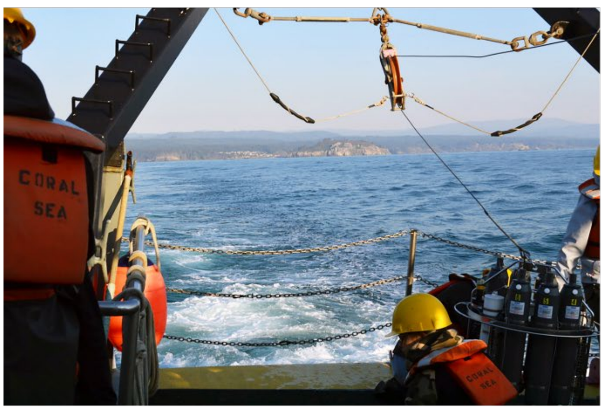
California Floating Offshore Wind: Evaluating Workforce Analyses and Assessing Professional Labor



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List of Acronyms

ABET: Accreditation Board for Engineering and Technology
Accredits college and university programs in applied science, computing, engineering, and engineering technology.

AHTS: Anchor Handling Tug Supply
Specialized vessels used for mooring system deployment in offshore wind.

BOEM: Bureau of Ocean Energy Management
U.S. agency responsible for managing offshore energy development.

BLS: Bureau of Labor Statistics
A division of the U.S. Department of Labor that collects, analyzes, and publishes essential economic data, including information on employment, wages, productivity, and labor market activity.

CEC: California Energy Commission
California's primary energy policy and planning agency.

COD: Commercial Operations Date
The date on which a project or facility begins producing electricity for sale or use

CPA: Certified Public Accountant
A professional designation for accountants, requiring licensure and a passing score on the CPA exam.

CPH: Cal Poly Humboldt
A university engaged in workforce education for the offshore wind sector.

CPP: Certified Purchasing Professional
Certification offered by the American Purchasing Society for expertise in procurement.

CSCP: Certified Supply Chain Professional
Certification offered by the Association for Supply Chain Management for supply chain expertise.

FOSW: Floating Offshore Wind
Offshore wind farms using floating platforms for turbines in deeper waters.

FTE: Full-Time Equivalent
A unit of job measurement representing one full-time worker employed for a year.

GIS: Geographic Information System
A system for managing, analyzing, and visualizing spatial and geographic data.

IMPLAN: Impact Analysis for Planning
Economic modeling tool for assessing impacts across industries.

I-O Modeling: Input-Output Modeling
Analytical method assessing economic impacts by tracking spending across economic sectors.

JEDI: Jobs and Economic Development Impact
A model developed by NREL to estimate economic and job impacts of renewable energy projects.

NREL: National Renewable Energy Laboratory
U.S. Department of Energy laboratory specializing in renewable energy research.

O&M: Operations and Maintenance
Activities required to ensure the efficient functioning of wind farms.

PE: Professional Engineer
A licensed engineer authorized to oversee projects, approve engineering designs, and provide public services.

SOC: Standard Occupational Classification
A system used by the Bureau of Labor Statistics to categorize occupations.

UPPCC: Universal Public Procurement Certification Council
Organization providing certification for public procurement professionals.

WEA: Wind Energy Area
A designated offshore region identified by the Bureau of Ocean Energy Management (BOEM) as suitable for wind energy development

Executive Summary

This report, *California Floating Offshore Wind: Evaluating Workforce Analyses and Assessing Professional Labor Needs*, provides Cal Poly Humboldt and other workforce development entities with key insights into the professional workforce required to deploy floating offshore wind (FOSW) in California. It evaluates existing workforce analyses and tools, examines key factors influencing job projections, and assesses professional labor needs across multiple industry activities, including project development, supply chain, operations and maintenance, port development, and transmission infrastructure.

For this analysis, "professional" occupations refer to those that typically require a university degree, and "professionals" are individuals in the workforce who hold such degrees.

Variability in Workforce Estimates and Key Assumptions

Existing workforce analyses for California's FOSW sector exhibit significant variability in job projections. By 2030, estimates range from 2,375 to 8,280 jobs, with differences largely driven by assumptions regarding project scale and in-state supply chain participation.

To better understand how these factors impact job generation, this report includes a job sensitivity analysis using the National Renewable Energy Laboratory (NREL)'s Jobs and Economic Development Impact (JEDI) model with inputs from the Humboldt Wind Energy Area.

Workforce Distribution Across the Supply Chain

Findings from the sensitivity analysis indicate that:

- **Component supply chain activities** account for over 60% of total jobs (16.08 FTEs[1]/Megawatt (MW)), with 76% of those driven by the material supply chain.
- **Staging, assembly, and installation** represent just over 10% of total jobs (2.73 FTEs/MW), with 44% of those tied to specialized vessel operations.
- **Development and soft costs** account for about 11% of total jobs (2.96 FTEs/MW), with 33% linked to the onshore electrical interconnection, and 7% to site assessment activities.
- **Operations and maintenance (O&M)** represent over 18% of total jobs (4.92 FTEs/MW), though these jobs will occur throughout the operational life of a project, estimated at 35 years from Commercial Operations Date (COD).

These findings clarify the key factors influencing estimates of job creation, emphasizing the significant impact of the rate of in-state participation in the FOSW supply chain.

Professional Labor Demand

An analysis of existing data found that by 2030, 37–41% of FOSW industry jobs and 20% of FOSW-associated port development jobs will require a university degree.

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[1] FTE, or Full-Time Equivalent, is a unit of measure representing the workload of a full-time employee over a year, typically 2,080 hours based on a 40-hour workweek (e.g., two half-time employees equal one FTE).

FOSW Industry Professional Occupations by Investment Scenario

The distribution and proportion of professional jobs in the FOSW industry is dependent on the level of domestic supply chain investment. This report evaluates workforce distribution under two supply chain investment scenarios:

- **High Investment Scenario** – Based on projections from the *AB 525 Workforce Readiness Plan*, this scenario assumes significant in-state manufacturing of major wind system components (nacelles, towers, and blades), resulting in higher overall job creation, with a larger share of professional employment at 41% of total jobs.
- **Low Investment Scenario** – Developed using the sensitivity analysis of the NREL JEDI model, this scenario assumes little to no in-state manufacturing of major wind system components, leading to about a 25% reduction in total job creation and a decrease in professional employment to 37% of the workforce.

Despite differences in total job creation, professional roles remain concentrated in three primary occupational categories in both scenarios:

- **Engineering occupations** will account for 49.8% (High Investment) to 47.0% (Low Investment) of professional jobs in 2030.
  - **Mechanical engineers** will make up 44.5% to 26.9% of engineering jobs, with significantly less demand without major component manufacturing.
  - **Civil engineers** will make up 26.2% to 41.0% of engineering jobs, representing a larger share of the reduced engineering workforce under lower supply chain investment.
- **Life and physical sciences occupations** will account for 12.2% to 18.0% of professional jobs, taking up a larger share of the reduced professional workforce under the Low Investment Scenario.
- **Management occupations** will comprise 24.5% to 20.5%, with fewer roles in supply chain oversight and coordination without major component manufacturing.

FOSW-Associated Port Development Professional Occupations

Within port development, professional roles will be concentrated in the following categories:

- **Management occupations** make up 44.7% of professional port development jobs, 50% of which are construction managers and 31% top executives.
- **Business and financial occupations** make up 35.5% of professional port development jobs, 50% of which are project management specialists and 25% cost estimators
- **Engineering occupations** account for 17% of professional port development jobs, 57% of which are civil engineers and 12% architects.[2]

[2] The absence of life and physical sciences roles in FOSW-associated port development workforce projections raises concerns, as environmental permitting, scientific surveying, and other specialized tasks are essential for project of this scale. This suggests a possible underrepresentation of these occupations in the AB 525 Workforce Development Readiness Plan.

Educational Pathways and Workforce Readiness

To assess workforce readiness, this report examines how professional FOSW industry and port development occupations align with degree programs at Cal Poly Humboldt (CPH). Findings include:

- CPH offers programs that align with nearly all professional roles in the FOSW industry and port development.
- Engineering and environmental sciences are particular strengths, with CPH projected to produce a significant number of qualified graduates by 2030.
- Graduate programs provide further pathways into the industry, particularly for specialized roles in engineering, life and physical sciences, and management.

Workforce Considerations for Transmission and Port Development

- **Transmission Professional Workforce Needs:** Only 15% of the onshore transmission infrastructure workforce are expected to be professionals, mainly in management, business, and engineering. Further analysis is needed to provide more accurate workforce projections.
- **Port Development Workforce Estimates:** A reassessment of the Workforce Readiness Plan finds that annual construction workforce needs for FOSW port development on the North Coast may have been overestimated by nearly 300%, leading to inflated job forecasts. Further analysis is needed to provide accurate workforce projections.

Key Takeaways and Next Steps

This report highlights opportunities and challenges in preparing a professional workforce for California's FOSW industry.

Recommendations:

- **Align Academic Programs with Industry Needs** – Identify curriculum gaps and align courses with FOSW careers.
- **Strengthen Industry Partnerships** – Collaborate with industry to provide experiential learning opportunities.
- **Improve Workforce Data Transparency** – Advocate for clearer modeling assumptions and refined job estimates.

Next Steps:

- **Conduct Economic Impact Assessments** of FOSW onshore transmission infrastructure.
- **Engage Industry to Define Job Roles** and refine workforce projections.
- **Expand Academic Offerings** to support specialized FOSW workforce development.

1 Introduction

Floating offshore wind (FOSW) has potential to play a vital role in California's broader strategy to transition to 100% clean energy by 2045. As outlined in *Assembly Bill 525 Offshore Wind Strategic Plan* (AB 525 Strategic Plan) by the California Energy Commission (CEC), the state has set ambitious targets for deploying FOSW in federal waters off its coast, aiming to achieve 2 to 5 gigawatts (GW) of capacity by 2030 and 25 GW by 2045.[3] This initiative is part of a larger effort to decarbonize the state's electricity grid by expanding diverse renewable energy sources, enhancing energy storage capabilities, and modernizing the grid to ensure reliability and affordability.

Building the Electricity Grid of the Future: California's Clean Energy Transition Plan (California's Energy Transition Plan), published by the Office of Governor Gavin Newsom, underscores the importance of offshore wind as a key element in the state's renewable energy portfolio. California's Energy Transition Plan recognizes that achieving 100% clean electricity will require a rapid and unprecedented scale of new clean energy resources, including offshore wind, which offers the advantage of providing consistent power, particularly during times when solar energy is less effective.[4] As California accelerates its clean energy goals, the demand for professional labor in the renewable energy sector, including the FOSW industry, is expected to rise significantly. For FOSW, this is particularly true for occupations in engineering, environmental science, and project management, as highlighted in the *AB 525 Workforce Development Readiness Plan* published by the California State Lands Commission.[5]

Given that most FOSW jobs will be within the building and construction trades, planning documents have predominantly focused on developing California's skilled labor force to support these roles, with less emphasis on the professional workforce needs. The Pacific Offshore Wind Consortium (POWC), established in Spring 2024, aims to address this gap by supporting the professional workforce development through its three partnering universities: Cal Poly Humboldt, Cal Poly San Luis Obispo, and Oregon State University. These universities are strategically positioned near the only currently identified offshore wind energy areas on the West Coast. This report serves as a foundational step in informing those efforts by quantifying and categorizing professional labor needs across critical areas within the FOSW industry and

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[3] California Energy Commission. *Assembly Bill 525 Offshore Wind Energy Strategic Plan, Volume II: Main Report*. June 2024. CEC-700-2023-009-V2-CMF. Download at: https://efiling.energy.ca.gov/GetDocument.aspx?tn=257700&DocumentContentId=93596.

[4] Office of Governor Gavin Newsom, *Building the Electricity Grid of the Future: California's Clean Energy Transition Plan*. May 2023. https://www.gov.ca.gov/wp-content/uploads/2023/05/CAEnergyTransitionPlan.pdf.

[5] California State Lands Commission. *AB 525 Workforce Development Readiness Plan*. Final Report. June 16, 2023. Prepared by Xodus Group and BW Research. Available at: https://www.slc.ca.gov/renewable-energy/workforce-development-readiness-plan/.

associated port and transmission development. Notably, while workforce and economic impact analyses exist for the FOSW industry and port development, no comprehensive assessment has yet been conducted on the workforce impacts of the transmission infrastructure essential for the off-take of FOSW energy.

Building upon workforce analyses cited in the AB 525 Strategic Plan, this report examines how job creation in the FOSW sector is influenced by project scale and supply chain participation. The Workforce Readiness Plan, which aligns closely with expected industry development, serves as the primary data source for occupational data in the FOSW industry and related port developments in California. However, given the industry's current timeline and planned projects, the plan may overestimate job creation. Due to the variability in FOSW job estimates across existing studies, this report aims to provide a clearer understanding of the professional occupations likely involved in these development areas and establish a framework for identifying educational pathways to employment within those roles. Additional analysis should be pursued as project details are further defined, considering factors such as California's involvement in the FOSW supply chain, the scale of FOSW port infrastructure projects, and the specific characteristics of the wind energy projects themselves.

This report also leverages data from the Bureau of Labor Statistics (BLS) and Cal Poly Humboldt (CPH) to map educational pathways to employment in the FOSW industry. It relates academic disciplines and degree programs—both undergraduate and graduate—to specific occupations within the FOSW industry and associated port development in California. While preliminary analysis of the professional workforce needs for transmission infrastructure is included, further research is necessary to produce more accurate job estimates and better understand the composition of jobs in California.

2 Review of Existing Workforce Data and Assumptions

This section reviews workforce analyses and methodologies included in California's AB 525 Strategic Plan to better understand future labor demands within the Floating Offshore Wind (FOSW) industry in California and how these forecasts were determined. These analyses are essential for strategic planning documents such as the Strategic Plan and serve as key resources for workforce practitioners, host communities, and other vested parties. These job forecasts provide labor suppliers—such as unions, colleges, universities, workforce development boards, and professional institutions—with market signals necessary to scale up and/or develop the appropriate training and educational programs. They also help communities plan for the social impacts of increased economic activity, from increased job opportunities to strain on the housing market or community services. The accuracy of these analyses is therefore crucial for effectively strategizing economic and workforce development efforts.

To estimate job creation, the AB 525 Strategic Plan drew from early workforce analyses that categorized jobs into construction, supply chain, and operations and maintenance (O&M) for the FOSW industry. Construction refers to direct jobs resulting from the construction and installations of the wind power plants themselves (turbine, substation, and electrical transmission installation, export cable laying, etc.); the supply chain encompasses indirect jobs associated with manufacturing, logistics, and distribution of components and other activities along the FOSW supply chain; and O&M jobs are those necessary to manage and maintain the wind farms over their operational life. A review of these analyses (Appendix A) revealed that variations in their assumptions resulted in the studies having significant differences in the number of jobs forecasted, as demonstrated in Table 2.1.

Table 2.1: Estimated Floating Offshore Wind Jobs in 2030[6]

Source/Model	Supply Chain	Construction	Operations & Maintenance	Total Jobs
American Jobs Project[7]	2,100	350	1,200	3,650
NREL[8]	5,490	1,130	1,660	8,280
Guidehouse[9]	1,936	125	314	2,375
Total Range	1,936 - 5,490	125 - 1,130	314 - 1,660	2,375 - 8,280

Despite each report considering multiple offshore wind energy development scenarios, only the estimates from the highest development scenario were published as part of the plan. These

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[6] California Energy Commission. *AB 525 Offshore Wind Energy Strategic Plan*. June 2024. 40, Table 3-2. Download at: https://efiling.energy.ca.gov/GetDocument.aspx?tn=257700&DocumentContentId=93596.

[7] American Jobs Project, *The California Offshore Wind Project: A Vision for Industry Growth*. February 2019. http://americanjobsproject.us/wp/wp-content/uploads/2019/02/The-California-Offshore-Wind-Project.pdf

[8] National Renewable Energy Laboratory, *Floating Offshore Wind in California: Gross Potential for Jobs and Economic Impacts from Two Future Scenarios*. April 2016. https://www.nrel.gov/docs/fy16osti/65352.pdf.

[9] Guidehouse Inc., *California Supply Chain Needs Summary Report*. May 2022. Download at: https://efiling.energy.ca.gov/GetDocument.aspx?tn=250520

figures underscore the potential economic impacts of FOSW development in California, yet the plan does not fully describe its underlying assumptions, nor does it explain the high degree of variability between the studies. Notably, these analyses predate California's current FOSW energy targets of 3- 5 GW by 2030 and 25 GW by 2045, with each study assuming its own unique scale and timeline for development. As critical, the studies also each assume different levels of California’s participation in the supply chain, such as the manufacturing of major components and sub-components, which make up two-thirds of forecasted jobs[10]. Therefore, assumptions regarding the level of supply chain participation in the state of California (also referred to as local content share) can significantly influence job estimates. This is further explored and demonstrated in Section 3: Workforce Sensitivity Analysis of NREL’s Offshore Wind JEDI Model.

Due to their inconsistency with FOSW energy targets and job modeling, these three analyses were not directly utilized in this assessment. However, they provide valuable insights into how policy decisions, project scale, and supply chain investments can affect economic and workforce impacts, while also highlighting the sensitivity of job estimates to these factors.

2.1 Review of the AB 525 Workforce Development Readiness Plan [11]

The California State Lands Commission *AB 525 Workforce Development Readiness Plan* was chosen as the primary source of occupational data for FOSW and associated port development because it aligns with California’s current FOSW goals and incorporates plausible or planned port developments to estimate workforce demand.

2.1.1 FOSW Workforce Analysis

The plan models workforce needs for FOSW under three scenarios—high, medium, and baseline—reflecting varying levels of in-state investment in supply chain activities/infrastructure (i.e. Facilities to manufacture and/or assemble wind farm components; nacelles, blades, towers, and mooring lines and anchors), from significant in-state manufacturing in the high scenario to minimal participation in the supply chain under the baseline scenario.

Under this plan, the offshore wind supply chain is described through several supply areas. **Project development** involves services to support pre-construction activities such as permitting, surveys, engineering and design, and project management. **Wind turbine supply** includes manufacturing the major wind system components that make up the turbines themselves; nacelles, blades, and towers. **Balance of Plant (BoP) supply** includes the production of all other components of a wind farm, turbine foundations, array and export cables, anchors, mooring systems, offshore substations, and onshore electrical infrastructure. **Installation and**

[10] Catalyst Environmental Solutions. *Analytical Guidance and Benefits Assessment for AB 525 Strategic Plan: Seaport and Workforce Development for Floating Offshore Wind in California*. (California Energy Commission, April 2023), 19..https://efiling.energy.ca.gov/GetDocument.aspx?tn=250296

[11] California State Lands Commission. *AB 525 Workforce Development Readiness Plan*. Final Report. June 16, 2023. Available at: https://www.slc.ca.gov/renewable-energy/workforce-development-readiness-plan/.

commissioning covers installing these components, integrating turbines with foundations at the port, towing and connecting units to offshore infrastructure, and providing port staging, logistics, and onshore construction. Lastly, **operations and maintenance (O&M)** involve operating the wind farm and maintaining turbine components and other wind-farm infrastructure. The different supply areas and development scenarios is described in more detail in Table 2.2.

Table 2.2: Timing of Workforce Availability by Supply Area[12]

Supply Area	Baseline Scenario	Medium Scenario	High Scenario
Project development	Entire supply can be delivered by local workforce from **2035**.	Entire supply can be delivered by local workforce from **2035**.	Entire supply can be delivered by local workforce from **2035**.
Wind turbine supply	Without local manufacturing facilities, no supply anticipated.	Local workforce for tower manufacturing from **2030**.	Nacelle assembly by **2030**; (2) blade manufacturing facilities by **2030** and **2035**; towers manufacturing from **2030**.
Balance of plant supply	Concrete supply for floating hulls and some onshore substation supply from **2030**.	Local workforce for foundation assembly by **2030**; nacelle manufacturing by **2030**; cable, moorings, and anchors manufacturing from **2035**.	Local workforce for foundation assembly by **2030**; nacelle manufacturing by **2030**; (2) cables manufacturing facilities, mooring, and anchors manufacturing from **2035**.
Installation & commissioning	Waterfront workforce for (S&I), loadout, offshore logistics and onshore construction, where ports will come online in **2029, 2030, and 2035**.	Quayside workforce for (S&I), loadout, offshore logistics and onshore construction, where ports will come online in **2029, 2030, and 2035**.	Quayside workforce for (S&I), loadout, offshore logistics and onshore construction, where ports will come online in **2029, 2030, and 2035**.
Operations & maintenance	Local workforce used for operations and maintenance from **2030**.	Local workforce used for operations and maintenance from **2030**.	Local workforce used for operations and maintenance from **2030**.

To estimate labor demand for FOSW, the plan analyzed the types and quantities of workers typically needed at each stage of offshore wind projects based on current industry employment. The high scenario projects that 3,177 jobs will be needed across various project areas by 2030. However, under the high scenario, from which job projection data was provided, the plan assumes that California will have operational blade, tower, and nacelle manufacturing facilities by 2030. This may lead to an overestimate of the number of jobs, as there are currently no confirmed plans to develop such manufacturing facilities.

The plan also provides the number of jobs broken down by supply area (Table 2.3), revealing that the majority of jobs are anticipated to be generated during project development. This

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[12] California State Lands Commission. *AB 525 Workforce Development Readiness Plan*. Final Report. June 16, 2023. Table 2.1. Available at: https://www.slc.ca.gov/renewable-energy/workforce-development-readiness-plan/.

contradicts earlier studies where two-thirds or more of jobs were the result of supply chain activities such as wind turbine supply and balance of plant supply. Unfortunately, occupational data by supply area is not available making it difficult to ascertain the professional workforce demand for the different activities and phases of development.

Table 2.3: FOSW jobs in 2030 (high scenario) [13]

Supply Area	2030
Project Development	1152
Wind Turbine Supply	565
Balance of Plant Supply	234
Installation & Commissioning	634
Operations & Maintenance	592

The Workforce Readiness Plan also breaks down workforce demand by region, emphasizing that job creation will vary significantly across California's North Coast, Bay Area, Central Coast, and Southern California, with the highest number of jobs expected to be generated in Southern California and the North Coast. The plan distinguishes between the workforce needed for FOSW projects and that required for port infrastructure upgrades, noting that while both demand substantial labor, the skills and certifications required for FOSW are often more specialized. Roles such as environmental impact assessment, offshore geological surveys, and electrical design in FOSW typically require university-level degrees and specific certifications, unlike the more generalized construction-related roles in port infrastructure.[14]

2.1.2 Port Infrastructure Workforce Analysis

Additionally, the Plan looks at the labor demand for FOSW-associated port development, the development of port infrastructure necessary to support FOSW development and certain supply area activities (i.e. staging and integration, O&M, and the manufacturing of major components). The authors also used a different methodology for the power infrastructure workforce analysis, choosing to utilize the input-output (I-O) modeling program IMPLAN to estimate the total number of workers during the construction period of potential port development projects. I-O modeling is an economic analysis method used to understand how changes in one industry or sector impact others by mapping the flow of goods and services within an economy. Under the high scenario, they estimated that there will be 9,290 FOSW-associated port development jobs in 2030. This job estimate is for that year alone, and not over the construction period.

[13] California State Lands Commission. *AB 525 Workforce Development Readiness Plan*. Final Report. June 16, 2023. Available at: https://www.slc.ca.gov/renewable-energy/workforce-development-readiness-plan/

[14] Ibid.

The analysis assumes over a $12 billion investment in port infrastructure across the four study regions under the high-development scenario, with the majority of that activity occurring before 2030. However, only two of the identified port sites have actual plans in place for development, the Port of Humboldt's Offshore Wind Heavy Lift Marine Terminal and the Port of Long Beach's Pier Wind, which equate to roughly an $8 billion investment combined. Moreover, according to the report, the Port of Humboldt development was expected to be completed by 2030, with the Port of Long Beach project to be completed by 2035. This puts the total investment in port infrastructure at closer to $6.3 billion, and even less by 2030. Assuming that investment was spread out evenly across the construction periods, this would equate to nearly half the number of jobs represented in this report. These estimates in terms of the Port of Humboldt development are further considered in Section 6: North Coast Workforce Assessment for Port Development.

Despite potential overestimations, the Workforce Readiness Plan was selected as the primary data source for this Professional Labor Assessment because of the level of detail provided and the alignment with California's current FOSW goals. The plan provides a comprehensive look at the quantity and composition of occupations in both FOSW and port development, focusing exclusively on direct job outputs. This targeted approach offers a clearer picture of immediate labor needs, although the likelihood of overestimated job numbers may limit its usefulness for state and regional economic and workforce development strategies.

