefore a larger portion of the demand for labor and materials required for construction and operations of the offshore wind projects can be met locally.

Workforce Development Opportunities

Employment opportunities in offshore wind are just starting to be understood. However, it's clear the industry will require new talents and skills from people who are currently in the workforce, while simultaneously expanding the offshore wind industry's capacity to educate a new generation of workers so they are able to acquire the skills, trainings and certifications that will be in heavy demand for decades.

// A Track Record of Clean Energy-Driven Job Growth

In the renewable energy industry, California has already successfully deployed an economic development and jobs growth model featuring strategic public policies that drive investments, innovation, workforce development and education.

Market structures that were enabled in part due to decades of smart policy have helped develop the broader clean energy industry to into a core and vital part of the state's robust economy. In the 1980s and 1990s, for example, California pioneered the U.S. onshore wind power industry, while simultaneously emerging as a global leader in solar technology. More recently, California has become a global titan of the electric vehicle (EV) industry, in part due to the 1-2 punch of nation-leading zero-emission vehicle standards and a culture of innovative entrepreneurship.

This has translated into jobs. According to E2's Clean Jobs America 2022 report, there are over 500,000 clean energy workers in the state, including roughly 130,000 in renewables, 53,000 in clean vehicles and 23,000 in storage and grid.[15] Just prior to Covid, clean energy jobs comprised 3 percent of statewide employment and a staggering 30 percent of construction jobs.

Clean energy jobs pay well, too. According to E2, California workers in renewable energy, energy efficiency, grid modernization and storage, clean fuels and clean vehicles earned a median hourly wage in 2019 of about $27.50. That's about 30 percent higher than the statewide median wage.[16] In addition, jobs in many clean energy sectors are more likely to be unionized and come with more health care and retirement benefits than the rest of the private sector. In addition, under the federal Inflation Reduction Act of 2022, to be eligible for the full value of most federal incentives, clean energy companies must pay prevailing wages and support training, suggesting an even greater boom in good-paying clean energy jobs to come.

State and federal lawmakers have the opportunity to replicate this success of high-paying blue- and white-collar California job creation through a thoughtful, sustainable build-out of the State's offshore wind resources.

3. ADDITIONAL BENEFITS: MANUFACTURING, EXPORT OPPORTUNITIES, A MORE RESILIENT GRID AND CLEANER AIR

Inland Manufacturing and 'Super-Regional' Supply Chains

Located approximately 20 miles offshore from the central San Luis Obispo County coastline, the Morro Bay Wind Energy Area includes a proposed project area of about 376 square miles. The Humboldt Wind Energy Area is located approximately 20 miles off the coast of central Humboldt County, with a proposed project area of about 207 square miles.

These offshore waters will host the turbines, towers, cables and mooring systems needed for wind generation. But the economic activity they generate will be felt across the state. Areas realizing beneficial impacts would include the coastal economies surrounding these Wind Energy Areas, where California is currently examining the feasibility of offshore wind manufacturing. It could also include places further inland, including Central Valley communities strung along the Bay Delta.[17]

The manufacture and transport of offshore wind blades has the potential to bring jobs and economic growth to the inland port city of Stockton. Stockton's port has shipping docks connected to two transcontinental railways, recurrent ship visits from more than 50 countries, and two cranes boasting 144 metric tons of capacity each that have already been utilized to transport wind turbine blades.[18]

"One area experiencing significant growth in 2020 was project cargoes with cargo shipments uniquely related to green energy projects," according to the Port of Stockton's 2020 annual report.[19] "For instance, the Port hosted six wind energy shipments for regional projects that will help the State of California achieve its goal of 100 [percent] renewable electricity generation by 2045.

"The projects involved equipment destined for a wide geographical area, reinforcing the Port's position as a super-regional logistics hub. The Port has been told to expect additional shipments of the same or similar cargoes [in the future]."