In the next Section, we use the National Renewable Energy Laboratory (NREL)'s Offshore Wind Jobs and Economic Development Impact (JEDI) model to analyze the correlation between offshore wind investment and activities and job estimates. The JEDI model was chosen for its specificity to the offshore wind industry, its dynamic framework, and explicit use in the previous workforce studies examined above.

3 Workforce Sensitivity Analysis of NREL's Offshore Wind JEDI Model

The National Renewable Energy Laboratory (NREL) developed the Offshore Wind Job and Economic Development Impact (JEDI) model as a publicly available Excel-based tool that uses input-output (I-O) analysis to evaluate the economic impacts of offshore wind projects in the United States. By inputting key project details and adjusting specific cost parameters, users can estimate project capital and operational expenditures, as well as the estimated number of jobs, earnings, and overall economic activity the project might generate within a given region.

JEDI categorizes economic impacts into three primary areas:

1. **Project development and on-site labor impacts (direct impacts)** – direct employment and immediate economic effects by project expenditures, such as onsite jobs during the construction of an offshore wind power plant.
2. **Turbine and supply chain impacts (indirect impacts)** – indirect effects of project expenditures on manufacturers and service providers along the offshore wind supply chain, including labor and material necessary to provide those goods and services.
3. **Induced impacts** – additional economic activity generated by household spending of wages earned through direct and indirect impacts.[15]

The following sensitivity analysis will focus only on the direct and indirect impacts on job creation resulting from offshore wind development, excluding any induced economic effects.

The JEDI model provides job estimates in full-time equivalents (FTEs), distinguishing between construction-phase employment, which is reported as a cumulative total over the development period, and operations-phase employment, which is reported annually. One FTE represents a full-time job for one year (2,080 hours).

For example, if the construction phase generates 1,500 FTEs over three years, this could be expressed as 500 jobs per year during construction. In contrast, operations and maintenance (O&M) jobs are reported on an annual basis, representing long-term positions that persist for the operational life of the wind farm. A project producing 200 O&M FTEs/year over 35 years is the same as 7,000 total FTEs over its lifespan. For the purposes of this report, O&M jobs are reported as total FTEs over a 35-year operational period[16], so that the different supply areas can be meaningfully compared.

However, FTE estimates do not fully capture workforce fluctuations. Certain activities, like turbine installation and cable laying, may require intensive labor over short periods, creating temporary workforce surges. Conversely, other activities such as site preparation or project

[15] Eric Lantz, Marshall Goldberg, and David Keyser, *Jobs and Economic Development Impact (JEDI) Model: Offshore Wind User Reference Guide* (Golden, CO: National Renewable Energy Laboratory, 2013), https://www.nrel.gov/docs/fy13osti/58389.pdf.

[16] According to 30 C.F.R. § 585.235(a)(4), once a Construction and Operations Plan (COP) is approved, a commercial offshore wind lease enters an operations period of 35 years, unless a different term is specified. This period was updated from 25 years as part of BOEM's Renewable Energy Modernization Rule, finalized on May 15, 2024.

management may require smaller, consistent workforces. Other factors that might influence the actual number of jobs created include overtime, remote work, and job displacement.

While JEDI includes default values based on general offshore wind development trends, users can adjust local content shares, cost assumptions, and labor versus material expenditures to reflect site-specific conditions and policy goals. The following section applies the JEDI model to the Humboldt Wind Energy Area (WEA) by modifying default inputs to align with the area's site characteristics. This analysis explores how different aspects of offshore wind development—such as component manufacturing, staging, installation, and long-term operations—contribute to job creation and economic activity.

3.1 Model Inputs and Parameters

For this analysis, the default inputs in the JEDI model were modified to align with the site characteristics of the Humboldt Wind Energy Area (WEA), as identified in NREL's *Assessment of Offshore Wind Energy Leasing Areas for Humboldt and Morro Bay Wind Energy Areas, California.*[17] The plant size was set at the lower bound of the WEA's estimated energy capacity, modeled as a 1.5GW wind farm comprising 100 15MW turbines on semisubmersible floating foundations, arranged in a grid with approximately one nautical mile of spacing. A detailed list of model inputs used in this analysis is provided in Appendix B.

The JEDI model lets users adjust the local content share for over 50 cost categories related to offshore wind farm development, construction, and operations. This share, shown as a percentage, reflects how much of each expense occurs locally (e.g., in California). A 0% share means no local spending, while 100% means all costs stay within the region. Since labor costs are part of most expenditures, the local content share directly impacts the estimated job creation. The connection between spending and jobs was analyzed by adjusting individual content shares for each expenditure and tracking the effects on the number of jobs generated.

The Jedi Model categorizes expenditures across the following supply areas: **turbine component manufacturing, balance of system, soft costs, and O&M.** While these supply areas may sound similar to those found in the Workforce Readiness Plan, they are not directly comparable. A full breakdown of the JEDI model supply areas and their associated expenditures can be found in Appendix B. For this analysis, expenditures were categorized into supply areas that utilize all the job-producing expenditures provided through the JEDI model while also aligning with analyses and language referenced throughout this report. These supply areas are listed below, and a list of all associated costs can be found in Figure 3.1.

Development and Associated Soft Costs refer to expenditures during the beginning stages of the project (i.e. auction price, site assessment activities, construction operations, etc.) as well as various soft costs (i.e. construction financing, insurance), and other project costs.

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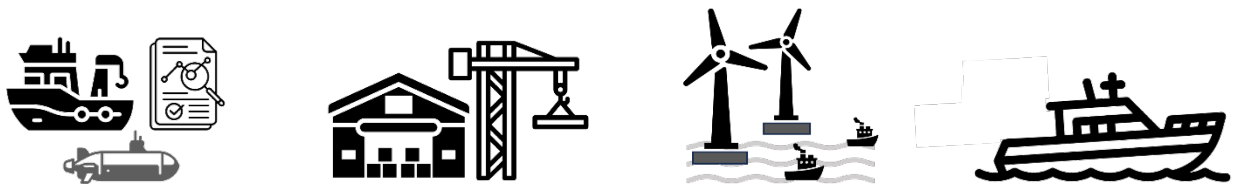
[17] Cooperman, Aubryn, Patrick Duffy, Matt Hall, Ericka Lozon, Matt Shields, and Walter Musial. *Assessment of Offshore Wind Energy Leasing Areas for Humboldt and Morro Bay Wind Energy Areas, California*. Golden, CO: National Renewable Energy Laboratory, April 2022. NREL/TP-5000-82341, pp. 9, Table ES-2. https://www.nrel.gov/docs/fy22osti/82341.pdf.

Component Supply Chain refers to labor and material costs to manufacture major wind system components (i.e. nacelles, towers, and blades), substructures and foundations (i.e. mooring system and semisubmersible foundation), and electrical infrastructure (i.e. array cable and export cable systems, and offshore substation) for the wind project.

Staging, Assembly, and Installation refers to the costs associated with the staging and assembly of components at port facilities, as well as the transportation and installation of the components within the project area.

Operations and Maintenance (O&M) refers to labor costs for the ongoing operations and maintenance of the wind farm.



Development and Soft Costs[18]	Component Supply Chain	Staging, Assembly, & Installation	Operations and Maintenance
• Site Auction Price • BOEM Review • Construction Operations Plan • Construction Operations Activities • Design Install Plan • Site Assessment Plan • Site Assessment Activities • Commissioning • Construction Finance • Construction Insurance • Contingencies • Electrical Interconnection	Material and labor costs for; • Nacelle • Blades • Tower • Mooring System • Semisubmersible Foundation • Array Cable System • Export Cable System • Offshore Substation	Costs associated with staging assembling and installing for; • Semisubmersible Foundation • Mooring System • Turbine Components • Array Cable System • Export Cable System • Offshore Substation	Labor costs for; • Offshore Technicians • Operation Management and General Administration

Figure 3.1: JEDI Model Costs by Supply Area

3.2 Model Dynamics of Job Creation

The JEDI model is designed to analyze the relationships between project inputs and typical expenditures, providing insights into how these variables and their related activities interact. For instance, increasing the average site depth input of the floating offshore wind farm being

[18] While the NREL Offshore Wind JEDI Model includes decommissioning as a soft cost, this analysis excludes jobs associated with decommissioning activities. This decision is based on the long timeline before decommissioning will occur and the current lack of real-world examples or data from U.S. offshore wind projects to inform reliable job estimates.

modeled raises expenditures related to mooring lines, as longer and more robust systems are required to anchor turbines to the seafloor. Similar positive cost correlations exist between greater turbine sizes and major component costs, as well as greater spacing between turbines with the wind farm to export and array cable costs.

Once project-specific inputs are established, the model calculates the cost of each expenditure per kilowatt (kW) and determines the total cost by multiplying the cost per kW by the wind farm's nameplate capacity. Consequently, expanding the plant size—either by increasing the number or capacity of turbines—proportionally raises the total cost across all expenditures.

In line with input-output (I-O) modeling principles, a portion of the costs associated with each expenditure is attributed to employee compensation, i.e. labor costs. As costs increase, employee compensation increases proportionally, leading to an increase in the estimated number of FTEs generated. By adjusting the local content share, the users can effectively control the proportion of the cost for each expenditure allocated to the focus area, thereby directly influencing the percentage of jobs generated locally.

With the site characteristics held in place, the analysis reveals a clear linear relationship between the local content share and the number of jobs created. This relationship across different supply areas is illustrated in Figure 3.2.

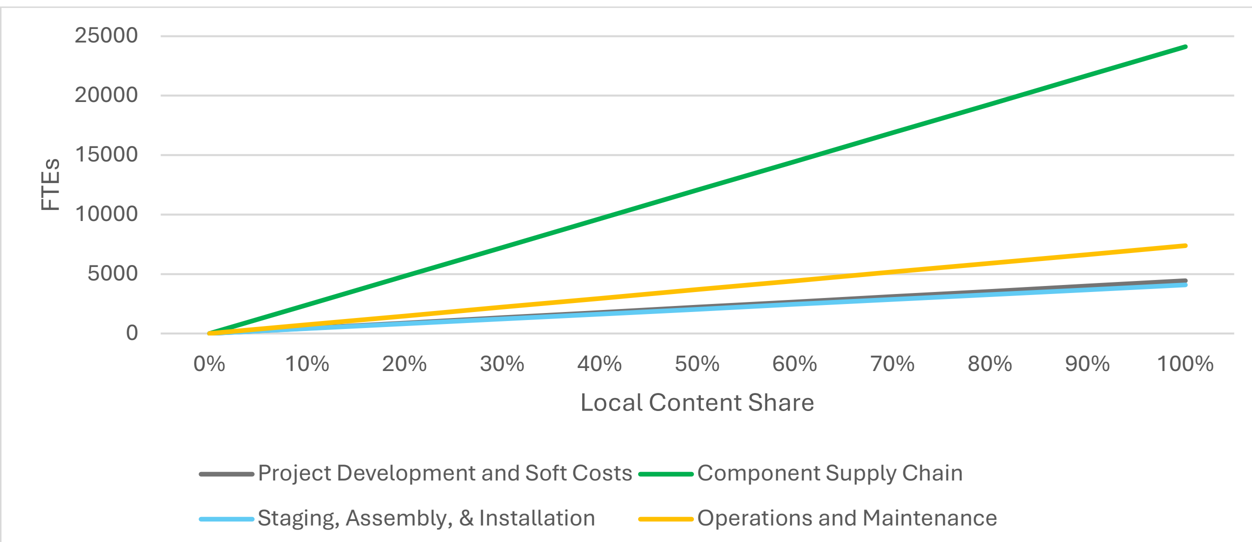


Figure 3.2: Estimated FOSW FTES by Supply Area – 1.5GW Plant in the Humboldt Wind Energy Area

However, the figure does not address the likelihood of achieving specific levels of local content share for the different supply areas. While the types and locations of jobs are discussed in the subsections, an in-depth analysis of the factors affecting local content share for each supply area activity is beyond the scope of this report.

The results below assume 100% local content share across all supply areas, i.e. an estimate of the total number of jobs that could possibly be generated in California for the modeled project.

To better understand the number of jobs that might be generated within California, you would need to estimate the level that the state is expected to participate in any given supply area activity. As the local share or participation level decreases, the number of jobs generated decreases proportionately. A breakdown of each supply area and the estimated number of jobs produced by supply area activity and local content share can be found in Appendix B.

Because this linear relationship also exists between plant size and the number of jobs generated, job creation can also be expressed as FTEs per megawatt (FTEs/MW). This metric provides a simplified way to understand the direct job impacts associated with different project activities and phases. The estimated FTEs/MW across the supply areas for the modeled project are illustrated in Figure 3.3.

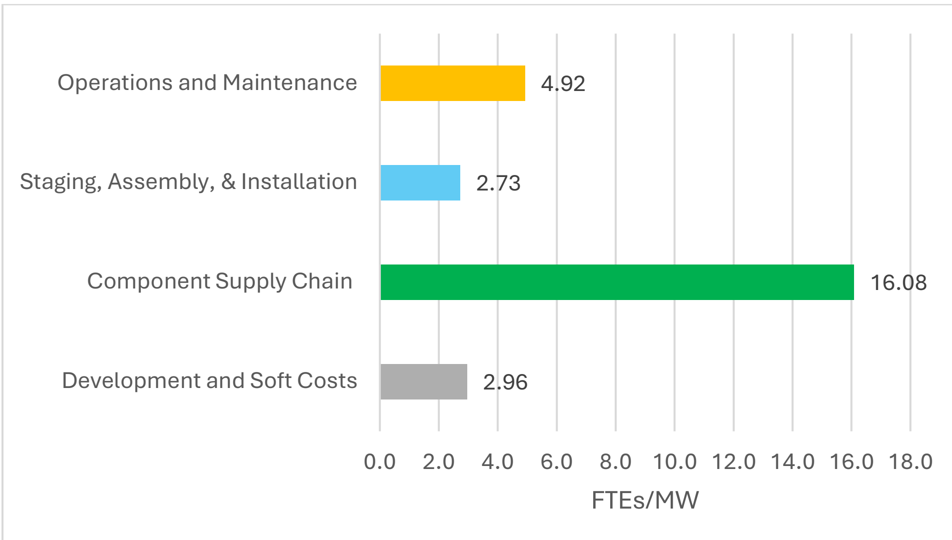


Figure 3.3: FTEs/MW by Supply Area[19]

In addition, understanding when job creation occurs across the different phases of an offshore wind project is key to identifying how employment will be distributed over time. For example, O&M jobs would occur throughout the operational life of the project and represent a steady and ongoing source of employment. So, while O&M contributes the second-highest number of full-time equivalent jobs per megawatt (FTEs/MW) for the modeled project (7,385 FTEs), it generates the fewest FTEs annually at 211 per year if spread out evenly over a 35-year operational life. However, other supply areas—such as staging, assembly, and installation—occur over shorter periods of time, leading to higher annual FTEs, but only during peak activity.

The time series graph in Figure 3.4 illustrates how FTEs might be distributed over time, relative to the project's Commercial Operations Date (COD).

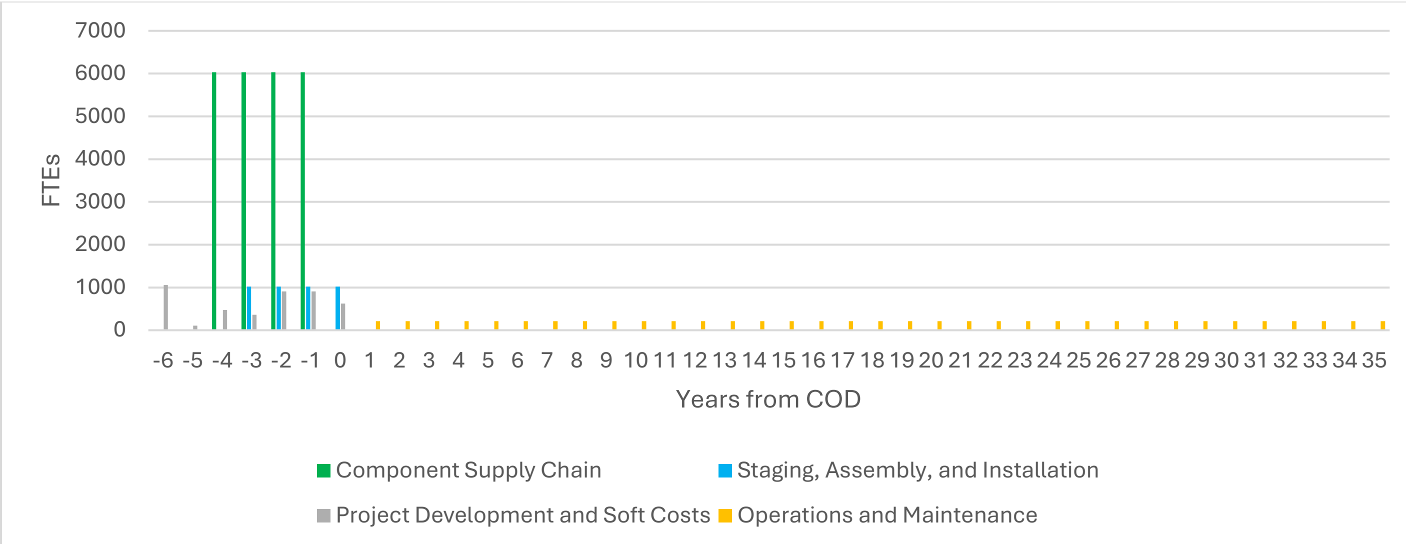


Figure 3.4: Annual FTEs for Supply Areas by Years from Commercial Operations Date[20]

While the JEDI model and its methodology provide valuable insights into the relationships between project parameters and job creation, it is important to acknowledge that the linear relationship it assumes is likely an oversimplification. The model does not account for economies of scale nor variations in labor intensity across different supply areas, which can significantly influence job creation dynamics. Nevertheless, it is a useful tool for identifying the key factors influencing job generation in the FOSW industry.

3.2.1 Component Supply Chain

According to the analysis, and as illustrated in Figures 3.2 and 3.3, component supply chain costs generate the greatest number of jobs across all supply areas, making up over 60% of jobs, or 16.08 FTEs/MW. This is consistent with findings from the AB 525 Strategic Plan, which found that upwards of 2/3 of estimated jobs would occur within the supply chain. These activities are expected to occur over five years, leading up to the COD, resulting in a total of 24,118 FTEs for the modeled project, or about 6,030 FTEs annually.

A breakdown of the number of jobs associated with supply chain expenditures can be found in Figure 3.4.

[20] Time series estimates based on information from the Bureau of Ocean Energy Management website: Bureau of Ocean Energy Management. *Regulatory Framework and Guidelines.* U.S. Department of the Interior. Accessed April 8, 2025. https://www.boem.gov/renewable-energy/regulatory-framework-and-guidelines.

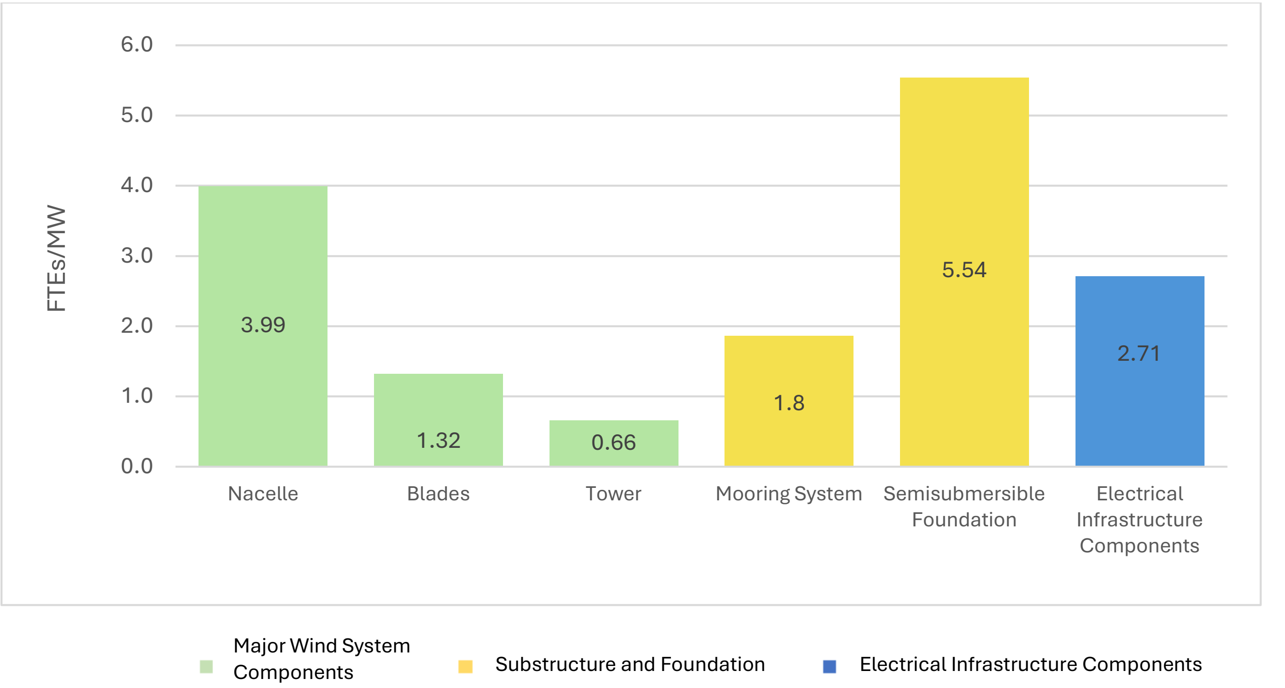


Figure 3.4: FTEs/MW by Supply Chain Component

According to the model, the fabrication/manufacturing of the semisubmersible foundations is the most expensive to produce, at $861/kW, and generates 3% of jobs (5.54 FTEs/MW, or 8,305 FTEs for the modeled project) within this supply area. This is followed by nacelle production, generating roughly 25% of jobs (3.99 FTEs/MW, or 5,985 FTEs for the modeled project), and then electrical infrastructure components at 17% of jobs (2.71 FTEs/MW, or 4,070 FTEs for the modeled project), which includes costs associated with offshore substation and the export and array cable systems. These job numbers also assume a 100% local content share across both labor and material costs for each component, each of which drives job generation differently.

The local content shares of labor and material costs can be adjusted independently for each major turbine component manufacturing (nacelles, towers, and blades) , which revealed that between 74-83% of jobs created across all components were a result of material costs.[21] For all other supply chain components, 74% of the cost was attributed to material costs, with the exception of the offshore substation at 68%. In total, 46% of all possible jobs for the project are a result of material costs related to supply chain components. This is significant because the

[21] In the model, no jobs were associated with labor costs for the production of turbine towers. It is assumed for the purposes of this analysis that this is an error in the model and that this data is simply not available (N/A). These jobs may or may not be accounted for in material costs, but with labor costs for towers in the model totaling $72,334,339, it is assumed that there are jobs associated with these costs that are not correctly being accounted for in the model. With an average per unit labor cost of $201,513 for Blades and Nacelle manufacturing, it is estimated that the cost of labor for the production of turbine towers would generate approximately 359 FTEs or 0.24 FTEs/MW.

jobs and activities associated with material costs could differ widely from those associated with direct labor costs. A breakdown of how material costs compared to labor costs in terms of the number of jobs created by the different supply chain components can be found in Figure 3.5.