As E2 noted in an August 2021 report on the economic benefits of climate action in California, the state has seen how manufacturing and supply chain investments in other clean industries spurs economic growth.[20] For example, Tesla alone has grown to be one of the state's largest manufacturing employers, with about 10,000 jobs at its largest plant in Fremont. The state's EV workforce is projected to nearly double by 2024. In 2020, EVs were the state's most valuable export, producing nearly $5.7 billion in revenue and eclipsing California's venerable aerospace industry for the first time.

If California makes smart investments and enacts the right policies now, the state can similarly compete alongside European corporate offshore wind incumbents like Ørsted, Iberdrola and Engie. (See box, Page 11.)

Importantly, these smart investments in supply chain manufacturing capacity have the opportunity to buoy California's coastal economies, as well as strategically located inland economies, such as those adjacent to the Port of Stockton.

Transmission Investments and Air Quality

Transmission infrastructure to support offshore wind development in the project areas analyzed in this study is currently designed to only serve electricity to the local area rather than the entire state of California. An upgrade in transmission systems and connection to the grid will not only create jobs to execute the build-out but is an important step in developing infrastructure for large offshore wind projects in the state, which can lead to other health and economic benefits.

For example, building a subsea transmission cable from the Los Angeles Basin to Diablo Canyon would enhance Southern California's link to future offshore wind developments. While additional study is needed to determine the necessity of this specific infrastructure investment, a subsea transmission cable connecting to clean offshore wind energy would allow Los Angeles' methane gas peaker plants to idle more frequently and for longer durations, which will improve air quality in neighboring areas, including in low-income communities.

Right now, methane gas peaker plants in Los Angeles release toxic pollution into the air that local residents breathe. This pollution costs Californians money: Decreased productivity, missed workdays, more hospital visits and additional healthcare expenses all exact a toll on area workers and businesses.

Beyond cleaner air (as well as economic growth and more jobs), the benefits of offshore wind-related transmission and grid development in Southern California and elsewhere in the state include relieving bottlenecks in the region's energy transmission system and minimizing threats from wildfires sparked by the electric grid.

// Exporting Innovations in Floating Offshore Wind Technologies

Even in a mature and booming offshore wind market like Europe's—which in 2020 alone attracted more than €26 billion, or nearly $30 billion, in investment—floating offshore wind remains a niche market in the early stages of development.[21] In Europe, just 4-5 GW of floating offshore wind are expected to be operational by 2030.[22] That's not far off from reasonable projections for California, where 3 GW could be developed by the end of this decade.

Europe hasn't invested in floating offshore wind because it hasn't had to—yet. In the North Sea, where much of the U.K.'s and Europe's fixed-bottom offshore wind developments lie, the average water depth is roughly 95 feet.[23] But with thousands of offshore wind turbines now spinning above the surface of Europe's coastal waters, near-shore industrial development is getting crowded, and Europeans are looking beyond the horizon toward the deep.

Unlike Europe (and, for that matter, the East Coast, where the only significant commercial-scale offshore wind development in the U.S. is in Rhode Island's Block Island Sound, at depths ranging from 75 to 90 feet), California doesn't have the luxury of shallow water.[24] California's continental shelf drops off quickly. The state's two proposed development areas are located in water ranging from about 2,700 to 3,300 feet deep, necessitating novel mooring and cabling technologies.

The dearth of floating offshore wind developments elsewhere in the world—combined with the Pacific Ocean's unforgiving bathymetry—present California with a golden opportunity to pioneer and ultimately lead a burgeoning global renewable energy segment, despite the state's relatively late entry into the broader offshore wind industry.

By 2050, floating offshore wind will be far cheaper than fixed offshore or onshore wind is today. Californians can cut the key that unlocks vast tracts of seacoast around the world for deep-water, gigawatt-scale renewable energy development.[25] This won't
just open California's own leasing areas—it will also unlock 80 percent of the offshore wind capacity potential remaining in Europe,[26] as well as Asian waters off Japan, Korea and Taiwan.[27]

This boosts homegrown jobs—and export opportunities—right here in California.