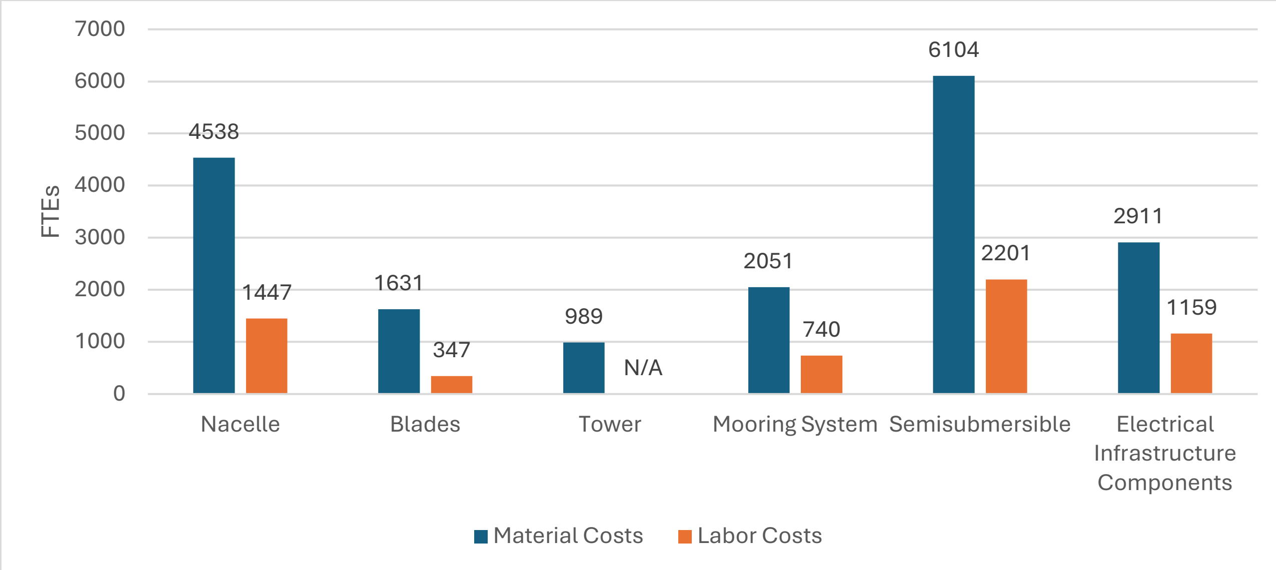


Figure 3.5: Component Supply Chain FTEs by Cost Type and Component

Material costs in the model refer to the expenses associated with producing the materials required to manufacture each supply chain component, including labor costs along the entire supply chain. These jobs can span multiple supply chain activities, such as raw material extraction and processing, material manufacturing, subcomponents manufacturing, logistics, and transportation, etc. As such, determining California's local content share of material costs accurately requires a comprehensive understanding of the supply chain for each component and an assessment of California's capacity and potential to play a significant role in these activities.

In contrast, jobs associated with labor costs are directly linked to manufacturing facilities. The local content share of these labor costs primarily depends on the presence and capacity of manufacturing facilities within California to meet industry demand. As a result, estimating the local content share for labor costs is generally more straightforward. However, there are currently no plans to develop component manufacturing facilities in the state, and thus future participation is uncertain.

3.2.2 Staging, Assembly, and Installation

According to the model, staging, assembly, and installation represent the smallest source of employment, accounting for approximately 10% of all jobs associated with the development of the modeled project, or 2.73 FTEs/MW. These activities occur during the construction phase of the project, estimated to occur over about 4 years, generating a total of 4,088 FTEs for the modeled project, or 1,022 FTEs annually.

The staging, assembly, and installation of a floating offshore wind farm requires a highly coordinated effort due to the complexity of deploying large-scale offshore infrastructure. Tasks may include the fabrication and assembly of semisubmersible foundations, the installation and mounting of turbines onto these floating foundations, and the preparation and deployment of mooring systems, export cables, and array cables. These components are transported to the project site using specialized vessels and equipment, often facing challenges such as weather dependencies, marine logistics, and deep-water operations. Each phase demands expertise in structural engineering, marine operations, subsea installation, and electrical systems, with careful planning to mitigate risks and ensure efficiency in installation activities[22]. Because these activities would need to occur in close proximity to the wind farm, the likelihood of these jobs being in-state is much higher, and thus the local content share might be easier to predict. A detailed breakdown of job distribution related to staging, assembly, and installation expenditures is shown in Figure 3.6.

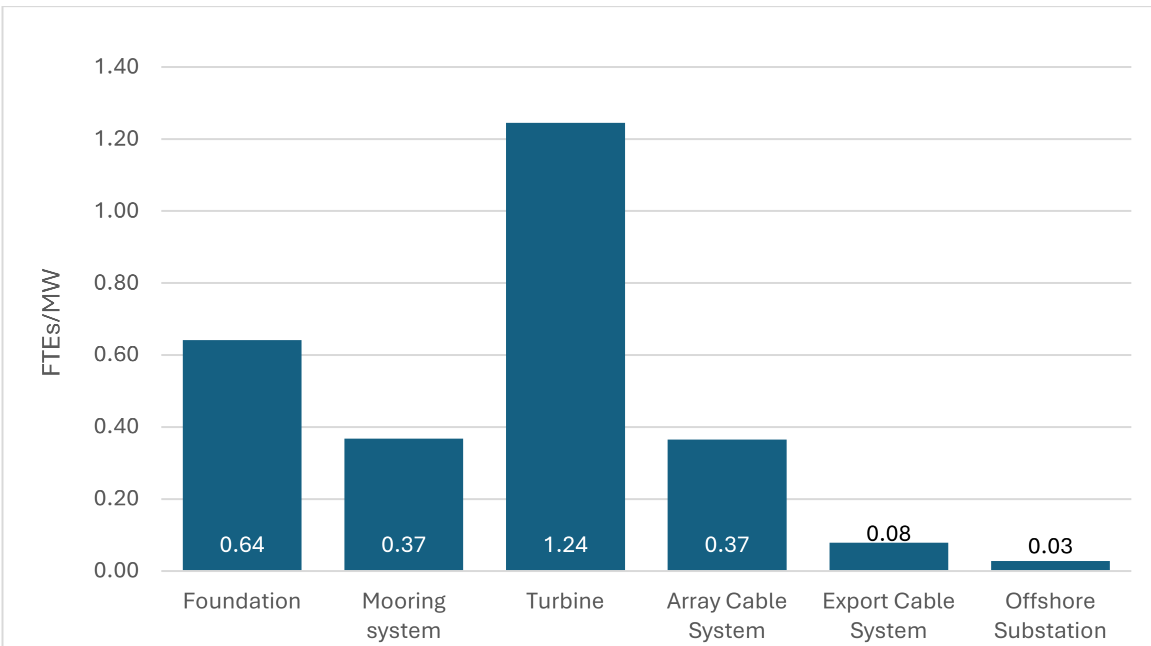


Figure 3.6: Staging, Assembly, and Installation FTEs/MW by component

Within this supply area, the staging, assembly and installation of turbines make up 46% of jobs in the entire supply area (1.24 FTEs/MW for the modeled project), followed by foundations at 23% of jobs (0.64 FTEs/MW for the modeled project). The model further distinguishes between ports and staging related jobs and installation and assembly jobs, with assembly and installation making up 65% of the total jobs, and port and staging the remainder. This distribution likely

[22] Hong, Xiaochen, et al. "Floating Offshore Wind Farm Installation: Challenges and Opportunities." *Ocean Engineering*, 2024. https://strathprints.strath.ac.uk/88961/1/Hong-etal-OE-2024-Floating-offshore-wind-farm-installation-challenges-and-opportunities.pdf.

reflects the significant role of vessel crews and other maritime personnel involved in installation activities, which accounts for a large portion of jobs in this supply area.

The installation of floating offshore wind farm components necessitates the use of highly specialized vessels tailored to specific tasks. For example, floating turbine installation requires dynamically positioned heavy-lift vessels to handle the turbines, while anchor and mooring systems demand anchor-handling tug supply (AHTS) vessels.[23] The JEDI model allows users to adjust local content shares for both vessel and labor costs separately within assembly and installation expenditures.

Adjusting these shares reveals that 66% of assembly and installation jobs are linked to vessel costs and they account for 43% of all jobs across the entire supply area. A breakdown of how installation and assembly vessel costs compare to labor costs in terms of the number of jobs created by component can be found in Figure 3.7.

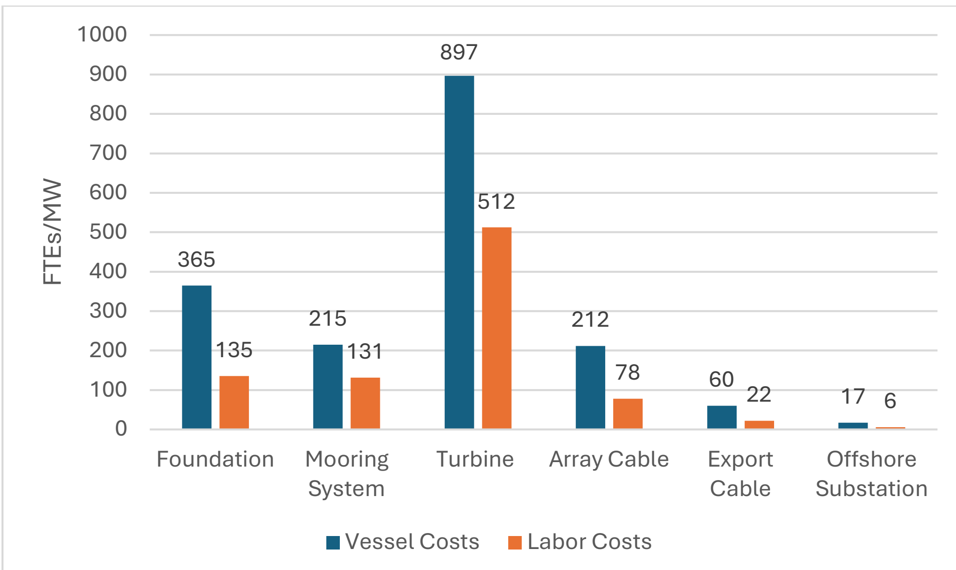


Figure 3.7: Installation and Assembly FTEs by Cost Type and Component

While staging, assembly, and installation activities may occur near the project site, potentially localizing some jobs, the specialized nature of installation vessels may mean that their crews are coming from outside of the state or region. Installation vessels are typically operated by specialized companies that provide their own skilled personnel, leading to a significant number of jobs associated with this supply area not being generated in-state.[24] This dynamic

[23] Xiaochen Hong et al., "Floating Offshore Wind Farm Installation: Challenges and Opportunities," *Ocean Engineering* (2024): 12, https://strathprints.strath.ac.uk/88961/1/Hong-etal-OE-2024-Floating-offshore-wind-farm-installation-challenges-and-opportunities.pdf.
[24] Xiaochen Hong et al., "Floating Offshore Wind Farm Installation: Challenges and Opportunities," *Ocean Engineering* (2024): 14, https://strathprints.strath.ac.uk/88961/1/Hong-etal-OE-2024-Floating-offshore-wind-farm-installation-challenges-and-opportunities.pdf.

underscores the importance of considering the origin of both vessels and their crews when assessing the in-state economic impact of floating offshore wind projects.

3.2.3 Project Development and Soft Costs

Project development and soft costs—which include financing, insurance, permitting, and related activities—account for approximately 10% of total jobs generated by the modeled offshore wind project, or 2.96 full-time equivalent (FTE) jobs per megawatt (MW), all of which occur during the project development phase of a project. On average, this supply area supports an estimated 634 direct FTEs annually over six years up until COD. The costs in this supply area encompass a variety of disjointed activities, with the primary contributors to employment in this supply area being the cost of the onshore electrical interconnection (33% of supply area jobs or 0.97 FTEs/MW for the modeled project), the site auction price (21% of supply area jobs or 0.64 FTEs/MW for the modeled project), construction operation activities (15% of supply area jobs or 0.43 FTEs/MW for the modeled project), and contingency (14% or of supply area jobs 0.40 FTEs/MW for the modeled project). While the model does not clearly define the specific jobs associated with these activities, some reasonable inferences can be made.

The site auction price was manually entered based on the lease details of the modeled site. Since the auction process is conducted through the federal government, it is likely that any resulting jobs would not be localized to the state or region where the project is occurring, but rather associated with administrative functions at the federal level. The cost of the onshore electrical interconnection is partially dependent on the distance from the export cable landing to the grid interconnection point, the default value of 2km was used for this analysis. Costs associated with this expenditure likely encompass both labor and materials that are required to install the private onshore electrical infrastructure that connects the wind farm to the grid.

Construction operation activities appear to represent engineering and management costs incurred during the wind farm's construction phase, likely involving roles such as project managers, engineers, and administrative support. Contingency costs, allocated for unforeseen events or complications, are inherently unpredictable, making it challenging to specify the types of jobs they would support.

Additionally, about 7% of jobs in this supply area, or 0.21 FTEs/MW for the modeled project, are related to site assessment activities, which likely include site surveys, environmental assessments, and geotechnical studies. These roles typically involve specialized expertise in marine surveying and engineering. The diverse set of activities that are encompassed by this supply area may require additional subsets, but for simplicity and purposes of this analysis, these activities are lumped into one supply area.

Lastly, while the NREL Offshore Wind JEDI Model includes decommissioning as a soft cost, this analysis excludes jobs associated with decommissioning activities. This decision is based on the long time horizon before decommissioning will occur and the current lack of real-world examples or data from U.S. offshore wind projects to inform reliable job estimates.

3.2.4 Operations and Maintenance (O&M)

According to the model, operations and maintenance (O&M) costs generate the second largest number of jobs among the activity areas, accounting for approximately 18% of total jobs and contributing 4.92 annual FTEs/MW for the modeled project. The majority of these jobs are expected to be located at an O&M facility near the Wind Energy Area (WEA), increasing the likelihood that they will be localized within the host community.

While the rate of job generation is relatively high, these positions are distributed across the 35-year operational life of the project. This translates to an estimated 211 direct FTEs annually during the operational phase. In contrast, the other supply areas contain activities that are concentrated over a shorter period of time, resulting in more FTEs annually, but perhaps generating fewer FTEs/MW.

Within O&M, about 76% of the jobs are associated with offshore technician roles, with the remaining 24% in operations management and general administration. While the model also estimates indirect and induced employment associated with O&M activities, those figures are not included in this analysis, suggesting that additional economic benefits may be realized beyond the direct jobs reported here.

For many host communities, the O&M phase may offer the most significant long-term economic opportunity, given the duration and local nature of the work. However, capitalizing on this opportunity would require the presence of a localized port capable of hosting an O&M facility.

3.3 Key Results from Sensitivity Analysis

This analysis of the JEDI model highlights the complexities of workforce dynamics and job creation within floating offshore wind (FOSW) projects. Key findings reveal that component manufacturing, primarily related to material production, represent the largest drivers of employment. However, the ability of California's industries to meaningfully contribute to these activities depends on existing infrastructure, workforce readiness, and targeted investments in the state's manufacturing and supply chain capabilities.

Staging, assembly, and installation activities were identified as the second-largest source of employment, though a significant portion of these jobs are tied to vessel costs and specialized crews necessary for installation activities, which are often sourced externally. Despite the high localization potential of certain tasks, such as site preparation and port operations, the reliance on specialized equipment and personnel underscores the need for strategic planning to maximize regional economic impacts by keeping jobs in-state.

Operations and maintenance (O&M), while generating the smallest share of jobs, offers long-term economic opportunities for host communities throughout the lifespan of the project. These roles, largely concentrated in offshore technician and management positions, may be particularly relevant for local and regional workforce planning and economic development.

The findings also underscore the importance of nuanced interpretation when using economic analysis tools like the JEDI model. The linear relationships assumed by the model, such as those between local content share and job creation, provide a simplified framework that does not account for economies of scale or variability in labor intensity. Nonetheless, the model remains a valuable tool for identifying key drivers of employment and informing workforce development strategies.

As California continues to position itself as a leader in offshore wind development, further refinement of workforce analyses, alongside investments in in-state supply chain capacity, will be critical. Detailed assessments of specific projects and site characteristics will provide the actionable insights needed to align local content strategies with the state's strengths and maximize economic and employment benefits. A comprehensive breakdown of the JEDI Model sensitivity analysis is available in Appendix B.

4 Professional Labor Assessment for FOSW and Associated Port Development in California

This assessment uses data from the Workforce Readiness Plan to evaluate the anticipated near-term workforce needs associated with Floating Offshore Wind (FOSW) and related port development in California. While the Workforce Readiness Plan may overestimate job creation and present optimistic timelines for project development, it aligns with California's current FOSW energy targets and provides a valuable framework for understanding the quantity and composition of occupations across FOSW activities. By examining the job estimates for 2030, this analysis aims to assess the near-term demand for professional labor within the FOSW industry and associated port development.

To better understand the supply of professional labor, this assessment examines university-level programs that may serve as career pathways to professional occupations within the Floating Offshore Wind (FOSW) industry and associated port development. Specifically, it explores educational programs at Cal Poly Humboldt (CPH) to identify potential opportunities for supporting professional workforce development in the offshore wind sector.

Because professional occupations, as defined in this report, require a university degree or higher, community colleges—such as College of the Redwoods—were not included in this labor assessment.

4.1 Review of Workforce Data

Workforce demand data for Port Development and OSW Workforce used in this assessment comes from the Workforce Readiness Plan's Appendix B: OSW Workforce Demand Tables[25] and Appendix H: Port Development Workforce Needs by Detailed Occupation[26], respectively. While the OSW workforce data is available by year from 2023-2046 under the high-development scenario, the Port Development workforce data is only available for 2030, also assuming a high-development scenario. This may be because the majority of the port development projects considered in the analysis are assumed to be completed by 2030. Although this development timeline may be unlikely, the job estimates still provide some insights into workforce needs over the next decade.

Under the high-development scenario, workforce demand by 2030 is expected to occur across all identified FOSW supply areas; project development, wind turbine supply, balance of plant supply, installation & commissioning, and operations and maintenance. However, individual occupational type data by supply area or development scenario were not made available as part of the plan. The outcomes of the plan are also under the assumption that operations will begin by 2030, holding true to California's FOSW energy targets. However, based on current

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[25] California State Lands Commission. *AB 525 Workforce Development Readiness Plan*. Final Report. June 16, 2023. 88-92. Available at: https://www.slc.ca.gov/renewable-energy/workforce-development-readiness-plan/.
[26] Ibid., 117-119

development timelines of port and transmission infrastructure necessary to support the FOSW industry, operations would likely not begin before 2031 or 2034[27].

4.2 Workforce Demand: FOSW and Port Development

According to data from the Workforce Readiness Plan, FOSW and associated port development could generate 12,595 jobs by 2030 under the high scenario. The largest portion of these jobs fall in the Construction and Extraction Occupations group, which includes skilled labor occupations typical to the building and construction trades, such as construction laborers (1,367 jobs), electricians (1,083 jobs), and carpenters (565 jobs). A significant number of skilled labor jobs are also expected in installation, maintenance, and repair occupations, as well as transportation and material moving occupations.

Table 4.1: California FOSW and Port Development Jobs in 2030

SOC Major Group	Occupational Group	Estimated Total Jobs in 2030[28]	Percent of Total Jobs
47-0000	Construction and Extraction Occupations	5,813	46.15%
11-0000	Management Occupations	1,195	9.49%
17-0000	Architecture and Engineering Occupations	1,151	9.14%
49-0000	Installation, Maintenance, and Repair Occupations	1,043	8.28%
43-0000	Office and Administrative Support Occupations	799	6.34%
13-0000	Business and Financial Operations Occupations	764	6.07%
53-0000	Transportation and Material Moving Occupations	621	4.93%
51-0000	Production Occupations	591	4.69%
19-0000	Life, Physical, and Social Science Occupations	264	2.10%
41-0000	Sales and Related Occupations	124	0.98%
15-0000	Computer and Mathematical Occupations	96	0.76%
37-0000	Building and Grounds Cleaning and Maintenance Occupations	52	0.41%
23-0000	Legal Occupations	36	0.29%
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	16	0.13%
33-0000	Protective Service Occupations	16	0.13%
35-0000	Food Preparation and Serving Related Occupations	14	0.11%
	Total	**12,595**	

While just under half of FOSW and port development jobs by 2030 will be within the skilled trades, a substantial percentage are professional occupations, that is occupations that typically require a university degree. Combining occupational data from the Bureau of Labor Statistics[29],

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[27] These dates are based on the conversations with project owners and the expected completion date of the North Coast offshore wind transmission infrastructure projects identified in CAISO's 2023/24 Transmission Plan.
[28] California State Lands Commission. *AB 525 Workforce Development Readiness Plan*. Final Report. June 16, 2023. 88-92. Available at: https://www.slc.ca.gov/renewable-energy/workforce-development-readiness-plan/.
[29] U.S. Bureau of Labor Statistics, *Education and Training Assignments by Detailed Occupation*, last modified September 6, 2023, https://www.bls.gov/emp/tables/education-and-training-by-occupation.html.

with FOSW and port development job data, revealed that about 41% of FOSW jobs, 20% of port development jobs, and 25% of the total jobs across both development areas will necessitate a bachelor’s degree or higher. The majority of these positions are concentrated in fields such as engineering, business and financial operations, and management occupations.

While Standard Occupation Codes (SOC) are useful for categorizing and summarizing occupational data, they are still a generalization of actual jobs and may not perfectly translate for certain jobs. For example, an occupation is considered to require a specific level of education when the largest share of workers in that occupation have attained that level of education. So, while the majority of the identified FOSW and port development occupations might typically require a bachelor’s degree, a significant proportion may also hold an advanced degree (i.e. master's or doctorate degree). This is useful when considering which jobs are the most likely to prefer or even require a certain level of education. The top ten most in-demand professional occupations are detailed below in Table 4.2 along with typical experience required and the percentage of the workforce who hold an advanced degree. A full list of professional occupations can be found in Appendix C.

Table 4.2: Professional Occupations in the FOSW Industry and Associated Port Development

SOC	Occupation	Number of jobs in 2030[30]	Experience in Related Occupation[31]	Percent with Advanced Degree[32]
11-9021	Construction Managers	415	None	7%
17-2051	Civil Engineers	350	None	30%
13-1082	Project Management Specialists	329	None	26%
17-2141	Mechanical Engineers	324	None	25%
11-1021	General and Operations Managers	246	5 years or more	13%
11-9199	Managers, All Other	246	Less than 5 years	21%
13-1051	Cost Estimators	163	None	6%
17-2071	Electrical Engineers	94	None	34%
11-3012	Administrative Services Managers	84	Less than 5 years	19%
17-2081	Environmental Engineers	80	None	43%

Given the uncertainties and assumptions inherent in job modeling, understanding the composition of occupations can be particularly valuable, especially when confidence in the total number of projected jobs is low. In an input-output model, if investment were uniformly decreased across all analyzed activities, the total number of jobs would decrease proportionally, but the composition of occupations would remain unchanged. Figures 4.1 and 4.2 illustrate the breakdown of professional occupations within the FOSW industry and associated port development, respectively.

[30] California State Lands Commission. *AB 525 Workforce Development Readiness Plan*. Final Report. June 16, 2023. 88-92. Available at: https://www.slc.ca.gov/renewable-energy/workforce-development-readiness-plan/.
[31] U.S. Bureau of Labor Statistics, *Education and Training Assignments by Detailed Occupation*, last modified September 6, 2023, https://www.bls.gov/emp/tables/education-and-training-by-occupation.html
[32] U.S. Bureau of Labor Statistics, *Educational Attainment for Workers 25 Years and Older by Detailed Occupation*, last modified September 6, 2023, https://www.bls.gov/emp/tables/educational-attainment.html.

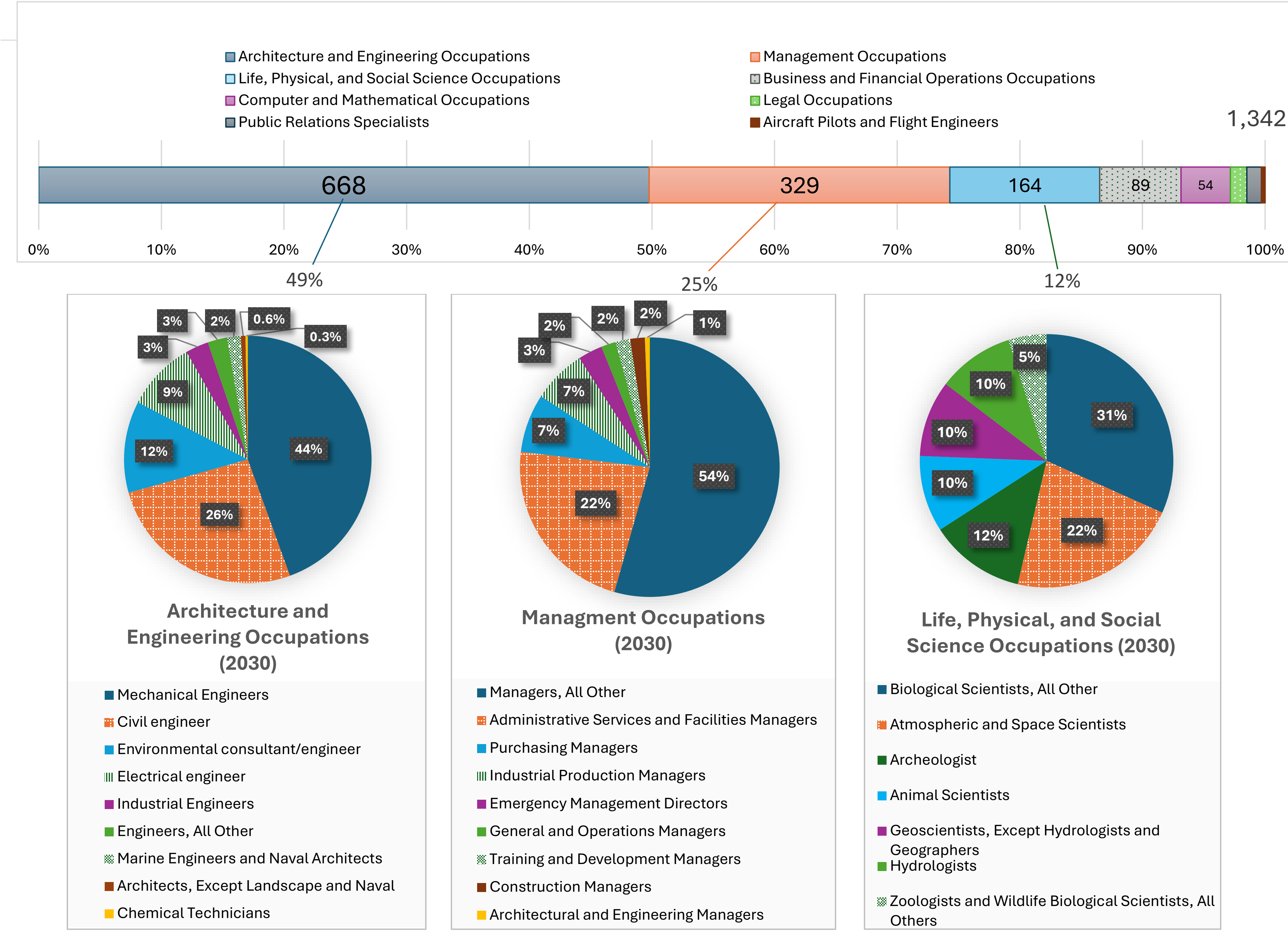

Figure 4.1: Professional FOSW Occupations in 2030

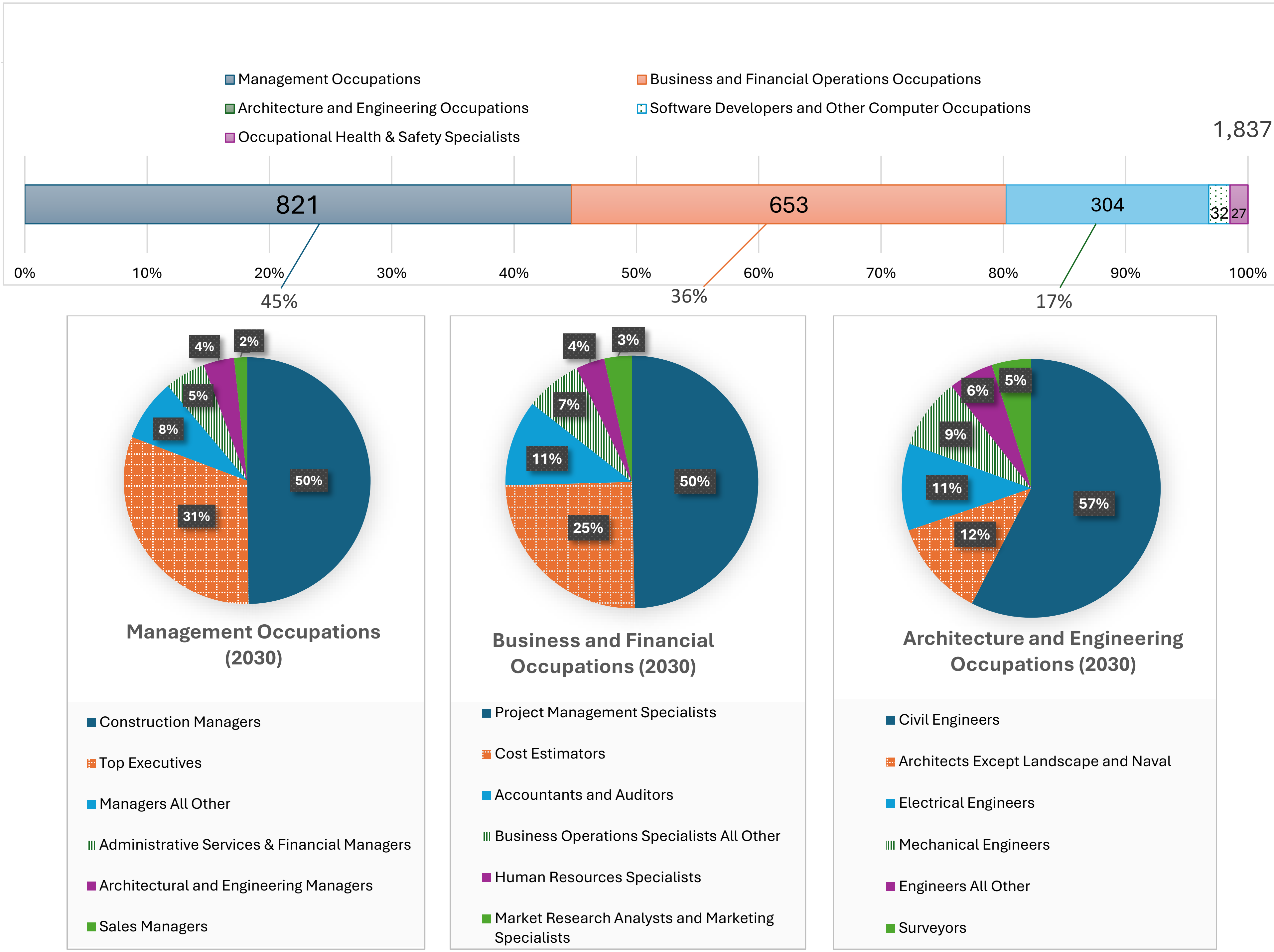

Figure 4.2: Professional FOSW Port Development Occupations in 2030

Managerial Occupations, which as a group is less degree-specific though more likely to require on-the-job experience, make up a significant portion of professional jobs in both FOSW and port development. Architecture and Engineering Occupations are also prevalent in both development areas and often require very specific education, degrees, and certifications for employment. The Life, Physical, and Social Occupations which make up 12% of professional FOSW jobs, are primarily in the life and physical sciences with an emphasis on ecological and geophysical professions. While Business and Financial Operations Occupations make up a significant portion of professional jobs in port infrastructure development, they only account for about 6% of jobs in the FOSW industry. These occupations also often have more flexible educational pathways, with the exception of more technical occupations like Accountants and Auditors.

4.3 Supply Chain Investment Impacts to Professional Labor in FOSW Industry

Because the *AB 525 Workforce Readiness Plan* only provides comprehensive job data under a high development scenario, further analysis was needed to understand how much this influences the projection and distribution of the professional labor force. The job data was analyzed across two supply chain investment scenarios.

Table 4.3: Supply Chain Investment Scenarios

Supply Area	Low Investment Scenario	High Investment Scenario[33]
Wind turbine supply	No in-state manufacturing of major wind system components.	Nacelle assembly by **2030**; one blade manufacturing facilities by **2030**; towers manufacturing from **2030**.
Balance of plant supply	Foundation assembly; no manufacturing or assembly of nacelles, cables, moorings nor anchors.	In-state workforce for foundation assembly by **2030**; nacelle manufacturing by **2030**;

Under the High Supply Chain Investment Scenario, the Workforce Readiness Plan assumes that by 2030, nacelles and towers will be manufactured in California, and one out of two blade manufacturing facilities will have been built. This scenario does not assume in-state manufacturing facilities for cables, mooring, or anchors. Additionally, the Plan only considers direct jobs in its analysis, excluding jobs associated with material or parts production. Under these assumptions, this scenario effectively translates to 100% local content for nacelles and towers, 50% local content for blades, and 0% local content for other component manufacturing and materials production.

Using findings from the NREL JEDI Model Sensitivity Analysis (Section 3), this report models a Low Supply Chain Investment Scenario, in which no components nor material is produced in-

[33] California State Lands Commission. *AB 525 Workforce Development Readiness Plan*. Final Report. June 16, 2023. Table 2.1. Available at: https://www.slc.ca.gov/renewable-energy/workforce-development-readiness-plan/.

state. Under this scenario, it's estimated that approximately 25% of total FOSW jobs would be lost due to an absence of the nacelle, tower, and blade manufacturing in California.

Occupations Affected by Supply Chain Investment

While exact data on job losses is unavailable, we can infer which occupations would be most impacted based on the distribution of jobs within the supply chain. The reductions are expected to primarily affect jobs in the following occupational groups:

- **Production Occupations** (*Manufacturing labor for nacelles, towers, and blades*)
- **Engineering Occupations** (*Design and quality control for domestic manufacturing*)
- **Management Occupations** (*Supply chain, production, and operations management*)
- **Business and Financial Occupations** (*Procurement, trade finance, and domestic contract management*)
- **Computer and Mathematical Occupations** (*Supply chain modeling, logistics software, and automation*)
- **Sales and Related Occupations** (*Supply chain sales and procurement specialists*)

The occupations most closely tied to manufacturing activities account for 40.36% of total jobs in the original study. While some occupational groups, like Production Occupations, are entirely manufacturing-related (comprising 38% of jobs in this subset and requiring no university degree), others contain only select roles that can be reasonably linked to manufacturing activities.

For example, within Engineering Occupations, roles such as electrical, mechanical, materials, and industrial engineers were identified as directly tied to manufacturing, whereas architects and civil engineers were excluded due to their limited direct involvement in production. These selected Engineering Occupations make up 35% of the jobs in this subset tied to manufacturing, and the majority require a university degree. While certain occupations are likely to be more impacted, for this analysis we treated all occupations that could be reasonably associated with manufacturing the same.

Since the total job reduction of 25% is being absorbed only within this subset, the actual reduction within these occupations is larger. Specifically, applying the 25% reduction only to the affected jobs results in an effective job loss rate of 61.44% within these occupations.

Additionally, professional occupations—including engineers, managers, and financial specialists—are disproportionately affected. Of the 820 total jobs lost to other geographies, 426 (52%) are professional jobs. As a result, the percentage of professional jobs in the OSW workforce could decrease from 41% to 37% under the high investment scenario.

Despite differences in total job creation, professional roles remain concentrated in three primary occupational categories, though the job share shifts significantly under the low supply chain investment scenario:

- **Engineering Occupations** decline from 49.8% to 47.0% of professional jobs.
  - **Mechanical engineers** will reduce from 44.5% to 26.9% of engineering jobs, with demand falling sharply if major component manufacturing is outsourced. These roles are heavily tied to design, quality control, and production oversight for nacelles, towers, and blades—jobs that largely disappear in a Low Investment Scenario.
  - **Civil engineers** will grow from 26.2% to 41.0% of engineering jobs under lower supply chain investment. Since their work focuses on infrastructure, installation, and site development, demand remains steady regardless of where components are manufactured.

- **Life and Physical Sciences Occupations** increase from 12.2% to 18.0% of professional jobs.
  - These jobs take up a larger share of the professional workforce under the Low Investment Scenario, as reductions in engineering and management shift the overall balance. Environmental and biological scientists remain critical for site surveys, permitting, and compliance, functions that are not tied to domestic manufacturing and are required in all scenarios.

- **Management Occupations** decline from 24.5% to 20.5% of professional jobs.
  - With component manufacturing, managers oversee domestic production, logistics, and supply chain operations. With no in-state manufacturing, these roles shrink, as supply chain coordination and manufacturing oversight become less relevant. However, project managers and site development leads remain in demand for infrastructure, permitting, and installation activities.

The reduction in domestic component manufacturing not only lowers total job creation but also disproportionately impacts professional occupations, particularly engineering, management, and finance-related roles. If major component manufacturing is not developed domestically, the offshore wind industry's professional workforce share will shrink, making it more difficult to sustain high-skill, high-wage job growth in California.

4.4 Professional Workforce Supply: Educational Pathways at Cal Poly Humboldt

To support the projected demand for professional labor, this assessment explores the educational pathways to employment for various occupations within the FOSW industry and associated port development. Drawing on data from the Bureau of Labor Statistics (BLS) *Occupational Outlook Handbook*[34], the handbook outlines the educational requirements, certifications, and licenses needed for key professional occupations.[35] The following examples

[34] Bureau of Labor Statistics, *Occupational Outlook Handbook*, U.S. Department of Labor. 2021. Available through: https://www.bls.gov/ooh.

[35] Where information on specific occupations was unavailable in the *BLS Occupation Outlook Handbook* supplemental information was gathered on similar occupations to help determine pathways.

illustrate this information for the three most in-demand professional occupations. A full list of relevant professional occupation descriptions can be found in Appendix D.

Construction Managers: Construction managers plan, coordinate, budget, and supervise construction projects from start to finish.

- **Education Summary:** Typically need a bachelor's degree in construction or relevant field and on-the-job training.
- **Licenses, Certifications, and Registrations:** Some states require construction managers to be licensed. While not mandatory, professional certification demonstrates expertise. The Construction Management Association of America offers the Certified Construction Manager (CCM) credential for those with experience who pass a technical exam. The American Institute of Constructors offers Associate Constructor (AC) and Certified Professional Constructor (CPC) credentials.

Civil Engineers: Civil engineers plan, design, and supervise the construction and maintenance of building and infrastructure projects.

- **Education Summary:** Typically need a bachelor's degree in civil engineering or a related field.
- **Licenses, Certifications, and Registrations:** Licensure is often required for public service. Professional Engineering (PE) licensure requires a degree from an ABET-accredited program, passing the Fundamentals of Engineering (FE) exam, having relevant work experience, and passing the PE exam. Certifications from the American Society of Civil Engineers (ASCE) in specialties like coastal or geotechnical engineering can enhance career prospects.

Project Management Specialists: Project management specialists coordinate the budget, schedule, and other details of a project. They lead and guide the work of technical staff and may also may serve as a point of contact for the client or customer.

- **Education Summary:** Typically need a bachelor's degree that may be in a variety of fields, including business or project management.
- **Licenses, Certifications, and Registrations:** Although not always required, certification may be beneficial. The Project Management Institute (PMI) offers several certifications in project management for workers at various experience levels, including the Project Management Professional (PMP).

Note, that while the data for this assessment uses Standard Occupation Codes (SOCs) to define occupations, these codes are only a generalization across all jobs within that occupation. Therefore, actual job titles, duties, and requirements may not perfectly reflect SOC data. For example, while an Electrical Engineer (17-2071) may typically require a bachelor's degree, the job role of an electrical controls engineer, which falls under the same SOC, may require a graduate degree or certification specific to that role. For this reason, further understanding of the actual job roles within the FOSW industry will be critical for supporting an industry-ready professional workforce, Additional information obtained from the *BLS Occupational Outlook Handbook*[36] was used to determine what educational disciplines might be best suited for which occupations. Based on the roles identified within the target development areas, these fields of study include Architecture, Business, Communications, Computer and Information Technology, Construction, Engineering, Mathematics, Natural Resources, Physical Science, and Public Policy & Social Services. BLS provided the top five occupational groups associated with each degree field. An example of this information for the Engineering discipline is shown in Table 4.4, with a complete list of BLS occupational groupings by degree field available in Appendix E.

Table 4.4: BLS Occupational Grouping by Degree Field[37]

Degree Field	Occupational group	Occupational group share
Engineering	Architecture and engineering occupations	30%
	Other	24%
	Management occupations	19%
	Computer and mathematical occupations	15%
	Business and financial operations occupations	7%
	Sales and related occupations	5%

This information was then used to identify relevant academic programs offered at Cal Poly Humboldt (CPH) that align with the identified disciplines. Academic programs were analyzed at the major option level for both undergraduate and graduate degrees.

While most professional occupations identified in this analysis typically require only a bachelor's degree, only two roles—Lawyers (18 jobs projected in 2030) and Anthropologists/Archaeologists (20 jobs projected in 2030)—specifically require an advanced degree or certificate. However, certain positions may still prefer or even require advanced degrees in related fields, particularly in engineering and the sciences, where a significant portion of the workforce holds higher-level qualifications. As a result, this assessment

[36] Bureau of Labor Statistics, *Occupational Outlook Handbook*, U.S. Department of Labor. 2021. Available through: https://www.bls.gov/ooh/field-of-degree/home.htm.

[37] Bureau of Labor Statistics, *Occupational Outlook Handbook*, U.S. Department of Labor. 2021. Available through: https://www.bls.gov/ooh/field-of-degree/home.htm.

separately analyzes CPH's undergraduate and graduate degree programs to better understand their contributions to the professional workforce supply.

Undergraduate Degree Programs

Undergraduate academic programs were categorized into the following degree fields; Communications, Sociology, Anthropology, Geography, Journalism and Mass Communication, Political Science, Biology, Wildlife, Geology, Fisheries Biology, Mathematics, Environmental Science and Management, Computer Science, Oceanography, Business Administration, Economics, Engineering.

The educational data provided in the *BLS Occupational Outlook Handbook* was used in combination with information from the from the CPH website (i.e. a list of careers associated with each degree program), to identify pathways to jobs in the FOSW industry and associated port development (As identified in the AB 525 Workforce Readiness Plan). A sample of this grouping can be found in Table 4.5, and a full list in Appendix F.

Table 4.5: CPH Academic Pathways for FOSW and Port Development Occupations

Degree Field	Potential Careers According to CPH[38]	Associated Offshore Wind and Port Jobs
Engineering	Air Pollution Engineer; Consulting Engineer; Design Engineer; Ecological Engineer; Energy Management Engineer; Environmental Engineer; Fisheries Engineer; Geo-Environmental Engineer; Hydrologist; Mechanical Engineer; Electrical Engineer;	Civil Engineers; Mechanical Engineers; Electrical Engineers; Environmental Engineers; Industrial Engineers; Architectural and Engineering Managers; Cost Estimators; Hydrologists
Business Administration	Accountant; Auditor; Budget Analyst; Business Manager; Credit Analyst; E-Commerce Coordinator; Social Media Coordinator; Financial Planner; Entrepreneur; Marketing Coordinator	Accountants and Auditors; Human Resources Specialists; Project Management Specialists; Logisticians Administrative Services Managers; General and Operations Managers
Biology	Field Biologists Ecologists Microbiologists Physiologists Marine Biologists Geneticists Cell Biologists Developmental Biologists Biotechnology Researchers Biochemists	Biological Scientists, All Other; Zoologists and Wildlife Biologists; Animal Scientists; Occupational Health and Safety Specialists;

As of the 23/24 academic year, CPH now offers several degrees that were not included in these estimates. Several of these new degrees are relevant to FOSW and port development jobs, but

[38] Cal Poly Humboldt. "Programs." Available through: https://www.humboldt.edu/academics/programs.

historical graduation rate data are not available. These new undergraduate degree options include; Energy Systems Engineering, Mechanical Engineering, Data Science, Environmental Science and Management (Energy and Climate), and Software Engineering. While these degrees were not included, each is part of a broader discipline and would likely have no change to the occupational pathways.

Based on the number of graduates over the past ten years, from 2013 through 2023, the average number of graduates for each field of study was determined and then used to project out the estimated number of graduates by 2030. A list of these disciplines, the estimated graduates by 2030, and the total FOSW associated port development jobs that the academic program could potentially accommodate can be found in Table 4.6.

Table 4.6: Estimated Number of CPH Undergraduates by Program[39] [40]

Academic Program	Average Annual Graduates 2013-2023	Estimated Graduates 2030	FOSW Jobs 2030	Port Development Jobs in 2030
Engineering	47.9	335.3	690	448
Business Administration	161.2	1128.4	157	698
Communications	41.2	288.4	5	410
Environmental Science and Management	118.5	829.5	132	0
Biology	197.3	1381.1	68	35
Oceanography	9.4	65.8	84	0
Sociology	72.9	510.3	58	24
Computer Science	30.5	213.5	16	42
Geography	21.1	147.7	36	15
Political Science	28	196	8	39
Economics	14.6	102.2	0	47
Journalism and Mass Communication	29.8	208.6	0	39
Mathematics	18.5	129.5	16	20
Geology	21.9	153.3	32	0
Wildlife	92.3	646.1	16	8
Anthropology	34.9	244.3	20	0
Fisheries Biology	18.9	132.3	0	8

Occupations that did not have a clear education pathway to employment through CPH included; Construction Managers (450 jobs in 2030), Marine Engineers and Naval Architects (12

[39] California State Lands Commission. *AB 525 Workforce Development Readiness Plan*. Final Report. June 16, 2023. Available at: https://www.slc.ca.gov/renewable-energy/workforce-development-readiness-plan/

[40] Cal Poly Humboldt. *Degrees Granted by Academic Year*. Available at: https://pine.humboldt.edu/anstud/cgi-bin/filter.pl?relevant=degreesallopts_M.out.

jobs in 2030), Emergency Management Directors (10 jobs in 2030), Architects, Except Landscape and Naval (41), Airline Pilots, Copilots, and Flight Engineers (4 jobs by 2030), and Lawyers (18 jobs by 2030).

This information should also only be used as a contextual framework for understanding educational pathways to employment within the FOSW sector and is not an accurate description of workforce supply and demand. CPH would of course not be expected to supply all the professional labor for the industry, nor would every graduate be expected to join the industry. Additionally, the majority of occupations have multiple educational pathways and thus there are certain occupations that are double counted in Table 4.6 above. For example: degree programs within the engineering field of study could lead to a career as a hydrologist, but so could degrees in environmental science and management, oceanography, and geology.

Engineering Programs and Occupations

Engineering programs at Cal Poly Humboldt (CPH) provide the most career pathways within the FOSW industry and associated port development, supporting nearly 1,338 jobs or about 30% of the professional workforce, with most attributed to roles within the FOSW industry. CPH's engineering program is comparatively strong and could be further bolstered by the new academic programs at the undergraduate and graduate levels. Notably, all undergraduate engineering programs at CPH are accredited through ABET (Accreditation Board for Engineering and Technology), a key requirement for obtaining a professional engineering license and often preferred or required for employment in most engineering occupations.

Within the FOSW industry, approximately 45% of these jobs will be for mechanical engineers, 26% for civil engineers, and 12% for environmental engineers. Engineering programs at CPH offer pathways to all three, although environmental engineering roles may also be accessed through CPH's environmental science and management programs. In the FOSW-associated port development, engineering jobs are primarily for civil engineers, who make up about 57% of the engineering workforce.

Some of these roles in the FOSW industry might include mechanical engineers designing and optimizing turbine components, civil engineers overseeing foundation and support structure construction, and electrical engineers working on power systems design, grid integration, and electrical component monitoring. However, due to a lack of detailed occupational data by supply area, it is difficult to precisely determine the actual roles within each occupation. Given CPH's work in renewable energy and grid integration through the Schatz Energy Research Center, the university may be well-positioned to supply electrical engineers to the industry, though these roles account for only about 9% of the engineering workforce across both the FOSW industry and associated port development.

Given that many professional jobs in the FOSW industry and associated port development may be available to students with engineering degrees, targeted investment in these programs could benefit CPH. The concentration of these jobs in the FOSW industry specifically presents an opportunity to develop industry-specific curricula, courses, research projects, and professional development opportunities, which could give students an edge in securing employment.

There are also engineering-related occupations without clear educational pathways through CPH's engineering programs, such as architects and marine engineers. Conversely, some roles outside the traditional engineering group, like cost estimators, hydrologists, and industrial production managers, may still find pathways through the engineering program at CPH.

Science Programs and Occupations

CPH's strong science programs, particularly in the life and physical sciences, are expected to produce over 4,000 graduates by 2030. Notable programs include Environmental Science & Management, Marine Biology, Oceanography, Geology, and Geography, all of which emphasize experiential learning, fieldwork, and research. These programs are well-suited to produce professionals with the skills necessary to address the environmental and technical challenges of offshore wind development, aligning with the need for socially and environmentally responsible development of FOSW.

Data on undergraduates also shows a strong advantage at CPH for several STEM programs, particularly within the life, physical, and social sciences, with more than 4,000 graduates expected between now and 2030. Some notable programs include Environmental Science & Management, Marine Biology, Oceanography, Geology, and Geography. These programs emphasize experiential learning, fieldwork, and research, making them well-suited to addressing the environmental and technical challenges associated with offshore wind development. The university's emphasis on sustainability and applied sciences aligns well with the needs of the FOSW sector.

The majority of jobs generated within the life, physical, and social sciences occupational group are projected to come from the FOSW industry, and primarily biological and life scientists, atmospheric and space scientists, and geoscientists. These professionals will be critical for surveying and scientific monitoring during the predevelopment and construction phases of an FOSW project.

The only jobs within the life, physical, and social science occupational group that were attributed to FOSW-associated port development were for occupational health and safety specialists. This seems extremely unlikely given the amount of surveying and monitoring work that would have to occur during the development of any port infrastructure project. This may indicate a substantial underestimate of the number of jobs within this occupational group specifically for port development.

Business Administration Programs and Occupations

Business administration programs also has a large number of graduates and strong job prospects within the industry, however, occupations available to these graduates also often overlap with other programs. While there are 1,270 jobs available to communication and business administration graduates, roughly 87% of these are within port development.