4. CONCLUSION

Policy Matters

California has been a global climate leader by passing policies that have created the market structures necessary to drive innovation, build the state's clean energy economy and reduce carbon emissions. To maximize the economic benefits of harnessing the state's offshore wind resources—especially in light of the major federal clean energy investments in the Inflation Reduction Act—state and federal governments must advance policies that will drive a sustainable, resilient offshore wind industry in California. Specifically, this includes:

// Development of a strategic plan by the end of 2023 that formalizes targets; identifies suitable sea space, programs and funding; advances economic and workforce development and in-state manufacturing opportunities; optimizes transmission planning and permitting; identifies potential impacts on ocean uses and the environment, as well as strategies for addressing those potential impacts; and helps de-risk projects early on in order to provide greater certainty for the industry.

// Ensuring that AB 525 requires the CEC to develop a permitting road-map that describes timeframes and milestones for a permitting process for offshore wind energy facilities and associated electricity and transmission infrastructure off the coast of California.

// The State of California must investigate the need for—and, if warranted, approve construction of—a subsea transmission cable from the Los Angeles Basin to Diablo Canyon. This could resolve current regional transmission constraints, reduce dependency on dirty natural gas peaker plants, and minimize threats of grid-induced wildfire, while providing transmission capacity to connect Southern California with potential future offshore wind development.

// State officials must leverage funding from the Infrastructure Investment and Jobs Act dedicated for grid modernization to upgrade the grid for offshore wind energy integration.

// Congress must invest more in grid modernization including passing a grid modernization tax credit that is essential to the development of offshore wind and the deployment of utility scale clean energy generally.

// The CEC, in partnership with the Ocean Protection Council and BOEM, must make continued investments in environmental planning and mapping for offshore wind development, primarily through the funding and support of the Offshore Wind Data Basin.

// The State should develop and fund an institute—under the purview of the California Coastal Commission—dedicated to the collecting and public sharing of data related to the monitoring and mitigation of ocean ecosystem impacts.

// BOEM must incorporate ocean ecosystem impact monitoring and mitigation stipulations in its lease agreements.

5. THE DATA

Phase One: 3 GW

The goal of developing 10 GW of offshore wind in California by 2045 is assumed to occur in two phases, at the two most likely locations, Morro Bay and Humboldt Bay. The first phase would likely be completed between 2028 and 2034. Below are the key assumptions for each of the two locations in the first phase.

Morro Bay is expected to build 1.8 GW of offshore wind capacity in the first phase, with a total construction cost of approximately $7.8 billion and a construction cost per kilowatt of $4,342.

Humboldt Bay is expected to build 1.2 GW of offshore wind capacity in the first phase, with a total construction cost of approximately $5.1 billion and a construction cost per kilowatt of $4,287.

Phase One: Construction

Expenditures during the construction stage will include materials, installation, labor, components, insurance, and development services such as engineering, legal and design. Total expenditure in this stage will be close to $13 billion, of which $5.7 billion (44 percent) would go to California businesses.

The total impact of construction of 3 GW of offshore wind in California will be more than **$11 billion** in economic benefits, **$3.7 billion** in local wages and **$5 billion** in Gross State Product. A total of **42,574 job-years** will be added as a result of the first phase of these offshore wind projects (Table 1).

Table 1 // Total Economic Impact of Building Phase One Offshore Wind Farms in California (2030 – One-Time Benefit)

Project	Job-Years	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**

Phase One: Operations and Maintenance

The impact of the operations stage of the 3 GW of offshore wind installed will continue annually, considering that the facilities remain active. Total annual costs of operation are approximately $363 million, including wages, materials and services. About $184 million (51 percent) of the total annual costs go to in-state businesses, and the local economic benefits reach close to **$330 million** annually. Almost 1,200 jobs are supported every year from the operations and maintenance of Phase One, resulting in close to $92 million in wages and more than $156 million in Gross State Product (Table 2).

Table 2 // Total Economic Impact of Operating Phase One Offshore Wind Farms in California (2030 – Annual Benefit)

Project	Annual Jobs	Wages	Value Added	Economic Benefits
Morro Bay	707	$ 55,041,223	$ 93,830,217	$ 197,727,705
Humboldt Bay	471	$ 36,694,149	$ 62,553,478	$ 131,818,470
California Total	**1,178**	**$ 91,735,372**	**$ 156,383,694**	**$ 329,546,175**

Construction activities for Phase One will have a one-time fiscal impact of about $470 million in state and local taxes, and more than $800 million in federal taxes (Table 3).

Table 3 // Fiscal Impacts for Construction Phase One (2030 – One-Time Benefit)

Project	State and Local Taxes	Federal Taxes
Morro Bay	$ 282,768,154	$ 482,042,198
Humboldt Bay	$ 186,962,889	$ 318,720,481
California Total	**$ 469,731,043**	**$ 800,762,678**

Annual operations and maintenance activities are responsible for more than $15 million in annual state and local taxes, and close to $26 million in annual federal taxes. These fiscal benefits are ongoing throughout the lifetime of the first phase of the offshore wind project (Table 4).

Table 4 // Fiscal Impacts for Operation Phase One (Annual Benefit)

Project	State and Local Taxes	Federal Taxes
Morro Bay	$ 9,118,462	$ 15,544,478
Humboldt Bay	$ 6,078,974	$ 10,362,985
California Total	**$ 15,197,436**	**$ 25,907,463**

Phase Two: 10 GW

The second phase of offshore wind development in California would likely be completed between 2035 and 2045. Below are the key assumptions for each of the two locations in the second phase.

Morro Bay is expected to build an additional 4.2 GW of offshore wind capacity in the second phase (6 GW from the first and second phases) with a total construction cost for the second phase of approximately $16.6 billion and a construction cost per kilowatt of $3,952.

Humboldt Bay is expected to build an additional 2.8 GW of offshore wind capacity in the second phase (4 GW from the first and second phases) with a total construction cost for the second phase of approximately $11.1 billion and a construction cost per kilowatt of $4,007.

Phase Two: Construction

Total expenditure in the construction of 7 GW additional to the existing 3 GW will be about $27.8 billion, of which $17.3 billion (62 percent) would go to California businesses. The overall construction of local content is higher than in Phase One, due to the assumption that the supply chain for offshore wind projects in California will be more developed when construction starts for the second phase.

The total impact of construction of 7 GW of offshore wind in California will be more than **$34 billion** in economic benefits, **$11.3 billion** in local wages and **$15.3 billion** in Gross State Product. A total of **126,187 job-years** will be added for the construction of Phase Two of this offshore wind project (Table 5).

Table 5 // Total Economic Impact of Building Phase Two Offshore Wind Farms in California (2040)

Project	Job-Years	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	$ 13,631,102,455
California Total	**126,187**	**$ 11,347,491,930**	**$ 15,255,160,716**	**$ 34,032,785,884**

Phase Two: Operations and Maintenance

Phase Two requires the annual operations and maintenance of a total of 10 GW of offshore wind capacity, the 3 GW from Phase One plus the 7 GW added in Phase Two. Total annual costs of operation are approximately $1.2 billion, and about $734 million (65 percent) go to in-state businesses. This stage brings **$1.3 billion** in annual economic benefits, and supports 4,576 jobs every year, with $354 million in wages and more than $618 million in Gross State Product (Table 6).

Table 6 // Total Economic Impact of Operating Phase Two Offshore Wind Farms in California (2040—Annual Benefit)

Project	Annual Jobs	Wages	Value Added	Economic Benefits
Morro Bay	2,749	$ 212,578,216	$ 371,485,357	$ 799,888,218
Humboldt Bay	1,828	$ 141,343,723	$ 246,995,821	$ 531,825,096
California Total	**4,576**	**$ 353,921,939**	**$ 618,481,178**	**$ 1,331,713,314**

The construction for Phase Two will have a one-time fiscal impact of more than $1.4 billion in state and local taxes, and more than $2.4 billion in federal taxes (Table 7).