Of business and financial occupations within port development, half are for project management specialists (50%), followed by cost estimators (25%), accountants and auditors (11%), business operations specialists (7%), and human resources and marketing occupations making up the remainder (7%). Accountants and auditors often have more narrowly defined educational pathways through business and financial programs, while cost estimators tend to require industry-specific knowledge and also have a pathway through engineering degrees. Business operations specialists as well human resource and marketing occupations, include a broader range of educational pathways, including through communications degrees.

The majority of relevant FOSW industry occupations are for human resource specialists, followed by logisticians, and minimal project management specialists. Human resource specialists, which would likely oversee workforce recruitment activities, also has pathways to employment through the communications program. Logisticians, which only has an identified pathway through the business and administration program, would likely oversee and coordinate supply chain activities.

While there are a significant number of jobs relevant to a business and administration degree, very few are related specifically to the FOSW industry. CPH also does not have an accredited business program, such as through the Association to Advance Collegiate Schools of Business (AACSB), which might hinder its ability to provide graduates at both the undergraduate and graduate levels who would be competitive in this labor market.

Graduate Degree Programs

As noted earlier, while BLS data indicates that many of these occupations typically only require a bachelor's degree in a related discipline, this is a generalization of the data across all U.S. industries and may not be perfectly reflective of actual jobs in FOSW. In fact, according to a study done by the Public Policy Center at UMASS Dartmouth, *Proposed Vineyard Wind Offshore Wind Energy Project Estimated Contribution to Employment and Economic Development*, many of these occupations within the offshore wind industry may require advanced degrees from graduate programs (i.e. master's or doctorate degree).

Table 6
Expected Occupations, Credentialing Requirements, and Earnings During Pre-Construction & Development

Major Occupations	Credentials	Annual Mean Earnings
Engineering		
Civil Engineers	Master's Degree	$91,930
Mechanical Engineers	Master's Degree	$94,500
Electrical Engineers	Master's Degree	$108,990
Marine Engineers & Naval Architects	Master's Degree	$98,370
Electrical and Electronic Eng. Techs.	Associate's Degree	$65,370
Mechanical Engineering Technicians	Associate's Degree	$56,110
Surveying and Scientific Monitoring		
Environmental Engineers	Bachelor's Degree	$88,800
Geoscientists	PhD	$84,310
Natural Sciences Managers	PhD	$172,000
Zoologists & Wildlife Biologists	PhD	$83,340
Atmospheric & Space Scientists	PhD	$103,770
Mechanical Engineering Technicians	Associate's or On-the-Job Training	$56,110
Geological & Petroleum Technicians	Associate's or On-the-Job Training	$56,450
Surveying Technicians	Associate's or On-the-Job Training	$51,680
Finance		
Financial Manager	Master's Degree	$138,610
Budget Analysts	Bachelor's Degree	$77,480
Cost Estimators	Bachelor's Degree	$74,200
Permitting		
Compliance Officers	Bachelor's Degree	$83,030
Paralegals & Legal Assistants	Associate's or On-the-Job Training	$55,250
Legal		
Lawyers	J.D.	$158,760
Paralegals & Legal Assistants	Associate's or On-the-Job Training	$55,250
PR and Marketing		
Market Research Analysts	Master's Degree	$79,030
Machine Maint./Port Services		
Bus/Truck Mech. Incl. Diesel	Associate's/Postsecondary Cert.	$54,880
Ship Engineers	Postsecondary Certificate	$90,120
Site Managers		
Construction Managers	Bachelor's Degree	$109,900
Architect/Eng. Managers	Bachelor's Degree	$145,000
Water Transportation Workers		
Captains/Mates/Pilots	Associate's/Postsecondary Cert.	$60,480
Sailors & Marine Oilers	Postsecondary Certificate	$38,670
Ship Engineers	Associate's/Postsecondary Cert.	$90,120

Vineyard Wind; U.S. Bureau of Labor Statistics; PPC calculations.

Figure 4.3: Offshore Wind Occupational Data with Credentials[41]

According to one table from the Dartmouth study (Figure 4.3), working as a civil, mechanical, or electrical engineer in the offshore wind industry would require a master's degree. However, 2022 data from the BLS states that only 25-34% of workers in these roles have an advanced

[41] David R. Borges et al., *Proposed Vineyard Wind Offshore Wind Energy Project: Estimated Contribution to Employment and Economic Development*, Public Policy Center, UMass Dartmouth. December 2017. 17, Table 6

degree.[42] Since the Dartmouth study is based on information from the BLS in combination with the developer, Vineyard Wind, it is reasonable to assume that this difference is due to influence from the developer. Thus, the actual requirement for employment may require direct conversations with developers and further research into current job trends.

Regardless, an advanced degree would likely only increase the chances for employment within the FOSW industry, and thus an assessment of graduate programs was used to frame advanced educational pathways through CPH.

Relevant Graduate Programs Offered at Cal Poly Humboldt

Of the fifteen graduate degrees offered at CPH, eight were determined to have clear pathways to employment within the FOSW industry and associated port development. Environmental Systems and Natural Resource degrees also included relevant concentrations.

- Applied Anthropology, M.A.
- Biology, M.S.
- Business Administration, M.B.A.
- Engineering & Community Practice, M.S.
- Environmental Systems, M.S.
    - Energy Technology and Policy Concentration, M.S.
    - Geology Concentration, M.S.
    - Environmental Resource Engineering, M.S.
- Natural Resources, M.S
    - Environmental Science and Management Concentration, M.S.
    - Fisheries Concentration, M.S.
    - Wildlife Concentration, M.S.
- Public Sociology, M.A.
- Social Science, Environment and Community Concentration, M.A.

In order to focus on occupations that are most likely to require a graduate degree, this portion of the assessment includes only occupations that the BLS determined were made of at least 20% of workers with an advanced degree. A list of these occupations can be found in Table 4.7.

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[42] U.S. Bureau of Labor Statistics, *Educational Attainment for Workers 25 Years and Older by Detailed Occupation*, last modified September 6, 2023, https://www.bls.gov/emp/tables/educational-attainment.html.

Table 4.7: Professional Occupations with Over 20% of Workers Holding an Advanced Degree

Occupation	Estimated Jobs by 2030 (FOSW and Port Development)	Percent of Workers with an Advanced Degree
Lawyers	18	92%
Anthropologists and Archeologists	20	57%
Zoologists and Wildlife Biologists	8	55%
Biological Scientists, All Other	52	55%
Hydrologists	16	53%
Geoscientists, Except Hydrologists and Geographers	16	53%
Data Scientists	20	48%
Architects, Except Landscape and Naval	41	46%
Environmental Engineers	80	43%
Animal Scientists	16	40%
Architectural and Engineering Managers	35	36%
Atmospheric and Space Scientists	36	35%
Software Developers	22	35%
Electrical Engineers	94	34%
Engineers, All Other	34	33%
Chief Executives	14	32%
Civil Engineers	350	30%
Training and Development Managers	6	29%
Emergency Management Directors	10	28%
Accountants and Auditors	72	28%
Public Relations Specialists	16	27%
Project Management Specialists	329	26%
Computer Systems Analysts	16	26%
Mechanical Engineers	324	25%
Market Research Analysts and Marketing Specialists	23	24%
Marine Engineers and Naval Architects	12	24%
Compliance Officers	8	24%
Business Operations Specialists, All Other	47	23%
Industrial Engineers	20	22%
Financial Managers	30	22%
Managers, All Other	246	21%
Purchasing Managers	24	21%
Human Resources Specialists	74	20%

Of these jobs, advanced degrees through CPH could be pathways to all except for the following occupations; marine engineers, architects, and lawyers. Though an advanced degree would likely open more employment opportunities, this assessment was chosen to be narrower in scope to ensure only the most relevant occupations were captured. A list of advanced degrees and their associated FOSW occupations can be found in Table 4.8. For newer degree programs where historical data on graduation rates is not available, "N/A" is indicated in the "Estimated Graduates 2030" column.

Table 4.8: CPH Advanced Degree and FOSW Occupations

Degree	Associated OSW and Port Jobs	Estimated Graduates 2030	Total Estimated OSW and Port Jobs (2030)
Engineering & Community Practice, M.S.	Civil Engineers; Environmental Engineers; Mechanical Engineers; Industrial Engineers; Electrical Engineers; Architectural and Engineering Managers;	N/A[43]	1247
Environmental Systems, M.S.	Civil Engineers; Environmental Engineers; Geoscientists, Except Hydrologists and Geographers; Hydrologists; Data Scientists; Atmospheric and Space Scientists	20	518
Business Administration, M.B.A	Accountants and Auditors; Financial Managers; Business Operations Specialists, All Other; Market Research Analysts and Marketing Specialists; Managers, All Other; Purchasing Managers	159	453
Social Science, Environment and Community Concentration, M.A.	Public Relations Specialists; Market Research Analysts and Marketing Specialists; Project Management Specialists	N/A	424
Public Sociology, M.A.	Public Relations Specialists; Market Research Analysts and Marketing Specialists; Project Management Specialists	25	368
Biology, M.S.	Zoologists and Wildlife Biologists; Biological Scientists, All Other; Environmental Engineers; Animal Scientists	73	156
Natural Resources, M.S.	Zoologists and Wildlife Biologists; Biological Scientists, All Other; Environmental Engineers; Animal Scientists	42	104
Applied Anthropology, M.A.	Anthropologists and Archeologists	N/A	20

[43] For newer degree programs where historical data on graduation rates is not available, "N/A" is indicated in the "Estimated Graduates 2030" column.

Unlike the undergraduate section, this section does not include a comparison of graduates by 2030 to jobs in 2030. Not surprisingly, each degree program has a significant gap between the estimated number of graduates and jobs by 2030, and not every occupation is going to require an advanced degree. This information, however, may prove useful for determining where CPH may want to concentrate investment into new programs and or curricula geared toward the FOSW industry.

5 Transmission Infrastructure Preliminary Workforce Analyses

A key component to the successful deployment of FOSW in California is transmission infrastructure. Large investments are being made to support this on the North Coast as detailed in California's Independent System Operator's (CAISO) 23/24 Transmission plan[44]. While a full economic impact analysis should be conducted to understand the socioeconomic impacts of this development to the various regions where the work will occur, for the purposes of this study we will only attempt break down the composition of the workforce necessary to carry out this project.

5.1 NREL Transmission JEDI Model

To understand the workforce needs for transmission infrastructure supporting Floating Offshore Wind (FOSW), this analysis initially employed NREL's JEDI model for transmission infrastructure. This JEDI model allows the user to input key project parameters (e.g. transmission line voltage, length, region, topography, etc.) to determine the cost of project expenditures across a variety of related sectors. The model then I-O analyses to estimate the impact (i.e. jobs and monetary output) that these expenditures have on the regional economy.

However, based on the project parameters outlined in CAISO's Transmission Plan, the cost estimates from the JEDI model were undervalued. While the Transmission Plan estimates the construction cost of the offshore wind transmission infrastructure at between $2.9 and $4.2 billion, the JEDI model, under the same assumptions, estimates the construction cost at $1.6 billion in 2024 dollars. This may be a result of the year the model was published and changes in the supply chain since then.

The model does, however, indicate that if all construction and installation labor is sourced locally within California, roughly 49% of the project construction and installation costs would go toward direct employee compensation. Although changes in the total project cost affect labor compensation, the relationship is not direct. Without detailed knowledge of the Transmission Plan's cost estimates, it is unclear which variables need adjustment in the model. According to the JEDI model, this project would generate 5,736 jobs over the construction period. If the project begins next year and is completed by the end of 2034 as anticipated, this would result in roughly 574 jobs per year over ten years.

[44] California Independent System Operator. *2023-2024 Transmission Plan*. Folsom, CA: California ISO, May 23, 2024. Accessed January 9, 2025. https://stakeholdercenter.caiso.com/InitiativeDocuments/BOARDAPPROVED_2023-2024_TransmissionPlan.pdf.

Applying the same 49% labor cost from the JEDI model to the lower cost estimate in the Transmission Plan ($2.9 billion) results in approximately $1.44 billion in employee compensation. Inputting this figure into the economic modeling software IMPLAN as industry employee compensation under “Construction of New Power and Communication Structures" industry yields nearly 23,536 jobs over the construction period, or 2,536 jobs per year. This gives a range of between 574 -2,536 jobs/year over 10-year period, which to wide a range to be practically useful. A more detail understanding of project parameters and expenditures is required to more meaningfully estimate accurate economic impacts from these projects.

While the use of IMPLAN may have resulted in an overestimate of the number of jobs, it does offer insights into occupational types, something that the JEDI model does not provide. Therefore, instead of running the model based on estimated expenditures or employee compensation, this analysis used IMPLAN to examine the composition jobs in "construction of new power and communication structures". Regardless of how the project was scaled the composition of labor remained the same for this specific industry. Though this is not useful for understanding the supply and demand of that workforce, it may be useful for understanding what role professional labor might play.

It is also important to note that of the workforce analyses reviewed as part of this assessment the majority were done as an analysis by parts (ABP) often including additional IMPLAN industry categories when estimating industry output. As noted in the *Economic Impact Analysis of the Southern Spirit Transmission Project on the State of Mississippi* conducted by Strategic Economic Research[45], estimating the impact using the through total project expenditure in the general category of “Construction of New Power and Communication Structure” may tend to overestimate the economic impact as it fails to account for where that expenditure occurs. This study instead attributed expenditures across a range of IMPLAN categories. Of likely the most consequence to the following analysis are the contributions to “Architectural, engineering, and related services,” “Legal Services,” and “Advertising, public relations, and related services,” which may skew the number of professional workers generated through these categories. However, the general category “Construction of new power and communication structures” should give a broad overview of the industry and how it traditionally operates in California.

[45] Strategic Economic Research, LLC. 2023. *Economic Impact Analysis of the Southern Spirit Transmission Project on the State of Mississippi.* San Francisco, CA: Pattern Energy. https://patternenergy.com/wp-content/uploads/2023/03/Southern-Spirit-MS-2.13.23.pdf.

5.2 Transmission Professional Labor Assessment Findings

Table 5.1: Composition of All Occupations - Construction of New Power and Communication Structures

Occupations	Percent of Jobs
Construction and Extraction Occupations	38.3%
Installation, Maintenance, and Repair Occupations	34.7%
Management Occupations	7.2%
Office and Administrative Support Occupations	6.8%
Business and Financial Operations Occupations	5.3%
Transportation and Material Moving Occupations	2.9%
Architecture and Engineering Occupations	1.8%
Production Occupations	0.9%
Life, Physical, and Social Science Occupations	0.6%
Computer and Mathematical Occupations	0.6%
Sales and Related Occupations	0.5%
Building and Grounds Cleaning and Maintenance Occupations	0.3%
Protective Service Occupations	0.2%
Legal Occupations	0.2%

The vast majority of occupations in this industry are in the skilled trades, found primarily in the construction and extraction occupation group and the installation, maintenance, and repair occupation group. Only about 14% of the workforce would likely require a bachelor's degree. These professional occupation are broken down further in Table 5.2.

Table 5.2: Composition of Professional Occupations - Construction of New Power and Communication Structures

Occupations	Percent of professional jobs
Management Occupations	49.16%
Business and Financial Operations Occupations	36.22%
Architecture and Engineering Occupations	7.62%
Life, Physical, and Social Science Occupations	3.36%
Computer and Mathematical Occupations	2.57%
Legal Occupations	0.76%
Sales and Related Occupations	0.30%

Nearly half of the professional jobs for transmission infrastructure development are within management occupations, a similar port development occupations which was also made up of mostly skilled trade jobs. 43% of the jobs in the management occupation group are for construction managers, of which there was no identified pathway to employment through CPH, and 35% were for general and operations managers, which is particularly broad.

Business and financial operations occupations make up the next greatest share, with about 17% attributed to project management specialists and the rest spread out across various other roles mainly related to financial management and risk mitigation, public relations-related roles, and supply chain operations. As noted earlier, many of these occupations have broad pathways to employment.

Table 5.3: Composition of Architecture and Engineering Occupations - Construction of New Power and Communication Structures

Occupations	Percent of Professional Jobs
Civil Engineers	40%
Electrical Engineers	25%
Electronics Engineers, Except Computer	4%
Engineers, All Other	8%
Environmental Engineers	1%
Health and Safety Engineers, Except Mining Safety Engineers	6%
Industrial Engineers	4%
Mechanical Engineers	4%
Surveyors	8%

Though they only make up under 2% of the jobs in this industry, occupations within the architecture and engineering, life, physical, and social science, and computer and mathematical occupations, align more closely with the programming offered at CPH. As noted earlier, this assessment, based only off of the construction of new power and communication structures, may be too narrow and underestimate the number of jobs created in some of these professional occupations.

Architecture and engineering occupations make up about 8% of the professional workforce for transmission infrastructure development. A breakdown of these occupations can be found in Table 5.3. Many of these jobs are for civil engineers, again similar to the findings for the port development workforce. Electrical engineers also make up a significant portion of this occupational category, far greater than what was found within the workforce for the FOSWS industry or associated port development.

Table 5.4: Composition of Life, Physical, and Social Science Occupations - Construction of New Power and Communication Structures

Occupations	Percent of Professional jobs
Foresters	3%
Occupational Health and Safety Specialists	97%

Illustrated in Table 5.4, occupational health and safety specialists make up nearly the entirety of jobs within the life, physical, and social sciences. Foresters also make up the remainder of this workforce, which may be particularly crucial constructing and maintaining transmission lines in the densely forested areas of Northern California.

Table 5.5:Composition of Computer and Mathematical Occupations - Construction of New Power and Communication Structures

Occupations	Percent of professional jobs
Computer Network Architects	30%
Network and Computer Systems Administrators	23%
Computer Occupations, All Other	19%
Software Developers	19%
Computer Systems Analysts	6%
Data Scientists	4%

Computer and mathematical occupations only make up about 2.5% of jobs in this industry, and a breakdown of these occupations can be found in Table 15. Although not highlighted as much in the professional workforce assessment for the FOSW industry and associated port development, a number of the professional occupations within the computer and mathematical group have educational pathways to employment through CPH, particularly given the new undergraduate programs in data science and software engineering.

This analysis highlights that the workforce needed for transmission infrastructure supporting FOSW in California is predominantly concentrated in skilled trades, with a smaller but critical component of professional occupations. While most jobs are in construction, installation, and repair roles, management occupations constitute a significant share of the professional workforce, primarily in construction management and operations management. The architecture, engineering, life, physical, and social science, and computer and mathematical occupations—although making up a smaller portion of the workforce—play vital roles, particularly in civil and electrical engineering, health and safety, and computer systems management. Given the unique regional demands and CPH’s existing and emerging academic programs, there is a clear opportunity for targeted investment in aligning educational pathways with industry needs to support the growing transmission infrastructure workforce.

6 North Coast Workforce Assessment for Port Development

As discussed earlier, the workforce analysis for the North Coast, conducted by Moffat & Nichol as part of the Workforce Readiness Plan, likely overestimates job numbers. In this section, we will briefly attempt to improve the accuracy of that assessment based on available information and data.

6.1 Port Infrastructure Investment

The Workforce Readiness Plan used the IMPLAN input-output modeling program to determine the number of direct jobs that would result from FOSW port infrastructure improvement. For the North Coast, the study assumed a $2.7 billion investment for two staging and integration sites and one manufacturing facility in the Port of Humboldt. According to the Humboldt Bay Harbor, Recreation, & Conservation District's Minimal Viable Port (MVP) Project, awarded by the Department of Transportation, the actual development cost is just under $900 million[46]. Because the Workforce Readiness Plan indicated it is direct jobs from port development projects, then its analysis is likely based on the amount of money spent on employee compensation, as any cost associated with materials, or goods and services, would result in indirect job creation. Assuming that the ratio of employee compensation to total project cost is stable, then the number of direct jobs is directly reflective of the total investment. According to The Workforce Readiness Plan, the North Coast's $2.7 billion port infrastructure project would result in 3,200 jobs annually by 2030. Based on this information we can assume that a $900 million project would result in roughly 1,067 jobs.

Assuming the composition of those jobs stays the same, then the number of jobs and types of occupation for the Humboldt Bay Offshore Wind Terminal are presented in Table 6.1 below.

[46] Humboldt Bay Harbor, Recreation, and Conservation District, *FY 2023-24 MPDG Humboldt Bay Offshore Wind MVP Proposal Package*, Humboldt Bay Harbor District, Table 6.

Table 6.1: Humboldt Bay Offshore Wind Terminal Revised Workforce Demand by 2030

SOC	Occupations	Percent of Jobs (*Workforce Readiness Plan)*	Estimated North Coast Jobs in 2030
47-2061	Construction Laborers	11.21%	120
47-2111	Electricians	11.17%	119
47-1011	First-Line Supervisors of Construction Trades and Extraction Workers	7.15%	76
47-2031	Carpenters	6.08%	65
47-2152	Plumbers Pipefitters and Steamfitters	5.02%	54
11-9021	Construction Managers	4.40%	47
49-9021	Heating Air Conditioning and Refrigeration Mechanics and Installers	3.78%	40
13-1082	Project Management Specialists	3.49%	37
43-9061	Office Clerks General	3.20%	34
47-2051	Cement Masons and Concrete Finishers	2.88%	31
47-2073	Operating Engineers and Other Construction Equipment Operators	2.85%	30
47-2141	Painters Construction and Maintenance	2.64%	28
11-1021	General and Operations Managers	2.58%	28
17-2051	Civil Engineers	1.88%	20
13-1051	Cost Estimators	1.75%	19
43-3031	Bookkeeping Accounting and Auditing Clerks	1.61%	17
43-6014	Secretaries and Administrative Assistants Except Legal Medical and Executive	1.53%	16
53-3032	Heavy and Tractor-Trailer Truck Drivers	1.43%	15
47-2211	Sheet Metal Workers	1.08%	11
41-3091	Sales Representatives of Services Except Advertising Insurance Financial Services and Travel	1.02%	11
47-2221	Structural Iron and Steel Workers	0.79%	8
13-2011	Accountants and Auditors	0.78%	8
51-4121	Welders Cutters Solderers and Brazers	0.76%	8
47-3013	Helpers--Electricians	0.74%	8
11-9199	Managers All Other	0.72%	8
53-7062	Laborers and Freight Stock and Material Movers Hand	0.64%	7
43-1011	First-Line Supervisors of Office and Administrative Support Workers	0.62%	7
49-1011	First-Line Supervisors of Mechanics Installers and Repairers	0.61%	7
47-2231	Solar Photovoltaic Installers	0.59%	6
49-2022	Telecommunications Equipment Installers and Repairers Except Line Installers	0.59%	6
47-3015	Helpers--Pipelayers Plumbers Pipefitters and Steamfitters	0.53%	6
49-2098	Security and Fire Alarm Systems Installers	0.51%	5
13-1199	Business Operations Specialists All Other	0.51%	5
47-2081	Drywall and Ceiling Tile Installers	0.51%	5
49-3042	Mobile Heavy Equipment Mechanics Except Engines	0.48%	5
17-3011	Architectural and Civil Drafters	0.44%	5
49-9098	Helpers--Installation Maintenance and Repair Workers	0.42%	4
49-9052	Telecommunications Line Installers and Repairers	0.41%	4
17-1011	Architects Except Landscape and Naval	0.40%	4

47-4031	Fence Erectors	0.40%	4
47-2121	Glaziers	0.38%	4
47-2151	Pipelayers	0.37%	4
17-2071	Electrical Engineers	0.36%	4
11-9041	Architectural and Engineering Managers	0.36%	4
37-3011	Landscaping and Groundskeeping Workers	0.34%	4
49-9071	Maintenance and Repair Workers General	0.33%	4
11-3031	Financial Managers	0.32%	3
17-2141	Mechanical Engineers	0.29%	3
19-5011	Occupational Health and Safety Specialists	0.29%	3
49-9099	Installation Maintenance and Repair Workers All Other	0.29%	3
53-7021	Crane and Tower Operators	0.28%	3
47-2071	Paving Surfacing and Tamping Equipment Operators	0.27%	3
43-5061	Production Planning and Expediting Clerks	0.26%	3
43-6011	Executive Secretaries and Executive Administrative Assistants	0.26%	3
13-1071	Human Resources Specialists	0.26%	3
47-4011	Construction and Building Inspectors	0.25%	3
47-3019	Helpers Construction Trades All Other	0.25%	3
13-1161	Market Research Analysts and Marketing Specialists	0.25%	3
13-1028	Purchasing Agents Except Wholesale Retail and Farm Products	0.24%	3
15-1252	Software Developers	0.24%	3
43-5032	Dispatchers Except Police Fire and Ambulance	0.23%	2
43-4051	Customer Service Representatives	0.23%	2
37-2011	Janitors and Cleaners Except Maids and Housekeeping Cleaners	0.22%	2
47-3012	Helpers--Carpenters	0.20%	2
41-4012	Sales Representatives Wholesale and Manufacturing Except Technical and Scientific Products	0.20%	2
53-3033	Light Truck Drivers	0.20%	2
43-3051	Payroll and Timekeeping Clerks	0.20%	2
47-2161	Plasterers and Stucco Masons	0.19%	2
47-2171	Reinforcing Iron and Rebar Workers	0.19%	2
53-7065	Stockers and Order Fillers	0.19%	2
17-2199	Engineers All Other	0.18%	2
49-9044	Millwrights	0.18%	2
43-4171	Receptionists and Information Clerks	0.18%	2
47-2072	Pile Driver Operators	0.17%	2
47-5022	Excavating and Loading Machine and Dragline Operators Surface Mining	0.17%	2
47-5023	Earth Drillers Except Oil and Gas	0.17%	2
47-4098	Construction and Related Workers All Other	0.17%	2
17-1022	Surveyors	0.16%	2
11-3012	Administrative Services Managers	0.15%	2
43-3021	Billing and Posting Clerks	0.15%	2
47-2011	Boilermakers	0.15%	2
11-1011	Chief Executives	0.15%	2
11-2022	Sales Managers	0.15%	2
47-3014	Helpers--Painters Paperhangers Plasterers and Stucco Masons	0.14%	1
53-7051	Industrial Truck and Tractor Operators	0.14%	1
17-3022	Civil Engineering Technologists and Technicians	0.14%	1
43-5071	Shipping Receiving and Inventory Clerks	0.13%	1

49-2097	Audiovisual Equipment Installers and Repairers	0.13%	1
53-1047	First-Line Supervisors of Transportation and Material Moving Workers Except Aircraft Cargo Handling Supervisors	0.13%	1
47-2021	Brick masons and Block masons	0.13%	1
47-2181	Roofers	0.12%	1
17-3023	Electrical and Electronic Engineering Technologists and Technicians	0.12%	1
17-3012	Electrical and Electronics Drafters	0.11%	1
15-1299	Computer Occupations All Other	0.11%	1
15-1232	Computer User Support Specialists	0.11%	1
51-9061	Inspectors Testers Sorters Samplers and Weighers	0.11%	1
49-9051	Electrical Power-Line Installers and Repairers	0.11%	1

Though the composition of the professional workforce is the same, a breakdown of this workforce is provided in Table 6.2 to provide more clarity. Noting again that any errors that were made in the original analysis related to the actual composition of the workforce would remain in the adjusted version. Of particular concern is the lack of life and physical science occupations, apart from occupational health and safety specialists.