Table 7 // Fiscal Impacts for Construction Phase Two (2040)

Project	State and Local Taxes	Federal Taxes
Morro Bay	$ 850,319,059	$ 1,449,560,927
Humboldt Bay	$ 572,832,573	$ 976,522,526
California Total	**$ 1,423,151,631**	**$ 2,426,083,454**

The operations and maintenance of the 10 GW are responsible for more than $60.5 million in annual state and local taxes, and more than $103 million in annual federal taxes. These fiscal benefits are ongoing throughout the lifetime of the 10 GW offshore wind project (Table 8).

Table 8 // Fiscal Impacts for Operation Phase Two (Annual)

Project	State and Local Taxes	Federal Taxes
Morro Bay	$ 36,342,845	$ 61,954,589
Humboldt Bay	$ 24,163,743	$ 41,192,559
California Total	**$ 60,506,588**	**$ 103,147,148**

5. METHODOLOGY

Impact Model Methodology

The research team estimated local economic impacts for the Morro Bay and Humboldt Bay offshore wind projects using NREL's modeling tool Jobs and Economic Development Impact (JEDI). JEDI is an input-output modeling tool used to generate outputs for employment, Gross Regional Product (GRP) and earnings for the construction and operations of a particular offshore wind project. The model illustrates the interdependent relationships between the different sectors of a region's economy, to produce employment figures that vary according to the modeled project's energy output and local content.

The offshore wind activities modeled for the two locations are used as inputs into the model to estimate the multiplier effect on business, household, and government expenditures and industry employment. JEDI estimates these effects based on facility size, energy output, year of construction and the built-in economic multipliers specific to the project location.

The economic outputs outlined in this report include:

// Jobs created from the construction of offshore wind facilities with 1.8 GW of capacity in Morro Bay and 1.2 GW in Humboldt Bay by 2030, a total of 3 GW in capacity across both sites.

// Jobs created from the construction of 4.2 GW of additional capacity in Morro Bay and 2.8 GW in Humboldt Bay between 2030 and 2040, to reach a total of 10 GW of offshore wind capacity across both sites.

// Annual number of jobs created for the operation of the initial 3 GW installed by 2030.

// Annual number of jobs created for the operation of 10 GW installed by 2040.

// Employment split by industry for Construction and Operations phases.

// Labor income resulting from jobs created by offshore wind projects.

// Additional GRP for Morro Bay and Humboldt Bay because of economic activity from offshore wind projects.

// Local, state, and federal tax revenue for Phases 1 and 2.

Detailed Model Inputs and Assumptions

The installation of the 10 GW of offshore wind capacity was split into two parts, a short-term goal of 3 GW installed by 2030 and a long-term goal of 10 GW installed by 2040. The capacity installed at each location was decided based on the proportion of modeled capacity potential for Moro Bay and Humboldt Bay, where the two sites are calculated, by Beiter et al., to have a final potential capacity of 4 GW.[28] The research team concluded that Morro Bay would be allocated 1.8 GW for the short term and 6 GW for the long term, following the proportions identified by Beiter et al., in NREL's offshore wind projections. Humboldt Bay was allocated 1.2 GW for the short term and 4 GW for the long-term energy output of its offshore wind projects.

Outputs generated using JEDI Offshore Wind Model Rel. 2021-2 used the following assumptions:[29]

// Turbine power of 12 MW in the short-term goal.

// Turbine power of 15 MW in the long-term goal.

// Semisubmersible substructure type.

// 55.5-kilometer distance from site to port.

// 42-kilometer distance from site to export cable.

// 1,013-meter mean water depth for Morro Bay.

// 832-meter mean water depth for Humboldt Bay.

// Both sites are under the same regulatory structure of building and hiring in California and require the same amount of human power to build 1 GW of offshore wind capacity.

// Local content for construction and operations derived from a combination of NREL's regional defaults and recent supply chain studies conducted by BW Research in New York and New Jersey.

Tax revenue figures were generated using IMPLAN input-output model, to calculate the tax revenue for an offshore wind project at the county, state and federal level.

Outputs Overview

Employment and economic impacts for the construction and operations of the offshore wind projects in California are divided into direct, indirect and induced effects within the local economy. These are defined below:

// **Direct effects** show the change in the economy directly associated with the initial economic activity. For this research, direct jobs represent construction workers involved in the construction of the offshore wind project, and technicians and managers working in the operations of the project.

// **Indirect effects** include all the supply chain responses resulting from the initial economic activity. An example of an indirect job added to the local economy would be a new worker involved in the manufacturing of the blades used for the wind turbines.

// **Induced effects** refer to the effects of increased household spending and are the result of direct and indirect workers spending their wages locally.

Due to the nature of the tool used for modeling these offshore wind projects, employment figures for the construction of these projects are provided as Full-Time Equivalent (FTE). FTEs are the units used to measure employees in a standardized manner even though they might work a different number of weekly hours. An FTE accounts for 40 hours worked per week, or 2,080 hours worked a year. Therefore, two FTEs in one year of construction represents two full-time workers, or 4,160 hours worked. In two years of construction, two FTEs represent one full-time employee that worked for two years, for a total of 4,160 hours worked across the two years.

The number of jobs presented for the operations of these offshore wind projects are annualized, and therefore represent the number of workers in one year.

APPENDIX A

Supply Chain Local Content Assumptions

Local Content for Construction Phase		
Category	**Local Content for Phase 1**	**Local Content for Phase 2**
Turbine Component Costs		
Nacelle/Drivetrain		
Materials	20%	50%
Labor	65%	95%
Blades		
Materials	40%	50%
Labor	50%	50%
Towers		
Materials	40%	75%
Labor	45%	75%
Other/Miscellaneous	50%	80%
Balance of System Costs		
Substructure and Foundation		
Monopile	60%	75%
Monopile Materials		
Monopile Labor		
Scour Protection	60%	75%
Scouring Protection Materials		
Scouring Protection Labor		
Spar	45%	60%
Spar Materials		
Spar Labor		
Semisubmersible	45%	60%
Semisubmersible Materials		
Semisubmersible Labor		
Mooring System	45%	60%
Mooring System Materials		
Mooring Systems Labor		

Local Content for Construction Phase		
Category	**Local Content for Phase 1**	**Local Content for Phase 2**
Electrical Infrastructure Components		
Array Cable System	30%	60%
Materials		
Labor		
Export Cable System	30%	60%
Materials		
Labor		
Offshore Substation	40%	50%
Materials		
Labor		
Assembly and Installation		
Foundation		
Vessel	60%	75%
Labor	100%	100%
Mooring System		
Vessel	60%	75%
Labor	100%	100%
Turbine		
Vessel	60%	80%
Labor	100%	100%
Array Cable		
Vessel	40%	80%
Labor	100%	100%
Export Cable		
Vessel	40%	80%
Labor	100%	100%
Offshore Substation		
Vessel	60%	80%
Labor	100%	100%
Scour Protection		
Vessel	60%	80%
Labor	100%	100%

Local Content for Construction Phase		
Category	**Local Content for Phase 1**	**Local Content for Phase 2**
Ports and Staging		
Foundation	100%	100%
Mooring System	100%	100%
Turbine	100%	100%
Array Cable	100%	100%
Export Cable	100%	100%
Offshore Substation	100%	100%
Scour Protection	100%	100%
Development and Other Project Costs		
Site Auction Price	100%	100%
BOEM Review	100%	100%
Construction Operations Plan	100%	100%
Design Install Plan	50%	80%
Site Assessment Plan	50%	80%
Site Assessment Activities	50%	80%
Onshore Transmission	50%	80%
Engineering and Management		
Construction Operations	50%	80%
Soft Costs		
Commissioning	100%	100%
Construction Finance	50%	50%
Construction Insurance	50%	50%
Contingency	50%	50%
Decommissioning	50%	50%
Other/Miscellaneous	0%	0%

Endnotes

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