Table 6.2: Professional Port Development Occupations for Development of the Humboldt Bay OSW Terminal in 2030 – Revised Workforce Demand

Occupational Health and Safety Specialists	Port Devlopment Jobs in 2030
Accountants and Auditors	8
Architects Except Landscape and Naval	4
Business Operations Specialists All Other	5
Chief Executives	2
Civil Engineers	20
Computer Occupations All Other	1
Cost Estimators	19
Electrical Engineers	4
Engineers All Other	2
General and Operations Managers	28
Human Resources Specialists	3
Market Research Analysts and Marketing Specialists	3
Mechanical Engineers	3
Occupational Health and Safety Specialists	3
Project Management Specialists	37
Software Developers	3
Surveyors	2
Total	147

While this simplified analysis is not perfect for refining actual workforce numbers, it does provide state and regional workforce practitioners with a more realistic outlook of short-term job creation numbers. This assessment also highlights the need to further refine these workforce analyses so that they reflect actual industry development and allow for more meaningful workforce strategies to be implemented both at the state and regional levels. For the North Coast region, primarily centered around the Humboldt Bay area, the difference between 3,200 and 1,067 workers is substantial. For a community that already faces a number infrastructure limitations and concerns, there is a real need to manage community expectations, both in terms of benefits and impacts of increased economic activity.

7 Conclusions and Recommendations

This report highlights substantial opportunities for Cal Poly Humboldt (CPH) to strategically align its academic programs with the anticipated workforce demands of the FOSW industry and associated port development. Engineering, life and physical sciences, and business administration programs at CPH are particularly well-positioned to support the evolving needs of the industry. However, there is a critical need for targeted investments in these programs to further strengthen educational pathways, develop industry-specific curricula, and integrate experiential learning opportunities that can directly prepare students for careers in FOSW. By enhancing these academic offerings, CPH can play a pivotal role in bridging the gap between workforce supply and industry demand.

Despite these opportunities, significant challenges remain. Accurately forecasting job numbers and understanding specific job roles within the FOSW industry is difficult due to the evolving nature of the sector and the variability in modeling assumptions. Current workforce analyses often lack the precision and consistency needed to inform strategic planning, as job creation estimates can vary widely based on differing project scales, supply chain participation levels, and local content assumptions. These uncertainties underscore the need for more precise, location-specific data and a deeper understanding of the unique workforce dynamics within California's coastal regions.

To achieve these goals, it is essential that workforce development efforts are grounded in accurate, transparent, and context-specific data that can guide educational and training programs. By focusing on aligning academic pathways with industry needs, enhancing program offerings, and refining workforce analyses, CPH and other vested parties can better position themselves to support the growth of the FOSW industry and contribute to California's broader clean energy transition.

7.1 Recommendations

1. **Course Mapping for FOSW Career Pathways:** Higher education institutions should map courses in relevant academic programs that align with careers in the FOSW industry. This mapping can provide students with a guide of relevant courses that may provide advantages to obtaining careers in the FOSW industry. This mapping will also help staff and faculty identify gaps and opportunities to align curricula with industry needs.

2. **Strengthen Industry-Academic Partnerships and Curriculum Alignment**: Forge deeper collaborations between CPH, industry stakeholders, and workforce boards to co-develop curricula, research projects, and experiential learning opportunities tailored to the FOSW industry. Aligning academic programs with actual roles in the industry will ensure students gain relevant skills and experience, particularly in high-demand areas like engineering, environmental sciences, and project management.

3. **Expand Targeted Educational Pathways and Certifications**: Invest in expanding and refining CPH's academic offerings, particularly in engineering, environmental resource management, and business administration. Consider developing new programs, certifications, or concentrations that directly address the specialized needs of the FOSW industry and associated port and transmission development – helping to bridge identified skill gaps.

4. **Enhance Data Transparency and Modeling Approaches**: Improve the accuracy and reliability of workforce projections by advocating for greater transparency in modeling assumptions used in workforce analyses and reports. Use updated, region-specific data to refine job estimates and better inform strategic workforce planning, ensuring alignment with the realities of the FOSW sector in California.

5. **Conduct Regionally Focused Workforce and Economic Impact Studies**: Undertake detailed assessments of specific FOSW projects, including associated port and transmission infrastructure development. These studies should focus on refining job estimates and offering a clearer understanding of regional occupational demands to support strategic economic and workforce development.

6. **Monitor Industry Trends and Adapt Educational Strategies**: Continuously review industry developments, technological advancements, and regulatory changes to keep academic programs and workforce strategies responsive to the evolving needs of the FOSW sector.

7. **Foster West Coast Collaboration to Align Workforce Development and Supply Chain Expectations:** Establish a collaborative framework among West Coast states, academic institutions, industry stakeholders, and workforce organizations to align methodologies for workforce analyses and refine supply chain expectations in the FOSW industry. By standardizing assumptions and modeling approaches, stakeholders can improve labor and supply chain projections, optimize training investments, and develop effective educational programs, supporting the sustainable growth of the FOSW sector.

7.2 Potential Next Steps

1. **Economic Impact Analysis of FOSW Transmission Infrastructure on the North Coast**: Conduct a detailed economic impact study focused on the North Coast's transmission infrastructure development to refine job estimates, assess regional and state economic impacts, and guide strategic workforce planning.

2. **Industry Outreach to Define FOSW Job Roles**: Engage directly with industry stakeholders to better define job roles, skill requirements, and workforce needs within the FOSW sector.

3. **Professional Labor Assessment for FOSW Science Occupations**: Conduct an assessment of workforce needs for science-related FOSW occupations. This assessment should

consider the absence of life, physical, and social science occupations represented in current projections for port development job growth.

4. **Assessment of Workforce Needs for FOSW Research, Policy, and Ancillary Activities**: Evaluate the labor requirements for roles in FOSW research, policy development, and other supporting activities, that are a direct result of federal, state, and philanthropic funding within the FOSW sector.

5. **Identify Curriculum Development and New Program Opportunities**: Based on labor assessments, pinpoint opportunities for new or enhanced academic programs at CPH that address critical skills in FOSW.

Appendix A - Literature Review – AB 525 Workforce Analyses

A review of existing workforce analyses reveals the complexities and variabilities in labor demand and supply forecasts for FOSW development on the West Coast. These analyses inform strategic planning documents, such as California's AB 525 Strategic Plan, and serve as critical resources for workforce practitioners, industry stakeholders, and host communities. They act as market indicators for labor suppliers, including unions, colleges, universities, and professional institutions, to ramp up their training and educational programming efforts. However, the wide range of projected outcomes within these analyses hinders the ability of labor suppliers to develop effective workforce development strategies.

Given the nascent stage of offshore wind development in the U.S., particularly floating offshore wind, these analyses rely heavily on economic input-output modeling, each with its set of assumptions around project scale and supply chain participation. The analyses predominantly focus on job creation within the FOSW and port development areas, overlooking the workforce needs for transmission infrastructure and essential research, policy, and planning activities. While this report will also only focus on jobs within the FOSW industry and associated port development, further workforce analysis should be done for offshore wind transmission infrastructure and research, policy, and planning activities.

The *AB 525 Strategic Plan* features two chapters dedicated to labor demand and workforce development within California's emerging OSW industry:

- **Chapter 3: Offshore Wind Potential Economic and Workforce Benefits**
- **Chapter 7: Workforce Development**

To estimate job creation, the AB 525 Strategic Plan relies on early workforce analyses of FOSW in California, categorizing job output into construction, supply chain, and operations and maintenance (O&M). Despite each report considering multiple offshore wind energy development scenarios, only the estimates from the highest development scenario were published as part of the plan. These figures underscore the potential economic impacts of OSW development in California, yet the plan does not fully describe their underlying assumptions nor does it explain the high degree of variability between the studies. Notably, these analyses predate California's new OSW energy targets of 5 GW by 2030 and 25 GW by 2045, each assuming a different scale and timeline for development. In addition, the studies assume varying levels of California's participation in the supply chain, including major components and sub-components. Given that some reports estimate that approximately two-thirds of jobs will be within the FOSW supply chain, these assumptions around local participation significantly impact the results of each study.[47]

Figure 1: AB 525 Strategic Plan – Workforce Demand for FOSW[48]

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

Below is a further breakdown of some of the FOSW workforce analyses included as part of the AB 525 Strategic Plan.

Review; *Floating Offshore Wind in California: Gross Potential for Jobs and Economic Impacts from Two Future Scenarios* (April 2016)

The 2016 report from the National Renewable Energy Laboratory (NREL), titled *Floating Offshore Wind in California: Gross Potential for Jobs and Economic Impacts from Two Future Scenarios*, utilized their self-developed JEDI (Jobs and Economic Development Impact) Model to evaluate the economic impacts of offshore wind development in California. The report provides a detailed analysis of how the level of participation in the supply chain can significantly affect job output and economic impacts. NREL assumed that a substantial portion of component manufacturing, such as nacelles, blades, and towers, would be produced domestically, based on the expectation that higher demand for offshore wind would stimulate local manufacturing and economic activity within the industry.

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[47] California Energy Commission, *Assembly Bill 525 Offshore Wind Strategic Plan* (California Energy Commission, 2024). https://efiling.energy.ca.gov/GetDocument.aspx?tn=257700&DocumentContentId=93596.

[48] California Energy Commission, *Assembly Bill 525 Offshore Wind Strategic Plan* (California Energy Commission, 2024), 133. https://efiling.energy.ca.gov/GetDocument.aspx?tn=257700&DocumentContentId=93596.

The model captures direct, indirect, and induced jobs. Direct jobs result from project development investments, whereas indirect jobs stem from spending on goods and services to support that development (e.g., supply chain activities). Induced jobs are created by increased spending of incomes earned through direct and indirect employment. Therefore, any adjustment in California's participation in the supply chain, or "local content share," affects the number of indirect and induced jobs created.

The report models two scenarios for FOSW deployment—Scenario A with 16 GW and Scenario B with 10 GW by 2050, with total state GDP impacts ranging from $16.2 billion to $39.7 billion during the construction phase, and $3.5 billion and $7.9 billion during operations, respectively. This underscores the substantial economic benefits that could result from expanding local content in the supply chain, and thus the importance of striving to meet the workforce demand at these higher FOSW energy deployment scenarios.

However, because the number of jobs is heavily dependent on these local content share assumptions and because the amount of energy installed does not match the current FOSW energy goals, job estimates from this report are outdated. Additionally, the report also does not provide detailed information on the specific types of occupations demanded.

Assumptions and Outcomes:

1. **Installed Capacity**: 16 GW by 2050
2. **Total Jobs**[49]: 17,950 (not including induced jobs) in 2045
    - **Construction**: 23,780
        - **Direct**: 2,340
        - **Indirect**: 11,280
        - **Induced**: 6,950
    - **Operations**: 4,260
3. **Local Content Share (California)**:
    - **Nacelle Manufacturing**: 25%
    - **Blade Manufacturing**: 50%
    - **Tower Manufacturing**: 100%
4. **Monetary Impact**[50]
    - **Scenario A (16 GW by 2050)**:
        - **Total State GDP Impact (Construction Phase)**: $39.7 billion
        - **Total State GDP Impact (Operations Phase)**: $7.9 billion
    - **Scenario B (10 GW by 2050)**:
        - **Total State GDP Impact (Construction Phase)**: $16.2 billion

[49] Jobs are in full-time equivalent (FTE). FTE is the equivalent of one person working full time (i.e., 40 hours per week) or two people working half time.
[50] While not specified in the analysis, results are assumed to be in 2015 dollars (the date the analysis was conducted) which is typical for economic input-output modeling.

- **Total State GDP Impact (Operations Phase)**: $3.5 billion[51]

Review; *The California Offshore Wind Project: A Vision for Industry Growth* (February 2019)

The *2019* report from the American Jobs Project, titled *The California Offshore Wind Project: A Vision for Industry Growth*[52], explores the potential economic impacts of offshore wind (OSW) development in California, with a focus on how progressive OSW policies might drive further deployment of offshore wind energy and result in increased economic impact. While the report provides an important perspective on the role of policy in fostering industry growth, it is less reliable for projecting actual job numbers due to several key limitations.

The report uses an input-output model to estimate job creation, yet does not provide a breakdown of the assumptions made as part of their model, nor does it offer a breakdown of job estimates by direct, indirect, and induced jobs. Additionally, the report is based on outdated energy targets, further reducing its reliability as a source for accurate job estimates.

Despite assuming a somewhat larger installed capacity value by 2045 than the NREL report for its high scenario model, this report estimates significantly fewer jobs across all activities.

Assumptions and Outcomes:

- **Installed Capacity:** 18 GW by 2045
- **Total Jobs:** 17,000 (direct, indirect, induced) by 2045
  - **Construction Jobs:** 13,000
  - **Operations Jobs:** 4,000
  - **Direct Jobs:** 8,000

Review and Summary of *California Supply Chain Needs Summary Report* (May 2022)

The 2022 report from Guidehouse Inc., titled *California Supply Chain Needs Summary Report*, provides an analysis of California's FOSW supply chain, including an analysis of workforce requirements. The report assumes a significant local content share in the FOSW supply chain, assuming that 50% of blades and towers would be produced in California, alongside varying assumptions in nearly 40 additional supply chain areas. These include; onshore electrical maintenance, materials, and labor for mooring systems and foundations, among others. These assumptions significantly influence job output projections, as the report utilized NREL's JEDI

[51] National Renewable Energy Laboratory, *Floating Offshore Wind in California: Gross Potential for Jobs and Economic Impacts from Two Future Scenarios* (NREL, April 2016. https://www.nrel.gov/docs/fy16osti/65352.pdf.

[52] American Jobs Project, *The California Offshore Wind Project: A Vision for Industry Growth* (February 2019), https://americanjobsproject.us/wp-content/uploads/2019/03/CA_OSW_2.21.pdf.

model, which, as discussed earlier, is extremely sensitive to changes in the local content share of the supply chain. Thus, the report's reliance on these assumptions presents certain limitations.

The report does include a workforce gap analysis, comparing the skilled labor needed for supply chain, installation, and operations and maintenance (O&M) activities to current employment levels in California. However, the analysis only covers three key occupations within the construction and O&M development areas.

The report is limited by its insufficient explanation for local content assumptions, a lack of job categorization into direct, indirect, and induced roles, and an incomplete classification of job types, industries, and roles. However, it does highlight the role of the workforce as part of the supply chain, and allows for some understanding of occupational pathways.

<u>Assumptions and Outcomes Under the Report's High Scenario:</u>

- **Installed Capacity**: 3 GW by 2030, 20 GW by 2050
- **Total Jobs**: 2030; 2045
    - 2,375; 5,063
    - **Construction**:
        - 125; 173
    - **Supply Chain**:
        - 2,413; 2,382
    - **Operations**:
        - 314; 1,508
- **Local Content Share (California)**:
    - **Nacelle Manufacturing**: 0%
    - **Blade Manufacturing**: 50%
    - **Tower Manufacturing**: 0%[53]

Review and Summary of AB 525 Workforce Development Readiness Plan (June 2023)

The California State Lands Commission AB 525 Workforce Readiness Plan[54] offers a comprehensive evaluation of the workforce requirements needed to support California's offshore FOSW goals of developing 3-5 GW of FOSW capacity by 2030 and 25 GW by 2045. This plan is divided into several critical sections, each addressing different aspects of workforce demand, infrastructure needs, and regional workforce gaps.

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[53] Guidehouse Inc., *California Supply Chain Needs Summary Report* (May 2022). https://www.nrel.gov/docs/fy22osti/81602.pdf.

[54] Moffat & Nichol, *AB 525 Workforce Development Readiness Plan* (Sacramento, CA: California State Lands Commission, 2023). https://www.slc.ca.gov/reports/ab-525-workforce-readiness-plan/.

Overview and Purpose

The Workforce Readiness Plan aims to provide recommendations for workforce development efforts that will be necessary for California's FOSW energy targets set by the CEC and the anticipated seaport investments and related activities identified in the *AB 525 Port Readiness Plan*.[55] The Workforce Readiness Plan outlines three key analyses: a needs assessment that analyzes the scale, timing, and necessary skills of the required workforce; an assessment of the current workforce and training infrastructure in California; and a gap and opportunity analysis between workforce needs and availability.

Key Scenarios and Workforce Modeling

The Workforce Readiness Plan models workforce demand for FOSW and associated port development under three scenarios: high, medium, and baseline. These scenarios reflect varying levels of local investment in FOSW supply chain infrastructure, ranging from significant in-state manufacturing facilities in the high scenario to minimal local content in the baseline scenario. Similar to previous studies, this modeling approach can have a significant impact on job estimates due to the heavy concentration of labor in the FOSW supply chain. However, it does offer insight into the maximum potential workforce demand that California could face if all planned infrastructure and manufacturing facilities are realized.

Table 2: Timing of Workforce Availability in Each Supply Area for Each of Three Analysis Scenarios[56]

Supply Area	Baseline Scenario	Medium Scenario	High Scenario
Project development	Entire supply can be delivered by local workforce from **2035**.	Entire supply can be delivered by local workforce from **2035**.	Entire supply can be delivered by local workforce from **2035**.
Wind turbine supply	Without local manufacturing facilities, no supply anticipated.	Local workforce for tower manufacturing from **2030**.	Nacelle assembly by **2030**; (2) blade manufacturing facilities by **2030** and **2035**; towers manufacturing from **2030**.
Balance of plant supply	Concrete supply for floating hulls and some onshore substation supply from **2030**.	Local workforce for foundation assembly by **2030**; nacelle manufacturing by **2030**; cable, moorings, and anchors manufacturing from **2035**.	Local workforce for foundation assembly by **2030**; nacelle manufacturing by **2030**; (2) cables manufacturing facilities, mooring, and anchors manufacturing from **2035**.

[55] California State Lands Commission. *AB 525 Port Readiness Plan* (July 2023). https://slcprdwordpressstorage.blob.core.windows.net/wordpressdata/2023/07/AB525-Port-Readiness-Plan_acc.pdf.

[56] Moffat & Nichol, *AB 525 Workforce Development Readiness Plan* (Sacramento, CA: California State Lands Commission, 2023), 11. https://www.slc.ca.gov/reports/ab-525-workforce-readiness-plan/.

Installation & commissioning	Quayside workforce for (S&I), loadout, offshore logistics and onshore construction, where ports will come online in **2029, 2030, and 2035**.	Quayside workforce for (S&I), loadout, offshore logistics and onshore construction, where ports will come online in **2029, 2030, and 2035**.	Quayside workforce for (S&I), loadout, offshore logistics and onshore construction, where ports will come online in **2029, 2030, and 2035**.
Operations & maintenance	Local workforce used for operations and maintenance from **2030**.	Local workforce used for operations and maintenance from **2030**.	Local workforce used for operations and maintenance from **2030**.

The high scenario for the AB 525 Workforce Readiness Plan assumes that California will invest in multiple local manufacturing facilities, including ports for turbine staging and integration, turbine nacelle assembly, blade manufacturing, and foundation manufacturing, among others. This scenario represents an optimistic upper limit for local workforce demand, and results from this scenario are the only ones made available in the published report.

Workforce by Region and Industry

The report also breaks down workforce demand by region, focusing on the North Coast (Humboldt & Del Norte Counties), San Francisco Bay Area, Central Coast, and Southern California. It emphasizes that job creation will differ significantly across these regions, with Southern California and the North Coast expected to support the highest number of full-time equivalents (FTEs).

In the high scenario, the North Coast is projected to require 3,200 FTEs annually during the construction of the Humboldt Bay Offshore Wind Terminal project. However, this number is likely highly inflated as it is based on a $2.7 billion investment in port infrastructure, assuming the port will also be used for major component manufacturing alongside staging and integration sites. According to the project proposal submitted to the U.S. Department of Transportation, this investment is likely closer to $1 billion dollar investment for a single staging and integration site under Phase 1, thus resulting in a significant reduction in the number of jobs created on the North Coast.[57]

Differentiation Between FOSW and Port Infrastructure Workforce

A key aspect of the Workforce Readiness Plan is its distinction between the workforce required in the FOSW industry and that needed for port infrastructure upgrades. The plan highlights that while both require substantial labor, the skills, and certifications necessary for the FOSW industry are often more specialized. For example, FOSW project development includes roles such as environmental impact assessment, offshore geological surveys, and electrical design, which typically require advanced degrees, specific certifications, and knowledge of the FOSW

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[57] Humboldt Bay Harbor, Recreation and Conservation District. *Humboldt Bay Offshore Wind Multi-Use Terminal Project Proposal.* FY 2023-24 MPDG Proposal Package. (August 2023). 5.

industry. On the other hand, port infrastructure work, though significant in scale, generally demands less specialized labor, focusing more on construction-related activities that are similar to other large-scale development projects.

Justification for Use in Professional Labor Assessment

The Workforce Readiness Plan was selected as the primary source of data for this Professional Labor Assessment due to its comprehensive and up-to-date analysis of workforce demand specific to California's FOSW goals. Unlike earlier reports, which may rely on outdated assumptions or less relevant data, this plan aligns closely with the state's current FOSW energy targets and provides a detailed examination of the types of occupations and skills that will be in demand. Additionally, the report’s focus on direct job outputs from development and supply chain activities, excluding indirect and induced jobs, provides a clearer picture of the immediate labor needs.[58]

[58] California State Lands Commission, *AB 525 Workforce Development Readiness Plan* (Sacramento, CA: California State Lands Commission, 2023). https://www.slc.ca.gov/reports/ab-525-workforce-readiness-plan/

Appendix B – A Sensitivity Analysis of NREL's Offshore Wind JEDI Model

Inputs used for the local content share sensitivity analysis of NREL's Offshore Wind Jobs and Economic Development Impact (JEDI) Model were based on the site characteristics of the Humboldt Wind Energy Area in California.

The analysis also assumes a 1.5GW Plant made up of 100 15MW floating turbines with semisubmersible foundations spaced approximately 1 nautical mile apart in a grid formation.

Job Creation by Cost Category to Level of Local Content Share/Plant Capacity

NREL's OSW Jedi Model allows users to adjust the local content share for all costs they have associated with the development of an offshore wind farm. A local content share is the percentage of costs for an activity which occurred within the region of focus, i.e. California. For example, if all labor costs to manufacture nacelles occurred in California, then it would have a local content share of 100%, thus all jobs generated from those expenditures would also occur in California.

For each of the cost categories listed below the local content share was adjusted from 0-100 percent to determine where the majority of jobs are generated and the sensitivity of local content share of cost has to the number of direct jobs generated. With all other variables fixes, each cost category was determined to have a linear relationship to the local content share as well as the number of turbines deployed. This relationship is detailed in the table below and inputs for this analysis can be found in the Model Inputs section.

The model estimates direct and induced jobs based on expenditures within specific cost categories in the region of focus. However, only direct jobs are reported here. These include jobs that might traditionally be considered indirect, such as those generated through supply chain expenditures. Since the model explicitly attributes expenditures to specific supply chain areas, these jobs are categorized as direct. In some cost categories, users can adjust the local content share between labor and materials (e.g., major component costs), while in others, this adjustment is unavailable. Similarly, for categories involving vessel expenditures, labor vs vessel-related can be adjusted, indicating certain jobs might be tied directly to the crewing of these vessels. For this analysis, labor and vessel local content share were adjusted proportionally.

Lastly, jobs are categorized as either construction or operations jobs. Construction jobs are measured in full-time equivalents (FTEs), representing 2,080 hours of labor, and reflect the total number of jobs generated over the duration of the activity. For instance, if foundation installation expenditures result in 300 FTEs over three years, this equates to approximately 100 jobs per year. Operations jobs, on the other hand, are long-term and reported as annual FTEs, representing jobs and economic activity sustained throughout the facility's operating life. Of the cost categories below all result in construction jobs or FTEs, except for the Operating Expenditures cost category.

Table 1: Job Creation by Cost Category and Local Content Share.

Local Content Share (15MW Plant)	Jobs/MW	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Major Component Costs	5.97	895.2	1790.4	2685.6	3580.8	4476	5371.2	6266.4	7161.6	8056.8	8952
Nacelle	3.99	599	1197	1796	2394	2993	3591	4190	4788	5387	5985
Labor	1.03	155	310	464	619	774	929	1084	1238	1393	1548
Material	2.96	444	887	1331	1775	2219	2662	3106	3550	3993	4437
Blades	1.32	198	396	593	791	989	1187	1385	1582	1780	1978
Labor	0.22	34	67	101	135	169	202	236	270	303	337
Material	1.09	164	328	492	656	821	985	1149	1313	1477	1641
Tower	0.66	99	198	297	396	495	593	692	791	890	989
Labor	0.00	0	0	0	0	0	0	0	0	0	0
Material	0.66	99	198	297	396	496	595	694	793	892	991
Balance of System Costs	**15.09**	**2263**	**4526**	**6789**	**9052**	**11316**	**13579**	**15842**	**18105**	**20368**	**22631**
Substructure and Foundation	**7.40**	**1110**	**2219**	**3329**	**4438**	**5548**	**6658**	**7767**	**8877**	**9986**	**11096**
Mooring System	1.86	279	558	837	1116	1396	1675	1954	2233	2512	2791
Semisubmersible	5.54	831	1661	2492	3322	4153	4983	5814	6644	7475	8305
Electrical Infrastructure Components	**2.71**	**407**	**814**	**1221**	**1628**	**2035**	**2442**	**2849**	**3256**	**3663**	**4070**
Array Cable System	0.59	89	178	267	356	446	535	624	713	802	891
Export Cable System	0.76	114	229	343	458	572	686	801	915	1030	1144
Offshore Substation	1.36	204	407	611	814	1018	1221	1425	1628	1832	2035
Assembly and Installation	**1.79**	**268**	**537**	**805**	**1074**	**1342**	**1610**	**1879**	**2147**	**2416**	**2684**
Foundation	0.33	50	100	150	200	250	299	349	399	449	499
Mooring System	0.18	27	55	82	110	137	164	192	219	247	274
Turbine	1.03	155	309	464	618	773	927	1082	1236	1391	1545
Array Cable	0.18	27	54	81	108	135	162	189	216	243	270
Export Cable	0.04	6	12	18	24	30	36	42	48	54	60
Offshore Substation	0.02	4	7	11	14	18	22	25	29	32	36
Ports and	**0.94**	**140**	**281**	**421**	**562**	**702**	**842**	**983**	**1123**	**1264**	**1404**
Foundation	0.31	46	92	139	185	231	277	323	370	416	462
Mooring system	0.19	28	56	83	111	139	167	195	222	250	278
Turbine	0.21	32	64	97	129	161	193	225	258	290	322
Array Cable System	0.19	28	56	83	111	139	167	195	222	250	278
Export Cable System	0.04	6	12	17	23	29	35	41	46	52	58
Offshore Substation	0.00	1	1	2	2	3	4	4	5	5	6
Development & Other Project Costs	**1.82**	**273**	**545**	**818**	**1091**	**1364**	**1636**	**1909**	**2182**	**2454**	**2727**
Site Auction Price	0.64	95	191	286	382	477	572	668	763	859	954
BOEM Review	0.00	0	0	0	0	0	0	0	0	0	0
Construction Operations	0.00	1	1	2	2	3	4	4	5	5	6
Design Install Plan	0.00	0	0	1	1	1	1	1	2	2	2
Site Assessment Plan	0.00	0	1	1	1	2	2	2	2	3	3
Site Assesment Acitvites	0.21	31	62	93	124	155	185	216	247	278	309
Onshore Transmission	0.97	145	291	436	581	727	872	1017	1162	1308	1453
Engineering Management	**0.43**	**65**	**130**	**195**	**260**	**325**	**390**	**455**	**520**	**585**	**650**
Construction Operations	0.43	65	130	195	260	325	390	455	520	585	650
Soft	**0.71**	**106**	**212**	**319**	**425**	**531**	**637**	**743**	**850**	**956**	**1062**
Commissioning	0.05	8	16	25	33	41	49	57	66	74	82
Construction Finance	0.20	30	60	91	121	151	181	211	242	272	302
Construction Insurance	0.05	7	15	22	29	37	44	51	58	66	73
Contingency	0.40	61	121	182	242	303	363	424	484	545	605
Decommissioning	0.00	0	0	0	0	0	0	0	0	0	0
Operating Expenditures	**3.52**	**528**	**1055**	**1583**	**2110**	**2638**	**3165**	**3693**	**4220**	**4748**	**5275**
Offshore Technicians	2.67	400	800	1200	1600	2000	2400	2800	3200	3600	4000
Operation Management and	0.85	128	255	383	510	638	765	893	1020	1148	1275
TOTAL JOBS	**25.28**	**3792**	**7584**	**11376**	**15168**	**18960**	**22752**	**26544**	**30336**	**34128**	**37920**

Model inputs

Inputs that were changed for this analysis are highlighted in yellow in the Model Inputs section below, all other inputs were left as default.

ADVANCED INPUTS		
Category	**Units**	**Input Value**
Project Parameters		
Project Name		Project
Economic Analysis Area	State, Region	California
Wind Plant Project Area	State, Region	California
Year Construction Starts	year	2031
Money Value (Dollar Year)	year	2024
Plant Characteristics		
Plant Capacity	MW	1500
Number of Turbines		100
Array Layout		Grid
Row Spacing	# Rotor Diameters	7.7
Turbine Spacing	# Rotor Diameters	7.7
Turbine Design		
Turbine Selector		15MW Reference
Turbine Rating	MW	15
Rotor Diameter	m	240
Hub Height	m	150
Rated Wind Speed	m/s	11
Blade Mass	tonnes	68
Blade Deck Space	m^2	200
Blade Length	m	120
Nacelle Mass	tonnes	985
Nacelle Deck Space	m^2	200
Tower Mass	tonnes	803
Tower Deck Space	m^2	200
Tower Length	m	130
# of Tower Sections		2
Site Characteristics		
Site Depth	m	754.5
Mean Windspeed	m/s	10.5
Distance: Port to Site	km	45
Distance: Site to Offshore Substation	km	2
Distance: Offshore Substation to Landfall	km	45
Distance: Landfall to Interconnection	km	2

Landfall Trench Length	km	2
Substructure Design		
Substructure Type		Semisubmersible
Foundation Type		Floating
Scour Protection	$/tonne	40
Electrical Infrastructure		
Export Cable Selector		XLPE 1000m 220kV
AC Resistance	ohms/km	0.03
Capacitance	F/km	300
Conductor Size	mm^2	1000
Current Capacity	A	900
Inductance	MHz/km	0.35
Linear Density	tonnes/km	90
Rated Voltage	kV	220
Cost	$/km	$850,000
Redundant Export Cable	cables	0
Additional Export Cable Length	%	0.00%
Array Cable Selector		XLPE 185mm 66kV
AC Resistance	ohms/km	0.128
Capacitance	F/km	163
Conductor Size	mm^2	185
Current Capacity	A	445
Inductance	MHz/km	0.443
Linear Density	tonnes/km	26.1
Rated Voltage	kV	66
Cost	$/km	$200,000
Second Array Cable Selector		None
AC Resistance	ohms/km	-
Capacitance	F/km	-
Conductor Size	mm^2	-
Current Capacity	A	-
Inductance	MHz/km	-
Linear Density	tonnes/km	-
Rated Voltage	kV	-
Cost	$/km	-
Additional Array Cable Length	%	0.00%
# Offshore Substations		2
Port Characteristics		
Port Name		Humboldt Bay
Port Rate	$/month	$2,000,000
# Cranes		1
Vessel Deployment		
Fixed-Bottom Installation	Wind Turbine Installation Vessel (WTIV)	

	# Vessels	1
	Day Rate	$180,000
	Feeder Vessel	
	# Vessels	1
	Day Rate	$75,000
	Scour Protection Installation Vessel	
	# Vessels	1
	Day Rate	$120,000
Offshore Substation Installation	Floating Heavy Lift	
	# Vessels	1
	Day Rate	$500,000
	Floating Barge	
	# Vessels	1
	Day Rate	$120,000
Cabling Installation	Array Cable Installation Vessel	
	# Vessels	1
	Day Rate	$120,000
	Export Cable Installation Vessel	
	# Vessels	1
	Day Rate	$120,000

COST SUMMARY		
Category	**Input**	**Cost Per kW**
Plant Capacity (MW)	1500	
Number of Turbines	100	
Total CapEx	$5,914,886,515	$3,943
Turbine Component Costs	$1,951,500,000	$1,301
Balance of System Costs	$3,769,886,515	$2,513
Soft Costs	$193,500,000	$129
Total OpEx (annual)	$178,314,081	$119

Category	Cost	Breakdown	Cost Per kW	% of Total Cost
Turbine Component Costs				**32.99%**
Nacelle/Drivetrain	$1,291,500,000		$861	21.83%
Materials	$979,149,692	76%	$653	
Labor	$312,350,308	24%	$208	
Blades	$387,000,000		$258	6.54%
Materials	$319,047,256	82%	$213	
Labor	$67,952,744	18%	$45	
Towers	$273,000,000		$182	4.62%
Materials	$200,665,661	74%	$134	
Labor	$72,334,339	26%	$48	

Balance of System Costs				
Substructure and Foundation	$2,035,933,692		**$1,357**	**34.42%**
Monopile	$0		$0	0.00%
Monopile Materials	$0	74%	$0	
Monopile Labor	$0	26%	$0	
Scour Protection	$0		$0	0.00%
Scouring Protection Materials	$0	82%	$0	
Scouring Protection Labor	$0	18%	$0	
Spar	$0		$0	0.00%
Spar Materials	$0	74%	$0	
Spar Labor	$0	26%	$0	
Semisubmersible	$1,469,302,348		$980	24.84%
Semisubmersible Materials	$1,079,994,601	74%	$720	
Semisubmersible Labor	$389,307,746	26%	$260	
Mooring System	$566,631,345		$378	9.58%
Mooring System Materials	$416,496,165	74%	$278	
Mooring Systems Labor	$150,135,180	26%	$100	
Electrical Infrastructure Components	**$558,705,560**		**$372**	**9.45%**
Array Cable System	$156,557,514		$104	2.65%
Materials	$115,075,886	74%	$77	
Labor	$41,481,628	26%	$28	
Export Cable System	$202,288,496		$135	3.42%
Materials	$148,689,944	74%	$99	
Labor	$53,598,552	26%	$36	
Offshore Substation	$199,859,550		$133	3.38%
Materials	$135,583,055	68%	$90	
Labor	$64,276,495	32%	$43	
Assembly and Installation	**$449,252,839**		**$300**	**7.60%**
Foundation	$91,785,625		$61	1.55%
Vessel	$78,446,657	85%	$52	
Labor	$13,338,968	15%	$9	
Mooring System	$42,368,750		$28	0.72%
Vessel	$36,211,409	85%	$24	
Labor	$6,157,341	15%	$4	
Turbine	$249,104,167		$166	4.21%
Vessel	$212,902,500	85%	$142	
Labor	$36,201,666	15%	$24	
Array Cable	$51,520,807		$34	0.87%
Vessel	$44,033,421	85%	$29	
Labor	$7,487,386	15%	$5	
Export Cable	$10,379,161		$7	0.18%
Vessel	$8,870,785	85%	$6	
Labor	$1,508,377	15%	$1	

Offshore Substation	$4,094,328		$3	0.07%
Vessel	$3,499,310	85%	$2	
Labor	$595,018	15%	$0	
Scour Protection	$0		$0	0.00%
Vessel	$0	85%	$0	
Labor	$0	15%	$0	
Ports and Staging	**$140,661,412**		**$94**	**2.38%**
Foundation	$46,639,726		$31	0.79%
Mooring System	$27,398,630		$18	0.46%
Turbine	$32,660,274		$22	0.55%
Array Cable	$28,131,949		$19	0.48%
Export Cable	$5,489,951		$4	0.09%
Offshore Substation	$340,881		$0	0.01%
Scour Protection	$0		$0	0.00%
Development and Other Project Costs	**$480,333,013**		**$320**	**8.12%**
Site Auction Price	$351,500,000	50	$115	2.92%
BOEM Review	$0		$0	0.00%
Construction Operations Plan	$1,000,000		$1	0.02%
Design Install Plan	$250,000		$0	0.00%
Site Assessment Plan	$500,000		$0	0.01%
Site Assessment Activities	$50,000,000		$33	0.85%
Onshore Transmission	$255,583,013		$170	4.32%
Engineering and Management	**$105,000,000**		**$70**	**1.78%**
Construction Operations	$105,000,000	70	$70	1.78%
Other/Miscellaneous	$0		**$0**	**0.00%**
Soft Costs				
Commissioning	$13,200,000		$9	0.22%
Construction Finance	$54,900,000		$37	0.93%
Construction Insurance	$13,200,000		$9	0.22%
Contingency	$94,800,000		$63	1.60%
Decommissioning	$17,400,000		$12	0.29%
Other/Miscellaneous	$0		$0	0.00%

Appendix C - Professional Occupations in FOSW and Associated Port Development

SOC Code	Occupation	Estimated Jobs by 2030 (FOSW and Port Development)[59]	Experience in Related Occupation[60]	Percent of Workers with an Advanced Degree[61]
11-9021	Construction Managers	415	None	7%
17-2051	Civil Engineers	350	None	30%
13-1082	Project Management Specialists	329	None	26%
17-2141	Mechanical Engineers	324	None	25%
11-9199	Managers, All Other	246	Less than 5 years	21%
11-1021	General and Operations Managers	246	5 years or more	13%
13-1051	Cost Estimators	163	None	6%
17-2071	Electrical Engineers	94	None	34%
11-3012	Administrative Services Managers	84	Less than 5 years	19%
17-2081	Environmental Engineers	80	None	43%
13-1071	Human Resources Specialists	74	None	20%
13-2011	Accountants and Auditors	72	None	28%
19-1029	Biological Scientists, All Other	52	None	55%
13-1199	Business Operations Specialists, All Other	47	None	23%
17-1011	Architects, Except Landscape and Naval	41	None	46%
19-2021	Atmospheric and Space Scientists	36	None	35%
11-9041	Architectural and Engineering Managers	35	5 years or more	36%
17-2199	Engineers, All Other	34	None	33%
11-3031	Financial Managers	30	5 years or more	22%
15-1299	Computer Occupations, All Other	28	None	15%
19-5011	Occupational Health and Safety Specialists	27	None	16%
13-1081	Logisticians	26	None	12%
11-3061	Purchasing Managers	24	5 years or more	21%
13-1161	Market Research Analysts and Marketing Specialists	23	None	24%
15-1252	Software Developers	22	None	35%
11-3051	Industrial Production Managers	22	5 years or more	14%
13-1028	Buyers and Purchasing Agents	22	#N/A	0%
19-3091	Anthropologists and Archeologists	20	None	57%
15-2051	Data Scientists	20	None	48%
17-2112	Industrial Engineers	20	None	22%

[59] California State Lands Commission. *AB 525 Workforce Development Readiness Plan*. Final Report. June 16, 2023. Available at: https://www.slc.ca.gov/renewable-energy/workforce-development-readiness-plan/
[60] U.S. Bureau of Labor Statistics, *Education and Training Assignments by Detailed Occupation*, last modified September 6, 2023, https://www.bls.gov/emp/tables/education-and-training-by-occupation.html
[61] U.S. Bureau of Labor Statistics, *Educational Attainment for Workers 25 Years and Older by Detailed Occupation*, last modified September 6, 2023, https://www.bls.gov/emp/tables/educational-attainment.html.

23-1011	Lawyers	18	None	92%
19-2043	Hydrologists	16	None	53%
19-2042	Geoscientists, Except Hydrologists and Geographers	16	None	53%
19-1011	Animal Scientists	16	None	40%
27-3031	Public Relations Specialists	16	None	27%
15-1211	Computer Systems Analysts	16	None	26%
17-1022	Surveyors	15	None	13%
11-1011	Chief Executives	14	5 years or more	32%
11-2022	Sales Managers	14	Less than 5 years	13%
17-2121	Marine Engineers and Naval Architects	12	None	24%
11-9161	Emergency Management Directors	10	5 years or more	28%
19-1023	Zoologists and Wildlife Biologists	8	None	55%
13-1041	Compliance Officers	8	None	24%
11-3131	Training and Development Managers	6	5 years or more	29%
53-2011	Airline Pilots, Copilots, and Flight Engineers	4	Less than 5 years	16%
11-3013	Facilities Managers	4	Less than 5 years	10%

Appendix D - Descriptions of Professional Occupations in FOSW and Associated Port Development[62]

Occupation	Description	Education Summary	Licenses, Certifications, and Registrations	Link
Construction Managers	Construction managers plan, coordinate, budget, and supervise construction projects from start to finish.	Typically need a bachelor's degree in a construction-related field. Large construction firms may prefer to hire candidates who also have construction experience.	Some states require construction managers to be licensed. While not mandatory, professional certification demonstrates expertise. The Construction Management Association of America offers the Certified Construction Manager (CCM) credential for those with experience who pass a technical exam. The American Institute of Constructors offers the Associate Constructor (AC) and Certified Professional Constructor (CPC) credentials to those who meet their requirements and pass exams.	Construction Managers : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Civil Engineers	Civil engineers plan, design, and supervise the construction and maintenance of building and infrastructure projects.	Typically need a bachelor's degree in civil engineering or a related field.	Licensure is often required for public service. Professional Engineering (PE) license requires a degree from an ABET-accredited program, passing the Fundamentals of Engineering (FE) exam, having relevant work experience, and passing the PE exam. Certifications from the American Society of Civil Engineers (ASCE) in specialties like coastal or geotechnical engineering can enhance career prospects.	Civil Engineers : Occupational Outlook Handbook
Project Management Specialists	Project management specialists coordinate the budget, schedule, and other details of a project. They lead and guide the work of technical staff. Project management specialists also may serve as a point of contact for the client or customer.	Project management specialists typically need a bachelor's degree that may be in a variety of fields, including business or project management.	The Project Management Institute (PMI) offers several certifications in project management for workers at various experience levels, including the Project Management Professional (PMP).	Project Management Specialists : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Mechanical Engineers	Mechanical engineers design, develop, build, and test mechanical and thermal sensors and devices.	Typically need a bachelor's degree in mechanical engineering or mechanical engineering technology.	Licensure is not required for entry-level positions. Professional Engineering (PE) license requires a degree from an ABET-accredited program, passing the FE exam, relevant work experience, and passing the PE exam. Continuing education may be required to maintain licensure.	Mechanical Engineers : Occupational Outlook Handbook

[62] Bureau of Labor Statistics, *Occupational Outlook Handbook*, U.S. Department of Labor. 2021. Available through: https://www.bls.gov/ooh.

Managers, All Other	Managers in this category oversee various administrative and operational functions across different industries.	Education requirements vary widely depending on the industry and specific managerial role.	Licenses, certifications, and registrations vary by industry. Examples include certifications from the Project Management Institute (PMI) for project managers and Certified Manager (CM) credentials from the Institute of Certified Professional Managers (ICPM).	Managers, All Other : Occupational Outlook Handbook
General and Operations Managers	N/A	N/A	N/A	N/A
Cost Estimators	Cost estimators collect and analyze data in order to assess the time, money, materials, and labor required to manufacture a product, construct a building, or provide a service. They generally specialize in a particular product or industry.	Construction cost estimators typically need a bachelor's degree in a related field, such as construction or engineering. Manufacturing cost estimators typically need a degree in business or finance.	N/A	Cost Estimators : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Electrical Engineers	Electrical engineers design, develop, test, and supervise the manufacture of electrical equipment.	Typically need a bachelor's degree in electrical engineering or electronics engineering.	Licensure for electrical engineers is not required for entry-level positions but can be obtained later for higher levels of leadership. The Professional Engineering (PE) license requires a degree from an ABET-accredited program, passing the Fundamentals of Engineering (FE) exam, gaining relevant work experience (typically at least four years), and passing the PE exam. Certifications from professional organizations, such as the IEEE, NICET, and ISA, can enhance career prospects. These include Certified Control Systems Technician (CCST) and Certified Automation Professional (CAP), which require written exams and periodic recertification.	Electrical Engineers : Occupational Outlook Handbook
Administrative Services Managers	Administrative services and facilities managers supervise staff, set departmental goals and deadlines, and recommend policy changes to improve operations. They ensure facilities are safe, secure, and well-maintained, oversee maintenance and repairs, and ensure compliance with environmental, health, and security standards.	Administrative services and facilities managers typically need a bachelor's degree, often in business or a related field.	Several professional associations offer certifications for administrative services and facilities managers. The International Facility Management Association (IFMA) specializes in facility management certification. The Institute of Certified Records Managers (ICRM) provides certification for records and information managers, and ARMA International offers certification for information governance specialists.	Administrative Services and Facilities Managers : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Environmental Engineers	Environmental engineers use engineering principles to develop solutions to environmental problems.	Typically need a bachelor's degree in environmental engineering or a related field, such as chemical, civil, or general engineering.	Professional Engineering (PE) license requires a degree from an ABET-accredited program, passing the FE exam, relevant work experience, and passing the PE exam. Certification from the American Academy of Environmental Engineers and Scientists (AAEES) is also available.	Environmental Engineers : Occupational Outlook Handb
Human Resources Specialists	Human resources specialists recruit, screen, interview, and place workers.	Typically need a bachelor's degree in human resources, business, or a related field.	Certification from professional organizations such as the Society for Human Resource Management (SHRM) can enhance job prospects.	Human Resources Specialists : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)

Accountants and Auditors	Accountants and auditors prepare and examine financial records, identify potential areas of opportunity and risk, and provide solutions for businesses and individuals. They ensure that financial records are accurate, that financial and data risks are evaluated, and that taxes are paid properly. They also assess financial operations and work to help ensure that organizations run efficiently.	Accountants and auditors typically need at least a bachelor's degree in accounting or a related field, such as business, to enter the occupation. Completing certification in a specific field of accounting, such as becoming a licensed Certified Public Accountant (CPA), may improve job prospects.	Accountants filing reports with the SEC must be licensed Certified Public Accountants (CPAs). CPAs are licensed by state Boards of Accountancy and must pass a national exam, complete 150 semester hours of college coursework, and meet state-specific requirements. Some states allow public accounting experience to substitute for a degree. CPAs must take continuing education courses to maintain their license. Additional certifications include: AICPA Certifications: Accredited in Business Valuation (ABV), Certified Financial Forensics (CFF), Certified Information Technology Professional (CITP), Personal Financial Specialist (PFS), and Chartered Global Management Accountant (CGMA). AGA: Certified Government Financial Manager (CGFM). IIA: Certified Internal Auditor (CIA), Certified in Control Self-Assessment (CCSA), Certified Government Auditing Professional (CGAP), Certified Financial Services Auditor (CFSA), and Certification in Risk Management Assurance (CRMA). IMA: Certified Management Accountant (CMA). ISACA: Certified Information Systems Auditor (CISA). These certifications require passing exams, relevant experience, and continuing education.	Accountants and Auditors : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Biological Scientists, All Other	Conduct research to understand biological processes and develop new products or solve problems.	Typically need a bachelor's degree in biology or a related field.	Licensure is generally not required, but certification in a specialized field may be beneficial.	Biological Scientists, All Other : Occupational Outlook Handbook
Business Operations Specialists, All Other	N/A	N/A	N/A	N/A
Architects, Except Landscape and Naval	Architects plan and design houses, factories, office buildings, and other structures.	Architects typically need a bachelor's degree in architecture. Most architects earn their degree through a 5-year Bachelor of Architecture degree program. Many earn a master's degree in architecture,	All states and the District of Columbia require architects to be licensed. Licensing requirements typically include completing a degree program in architecture, gaining relevant experience through a paid internship, and passing the Architect Registration Examination.	Architects : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Atmospheric and Space Scientists	Atmospheric scientists study the weather and climate. They may compile data, prepare reports and forecasts, and assist in developing new data collection instruments.	Typically need a bachelor's degree in meteorology or a related physical science.	Certification from the American Meteorological Society (AMS) can be beneficial.	Atmospheric Scientists, Including Meteorologists : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Architectural and Engineering Managers	Architectural and engineering managers plan, direct, and coordinate activities in the fields of architecture and engineering.	rchitectural and engineering managers typically need at least a bachelor's degree and considerable work experience as an architect or engineer.	Architectural and engineering managers typically do not need a license. However, these managers may advance from other occupations that do require licensure. For example, all states require architects to be licensed, and some engineers obtain a professional engineering (PE) license.	Architectural and Engineering Managers : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Engineers, All Other	N/A	N/A	N/A	N/A

Financial Managers	Financial managers are responsible for the financial health of an organization. They create financial reports, direct investment activities, and develop plans for the long-term financial goals of their organization.	Financial managers typically need at least a bachelor's degree in business, economics, or a related field and 5 years or more of experience in another business or financial occupation, such as an accountant, securities sales agent, or financial analyst.	Professional certification, though not required, signifies competence for financial managers. The Association of Government Accountants (AGA) offers the Certified Government Financial Manager (CGFM) designation for those with a bachelor's degree, relevant exams, and professional-level government financial management experience, along with continuing education for maintenance. The CFA Institute awards the Chartered Financial Analyst (CFA) certification to investment professionals who meet education and experience requirements and pass three exams. The Association for Financial Professionals provides the Certified Treasury Professional (CTP) and Certified Corporate Financial Planning Analysis Professional (FP&A) credentials, both requiring exams and relevant education or experience. Certified Public Accountants (CPAs) are licensed by state boards of accountancy and must pass the AICPA exam.	Financial Managers : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Computer Occupations, All Other	N/A	N/A	N/A	N/A
Occupational Health and Safety Specialists	Occupational health and safety specialists and technicians collect data on, analyze, and design improvements to many types of work environments and procedures. Specialists inspect workplaces and enforce adherence to regulations on safety, health, and the environment. Technicians work with specialists to implement and evaluate programs aimed at mitigating risks to workers, property, the environment, and the public.	Occupational health and safety specialists typically need a bachelor's degree in occupational health and safety or a related field, such as biology or healthcare and related majors.	Professional certification for occupational health and safety specialists and technicians, preferred or required by employers, is available through organizations such as the Board for Global EHS Credentialing, the Board of Certified Safety Professionals, and the National Association of Safety Professionals. Certification typically requires graduating from an accredited educational program, completing relevant work experience, and passing an examination. Maintaining certification usually involves completing a specified number of continuing education hours.	Occupational Health and Safety Specialists and Technicians : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Logisticians	Analyze and coordinate an organization's supply chain—the system that moves a product from supplier to consumer.	Typically need a bachelor's degree in logistics and supply chain management, business, or related disciplines.	Although not required, certification demonstrates professional competence and a broad knowledge of logistics. Certifications include those available through the Association for Supply Chain Management (ASCM) and the International Society of Logistics (SOLE). Certifications available from the Defense Acquisition University (DAU) are required for Department of Defense acquisitions.	Logisticians : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Purchasing Managers	Buyers and purchasing agents buy products and services for organizations to use or resell. They evaluate suppliers, negotiate contracts, and review the quality of products. Purchasing managers oversee the work of buyers and purchasing agents and typically handle more complex procurement tasks.	Buyers and purchasing agents typically have a bachelor's degree. A bachelor's degree and a few years of work experience in procurement is required for purchasing manager positions.	Certifications for buyers and purchasing agents include the Certified Purchasing Professional (CPP) from the American Purchasing Society, the Certified Supply Chain Professional (CSCP) from the Association for Supply Chain Management, the Senior Professional in Supply Management (SPSM) from the Next Level Purchasing Association, the Certified Professional Public Buyer (CPPB), and the Certified Public Purchasing Officer (CPPO) from the Universal Public Procurement Certification Council	Purchasing Managers, Buyers, and Purchasing Agents : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)

			(UPPCC). Additionally, the National Institute of Government Purchasing (NIGP) and the National Association of State Procurement Officials (NASPO) offer preparation courses for the UPPCC certification exams.	
Market Research Analysts and Marketing Specialists	Market research analysts study consumer preferences, business conditions, and other factors to assess potential sales of a product or service. They help companies understand what products people want, who will buy them, and at what price.	Market research analysts typically need a bachelor's degree in market research or a related business, communications, or social science field.	he Insights Association offers several certifications for market research analysts, including the IPC Principal and the IPC Masters.	Market Research Analysts : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Industrial Production Managers	Industrial production managers oversee the operations of manufacturing and related plants. They coordinate, plan, and direct activities involved in creating a range of goods, such as cars, computer equipment, and paper products.	Industrial production managers typically need a bachelor's degree and several years of related work experience. For workers who have a degree, common majors include business and engineering. Some employers prefer to hire industrial production managers who have a Master of Business Administration (MBA) or a graduate degree in industrial management.	The American Society of Quality (ASQ) offers credentials in quality control and various levels of Six Sigma certifications.	Industrial Production Managers : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Software Developers	Software developers create the computer applications that allow users to do specific tasks and the underlying systems that run the devices or control networks.	ically need a bachelor's degree in computer and information technology or a related field. Some employers prefer to hire developers who have a master's degree.	N/A	Software Developers, Quality Assurance Analysts, and Testers : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Buyers and Purchasing Agents	Buyers and purchasing agents buy products and services for organizations to use or resell. They evaluate suppliers, negotiate contracts, and review the quality of products.	Buyers and purchasing agents buy products and services for organizations to use or resell. They evaluate suppliers, negotiate contracts, and review the quality of products.	Certifications for buyers and purchasing agents include the Certified Purchasing Professional (CPP) from the American Purchasing Society, the Certified Supply Chain Professional (CSCP) from the Association for Supply Chain Management, the Senior Professional in Supply Management (SPSM) from the Next Level Purchasing Association, the Certified Professional Public Buyer (CPPB), and the Certified Public Purchasing Officer (CPPO) from the Universal Public Procurement Certification Council (UPPCC). Additionally, the National Institute of Government Purchasing (NIGP) and the National Association of State Procurement Officials (NASPO) offer preparation courses for the UPPCC certification exams.	Purchasing Managers, Buyers, and Purchasing Agents : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)

Anthropologists and Archeologists	Anthropologists and archeologists study the origin, development, and behavior of humans. They study the culture and characteristics of living or past civilizations throughout the world.	To enter the occupation, anthropologists and archeologists typically need at least a master's degree in anthropology or archeology.	N/A	Anthropologists and Archeologists : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Data Scientists	Data scientists use analytical tools and techniques to extract meaningful insights from data.	Data scientists typically need at least a bachelor's degree in mathematics, statistics, computer science, or a related field to enter the occupation. However, some employers require or prefer that candidates have a master's or doctoral degree.	N/A	Data Scientists : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Industrial Engineers	Industrial engineers devise efficient systems that integrate workers, machines, materials, information, and energy to make a product or provide a service. They assess workers, quality control, logistics, and other factors involved in coordinating production.	Industrial engineers typically need a bachelor's degree in industrial engineering or a related field, such as mechanical or electrical engineering.	Although certification is not required, some industrial engineers choose to earn a professional credential. For example, the Society of Manufacturing Engineers and the Project Management Institute offer certification specific to their areas of focus. Professional Engineering (PE) license requires a degree from an ABET-accredited program, passing the FE exam, relevant work experience, and passing the PE exam.	Industrial Engineers : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Lawyers	Lawyers advise and represent clients on legal proceedings or transactions.	Lawyers typically need a law degree and a state license, which usually requires passing a bar examination.	License to practice law	Lawyers : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Computer Systems Analysts	Computer systems analysts, sometimes called systems architects, study an organization's current computer systems and procedures and design improvements to them. In doing so, these analysts help the organization operate more efficiently.	Computer systems analysts typically need a bachelor's degree to enter the occupation. Studying a computer science or information systems field is common, although not always a requirement. Some firms hire job candidates who have a degree in business or liberal arts along with relevant skills.	N/A	Computer Systems Analysts : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Geoscientists, Except Hydrologists and Geographers	Geoscientists study the physical aspects of the Earth, such as its composition, structure, and processes, to learn about its past and present and to predict future events.	Geoscientists typically need a bachelor's degree to enter the occupation. For some positions, employers prefer to hire candidates who have a master's or doctoral degree. Most geoscientists need a state-issued license.	Licensing for geologists who offer services to the public is required in most states and involves activities related to civil engineering projects, environmental protection, and regulatory compliance. Licensure requirements typically include meeting minimum education and experience standards and passing an exam, though specifics vary by state. Examining authorities also differ, with some states using exams provided by the National Association of State Boards of Geology (ASBOG) or the American Institute of Professional Geologists (AIPG).	Geoscientists : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Hydrologists	Hydrologists analyze how water influences the surrounding environment and how changes to the environment influence the quality and quantity of water. They use their expertise to solve problems concerning water quality and availability.	Hydrologists typically need a bachelor's degree for entry-level jobs; however, some employers prefer to hire candidates who have a master's degree.	N/A	Hydrologists : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)

Animal Scientists	N/A	N/A	N/A	N/A
Public Relations Specialists	Public relations specialists create and maintain a positive public image for the individuals, groups, or organizations they represent. They craft media releases and develop social media programs to shape public perception of their clients and to increase awareness of each client's work and goals.	Public relations specialists typically need a bachelor's degree to enter the occupation. Employers may prefer to hire candidates who have studied a particular field, such as communications or business.	N/A	Public Relations Specialists : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Surveyors	Surveyors make precise measurements to determine property boundaries. They provide data relevant to features of the Earth's surface, such as shape and contour, for engineering, mapmaking, construction, and other purposes.	Surveyors typically need a bachelor's degree in land surveying or a related field, such as engineering or natural resources.	All 50 states and the District of Columbia require surveyors to be licensed to provide public services, including certifying legal documents for property lines and construction markings. Prospective licensed surveyors typically need a bachelor's degree from an accredited program and several years of experience working under a licensed surveyor to qualify for licensure. The licensing process varies by state but generally follows guidelines established by the National Council of Examiners for Engineering and Surveying (NCEES), which specifies requirements for education, exams, and work experience.	Surveyors : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Sales Managers	Sales managers direct organizations' sales teams. They set sales goals, analyze data, and develop training programs for organizations' sales representatives.	Sales managers are typically required to have a bachelor's degree, although some positions may only require a high school diploma. Courses in business law, management, economics, accounting, finance, mathematics, marketing, and statistics are advantageous.	N/A	Sales Managers : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Chief Executives	Top executives plan strategies and policies to ensure that an organization meets its goals. They coordinate and direct work activities of companies and organizations.	Top executives typically need a bachelor's or master's degree in an area related to their field of work, such as business or engineering. Top executives in the public sector may have a degree in business administration, public administration, law, or the liberal arts. Top executives of large corporations may have a master's degree in business administration (MBA).	Some top executive positions may require the applicant to have a license or certification relevant to their area of management. For example, some employers may require their chief executive officer to be a certified public accountant (CPA).	Top Executives : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)

Marine Engineers and Naval Architects	Marine engineers and naval architects design, build, and maintain ships, from aircraft carriers to submarines and from sailboats to tankers. Marine engineers are also known as marine design engineers or marine mechanical engineers and are responsible for the internal systems of a ship, such as the propulsion, electrical, refrigeration, and steering systems. Naval architects are responsible for the ship design, including the form, structure, and stability of hulls.	Marine engineers and naval architects typically need a bachelor's degree in marine engineering and naval architecture, respectively, or a related field, such as engineering. Some marine engineering and naval architecture programs are offered at state maritime academies.	The Professional Engineering (PE) license allows for higher levels of leadership and independence and can be acquired later in one's career. Licensed engineers, called professional engineers (PEs), can oversee the work of other engineers, sign off on projects, and provide services directly to the public. State licensure generally requires a degree from an ABET-accredited engineering program, a passing score on the Fundamentals of Engineering (FE) exam, relevant work experience (typically at least 4 years), and a passing score on the Professional Engineering (PE) exam. The initial FE exam can be taken after earning a bachelor's degree, and those who pass are commonly called engineers in training (EITs) or engineer interns (EIs). After meeting work experience requirements, EITs and EIs can take the second exam, called the Principles and Practice of Engineering (PE).	Marine Engineers and Naval Architects : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Emergency Management Directors	Emergency management directors prepare plans and procedures for responding to natural disasters and other emergencies. They also help lead the response during and after emergencies, often in coordination with public safety officials, elected officials, nonprofit organizations, and government agencies.	Emergency management directors typically need a bachelor's degree and many years of work experience in emergency response, disaster planning, or public administration.	N/A	Emergency Management Directors : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Compliance Officers	N/A	N/A	N/A	N/A
Zoologists and Wildlife Biologists	Zoologists and wildlife biologists study animals, those both in captivity and in the wild, and how they interact with their ecosystems. They focus primarily on undomesticated animals and their behavior, as well as on the impact humans have on wildlife and natural habitats.	Zoologists and wildlife biologists typically need a bachelor's degree for entry-level positions and may need a master's degree for higher level jobs. They typically need a Ph.D. to lead research projects.	N/A	Zoologists and Wildlife Biologists : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Training and Development Managers	Training and development managers plan, coordinate, and direct skills- and knowledge-enhancement programs for an organization's staff.	Typically requires a bachelor's degree, though some jobs require a master's degree. Although training and development managers come from a variety of educational backgrounds, these workers commonly have a bachelor's degree in business, communications, social science, or a related field.	N/A	Training and Development Managers : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
Facilities Managers	Administrative services and facilities managers supervise staff, set departmental goals and deadlines, and recommend policy changes to improve operations. They ensure facilities are safe, secure, and well-maintained, oversee maintenance and repairs, and ensure compliance with environmental, health, and security standards.	Administrative services and facilities managers typically need a bachelor's degree, often in business or a related field.	Several professional associations offer certifications for administrative services and facilities managers. The International Facility Management Association (IFMA) specializes in facility management certification. The Institute of Certified Records Managers (ICRM) provides certification for records and information managers, and ARMA International offers certification for information governance specialists.	Administrative Services and Facilities Managers : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)

Airline Pilots, Copilots, and Flight Engineers	N/A	N/A	N/A	N/A

Appendix F - Cal Poly Humboldt Undergraduate Career Pathways in Floating Offshore Wind

Academic Program	Potential Careers	Offshore Wind and Associated Port Jobs
Engineering	Air Pollution Engineer; Consulting Engineer; Design Engineer; Ecological Engineer; Energy Management Engineer; Environmental Engineer; Fisheries Engineer; Geo-Environmental Engineer; Hydrologist; Mechanical Engineer; Electrical Engineer;	Civil Engineers; Mechanical Engineers; Electrical Engineers; Environmental Engineers; Industrial Engineers; Architectural and Engineering Managers; Cost Estimators; Hydrologists; Industrial Production Managers; Engineers, All Other
Business Administration	Accountant; Auditor; Budget Analyst; Business Manager; Credit Analyst; E-Commerce Coordinator; Social Media Coordinator; Financial Planner; Entrepreneur; Marketing Coordinator	Accountants and Auditors; Human Resources Specialists; Project Management Specialists; Logisticians Administrative Services Managers; General and Operations Managers; Purchasing Managers
Communications	Advertising; Business Management; Education; Journalism; Law; Marketing; Mediation; Politics; Public Relations; Radio & TV Broadcasting	Public Relations Specialists; Market Research Analysts and Marketing Specialists; Business Operations Specialists, All Other; Project Management Specialists
Environmental Science and Management	Coastal Program Analyst; Climatologist; Ecologist; EcoTourism Manager; Environmental Scientist; Land Management Supervisor; Nature Writer; Park Ranger; Pollution Control Technologist; Recreation Specialist	Atmospheric and Space Scientists; Environmental Engineers; Hydrologists
Biology	Field Biologists Ecologists Microbiologists Physiologists Marine Biologists Geneticists Cell Biologists Developmental Biologists Biotechnology Researchers Biochemists	Biological Scientists, All Other; Zoologists and Wildlife Biologists; Animal Scientists; Occupational Health and Safety Specialists;
Oceanography	Oceanographer; Marine Biologist; Hydrologist/Water Pollution Technician; Marine Resource Specialist; Hydrographic Survey Technician; Scientific Diver; Research Assistant; Laboratory Assistant; Oceanographic Instrumentation Technician; NOAA Corps Officer; Physical Oceanographer; Chemical Oceanographer; Coastal/Ocean Engineer; Geological Oceanographer; Aquaculture Technician	Geoscientists, Except Hydrologists and Geographers; Hydrologists; Biological Scientists, All Other

Sociology	Attorney/Mediator; Clinical Research Associate; Community Organizer; Criminologist; Diplomat; Director; Drug Counselor; Employment Counselor; Executive Director; Researcher; School Counselor; Social Worker	Human Resources Specialists; Compliance Officers
Computer Science	Commercial Banking Computer Programmer; Computer Game Developer; Computer Hardware Engineer; Computer Systems Analyst; Cryptologist; Data Mining Specialist; Database Developer; Information Systems Programmer; Medical Systems Administrator; National Security Analyst; Telecommunication Designer; Web Architect	Software Developers; Computer Systems Analysts; Data Scientists
Geography	Aerial Photo Interpreter; Cartographer; City Planner; Climatologist; Demographer; Environmental Planner; GIS Coordinator; Intelligence Analyst; Land Use Management Specialist; Map Editor	Surveyors; Atmospheric and Space Scientists
Political Science	Attorney; Elected Official; Intelligence Analyst; Journalist; Legislative Assistant; Marketing Research Analyst; Nonprofit Leader; Policy Analyst; Political Consultant; Public Relations Specialist; Union Leader	Public Relations Specialists; Compliance Officers; Market Research Analysts and Marketing Specialists
Economics	Actuary Claim Adjustor/Appraiser Economist Lawyer Loan Officer Applied Data Analyst Lobbyist Public Policy Analyst Environmental Planner Sustainability Consultant Urban and Regional Community Development Planner	Business Operations Specialists, All Other
Journalism and Mass Communication	Advertising Director; Attorney; Broadcast News Director; Radio/Podcast Producer and Reporter; Communications Director; Editor; Web Content Editor; Graphic Designer; Photographer; Press Officer; Social Media Manager; TV News Anchor; Web Designer	Public Relations Specialists; Market Research Analysts and Marketing Specialists
Mathematics	Data Analyst; Statistician; Campaign Manager; Testing Product Engineer; Math Teacher (K-12); Business Analyst; Actuary; Computer Scientist; Mathematician	Data Scientists; Computer Systems Analysts
Geology	Engineering Geologist; Environmental Geologist; Geomorphologist; Environmental Scientist; Journalist/Technical Writer; Emergency Manager; Field Geologist; Marine Geologist; Hydrogeologist; Science Teacher	Geoscientists, Except Hydrologists and Geographers; Hydrologists;

Wildlife	Wildlife Biologist; Wildlife Refuge Manager; Wildlife Program Specialist; Wildlife Manager; Special Agent - Wildlife; Fish & Game Warden; Shooting Preserve Manager; Fish & Wildlife Assistant; Wildlife Technician; Animal Biologist; Animal Handler; Animal Keeper	Zoologists and Wildlife Biologists; Animal Scientists
Anthropology	Archaeologist; Museum Curator; Ethnographer; Linguist; Cultural Resources Manager; Paleoanthropologist; Forensic Anthropologist; Primatologist; Environmental Anthropologist; Medical Anthropologist	Anthropologists and Archeologists, Archeologist
Fisheries Biology	Aquaculturist; Aquatic Biologist; Customs Inspector; Fish Hatchery Manager; Fish & Game Warden; Fisheries Biologist; Habitat Restoration Specialist; Reservoir Manager; Wastewater Treatment Analyst; Watershed Restoration Specialist	Zoologists and Wildlife Biologists

Appendix G - Cal Poly Humboldt Undergraduate Academic Pathways to Employment in the FOSW Industry and Associated Port Development

Professional Occupations	Estimated Jobs by 2030	COMM	SOC	ANTH	GEOG	JMC	POLI	BIOL	WLDF	GEOL	FISH	MATH	ESM	CS	OCN	BUS	ECON	ENGR
Estimated Undergraduates by 2030		**288**	**510**	**244**	**148**	**209**	**196**	**1381**	**646**	**153**	**132**	**130**	**830**	**214**	**66**	**1128**	**102**	**335**
Accountants and Auditors	72															X		
Administrative Services Managers	84															X		
Airline Pilots, Copilots, and Flight Engineers	4																	
Animal Scientists	16							X	X									
Anthropologists and Archeologists	20			X														
Architects, Except Landscape and Naval	41																	
Professional Occupations	**Estimated Jobs by 2030**	**COMM**	**SOC**	**ANTH**	**GEOG**	**JMC**	**POLI**	**BIOL**	**WLDF**	**GEOL**	**FISH**	**MATH**	**ESM**	**CS**	**OCN**	**BUS**	**ECON**	**ENGR**

Professional Occupations	Estimated Jobs by 2030	COMM	SOC	ANTH	GEOG	JMC	POLI	BIOL	WLDF	GEOL	FISH	MATH	ESM	CS	OCN	BUS	ECON	ENGR
Architectural and Engineering Managers	35																	X
Atmospheric and Space Scientists	36				X								X					
Biological Scientists, All Other	52							X							X			
Business Operations Specialists, All Other	47	X														X	X	
Buyers and Purchasing Agents	22															X		
Civil Engineers	350																	X
Compliance Officers	8		X				X											
Computer Occupations, All Other	28													X				

Professional Occupations	Estimated Jobs by 2030	COMM	SOC	ANTH	GEOG	JMC	POLI	BIOL	WLDF	GEOL	FISH	MATH	ESM	CS	OCN	BUS	ECON	ENGR
Computer Systems Analysts	16													X				
Construction Managers	415																	
Cost Estimators	163															X		X
Data Scientists	20											X						
Electrical Engineers	94																	X
Emergency Management Directors	10																	
Engineers, All Other	34																	X
Environmental Engineers	80												X					X

Professional Occupations	Estimated Jobs by 2030	COMM	SOC	ANTH	GEOG	JMC	POLI	BIOL	WLDF	GEOL	FISH	MATH	ESM	CS	OCN	BUS	ECON	ENGR
Facilities Managers	4															X		
Financial Managers	30															X		
General and Operations Managers	246	X														X		
Geoscientists, Except Hydrologists and Geographers	16				X					X					X			
Human Resources Specialists	74		X													X		
Hydrologists	16				X								X		X			X
Industrial Engineers	20																	X
Industrial Production Managers	22															X		X

Lawyers	18																	
Logisticians	26															X		
Managers, All Other	246	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Marine Engineers and Naval Architects	12																	
Market Research Analysts and Marketing Specialists	23	X				X	X											
Mechanical Engineers	324																	X
Occupational Health and Safety Specialists	27							X										
Project Management Specialists	329	X														X		
Professional Occupations	**Estimated Jobs by 2030**	**COMM**	**SOC**	**ANTH**	**GEOG**	**JMC**	**POLI**	**BIOL**	**WLDF**	**GEOL**	**FISH**	**MATH**	**ESM**	**CS**	**OCN**	**BUS**	**ECON**	**ENGR**

Public Relations Specialists	16	X				X	X											
Purchasing Managers	24															X		
Sales Managers	14	X														X		
Software Developers	22													X				
Surveyors	15				X													
Training and Development Managers	6	X	X															
Zoologists and Wildlife Biologists	8							X	X		X							
Total Jobs		343	59	35	57	30	31	78	26	21	18	35	77	81	50	721	30	994