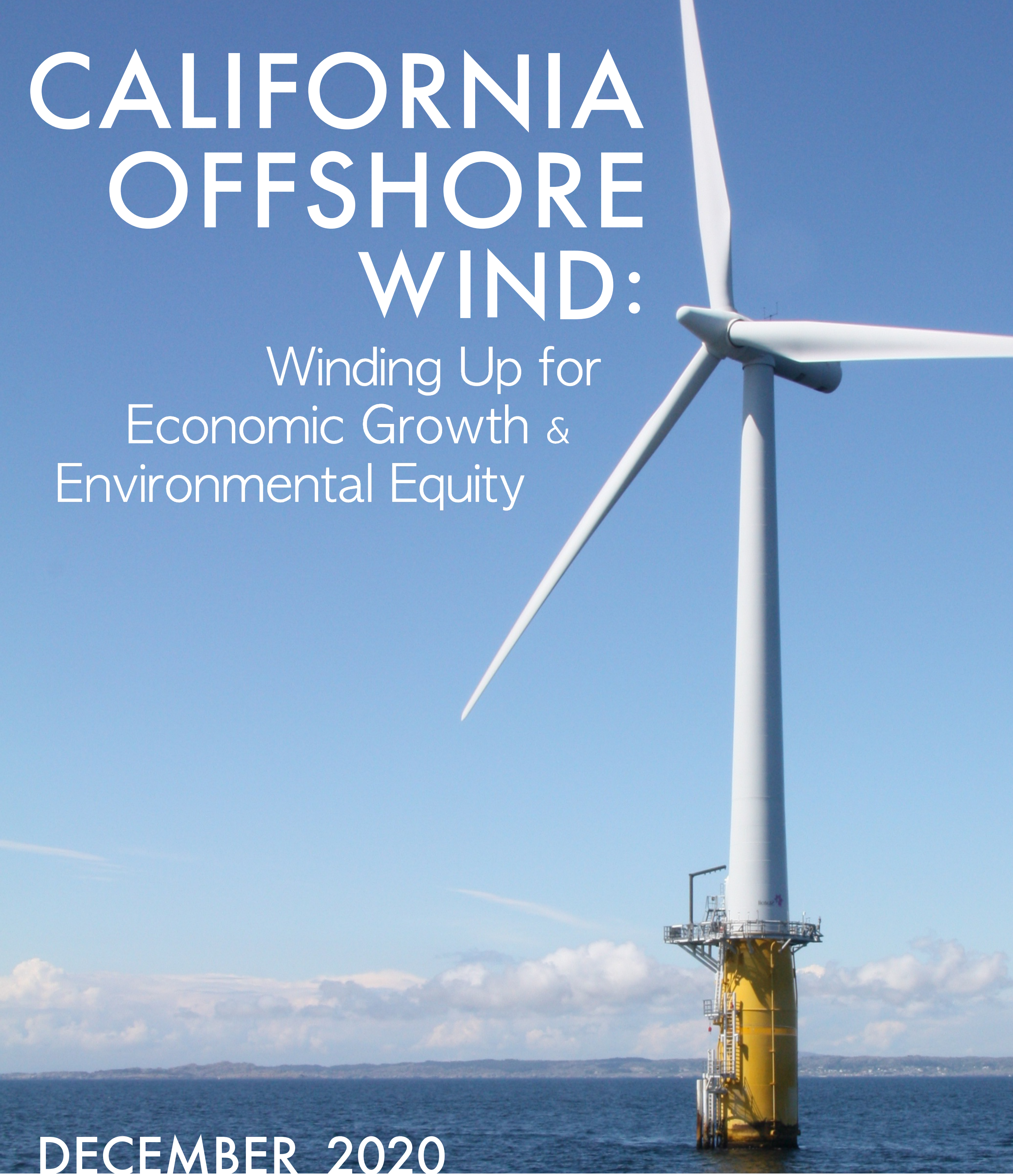
CALIFORNIA OFFSHORE WIND:

Winding Up for Economic Growth & Environmental Equity



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brightline DEFENSE

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Created by Brightline Defense

Brightline is an environmental justice nonprofit organization that works to empower communities and create sustainable environments. While advocating for clean energy for our communities, our organization pursues equity through programs in job training, air quality monitoring, and youth leadership in California.

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Cover photo: Hywind floating offshore wind turbine in North Sea, Norway.
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Executive Summary

With a new incoming federal administration prioritizing climate change, one innovative clean energy source offers a scalable pathway to economic recovery, local jobs, and cleaner air: offshore wind. Given the technology's need for skilled labor, California offshore wind will bring both new short-term and long-term investments in the state's economy and workforce. For instance, offshore wind will create shovel-ready jobs in port revitalization, turbine demonstration, and transmission line projects. Over the decades, offshore wind will also create sustainable long-term jobs in construction, manufacturing, and installation of offshore wind floating systems. Provisions in state policy or in Project Labor Agreements (PLAs) can support local hiring for these projects, creating direct local investment opportunities. Furthermore, incorporating local business enterprises (LBE) and disadvantaged business enterprises (DBE) can promote equity across these projects. Coupled with the right policy tools, this rapidly evolving technology could fulfill the promise of an equitable transition to a green economy.

This report also outlines the environmental health benefits that will come with the adoption of offshore wind. Currently, California relies on simple-cycle gas turbines, named "peaker plants," to meet peak electricity demands. 78% of gas-powered plants are located in frontline environmental justice communities that struggle with a number of other socioeconomic and environmental burdens. Community proximity to natural gas combustion has been linked with worsening air quality and increased adverse health outcomes. As these fossil fuel power plants are retired, the current transmission capacity could be opened for offshore wind, obviating the need for new transmission infrastructure to be built. If built to scale, offshore wind can thus alleviate environmental inequity and transform older infrastructure that have perpetuated environmental injustices.

The coordination and cooperation of community, government, and private sector stakeholders are crucial for a successful floating offshore wind industry. According to research by the Bureau of Ocean Energy Management (BOEM) and the National Renewable Energy Laboratory (NREL), California could provide up to 25% of the state's electricity needs through the development of 5 offshore wind sites. As California establishes itself as the West Coast leader of the worldwide offshore wind supply chain, offshore wind would bolster California's economic recovery, strengthen the local workforce, and promote equity. As California grapples with the devastating effects of an ongoing pandemic and widespread wildfires in 2020, offshore wind would subsequently be a win for environmental justice.

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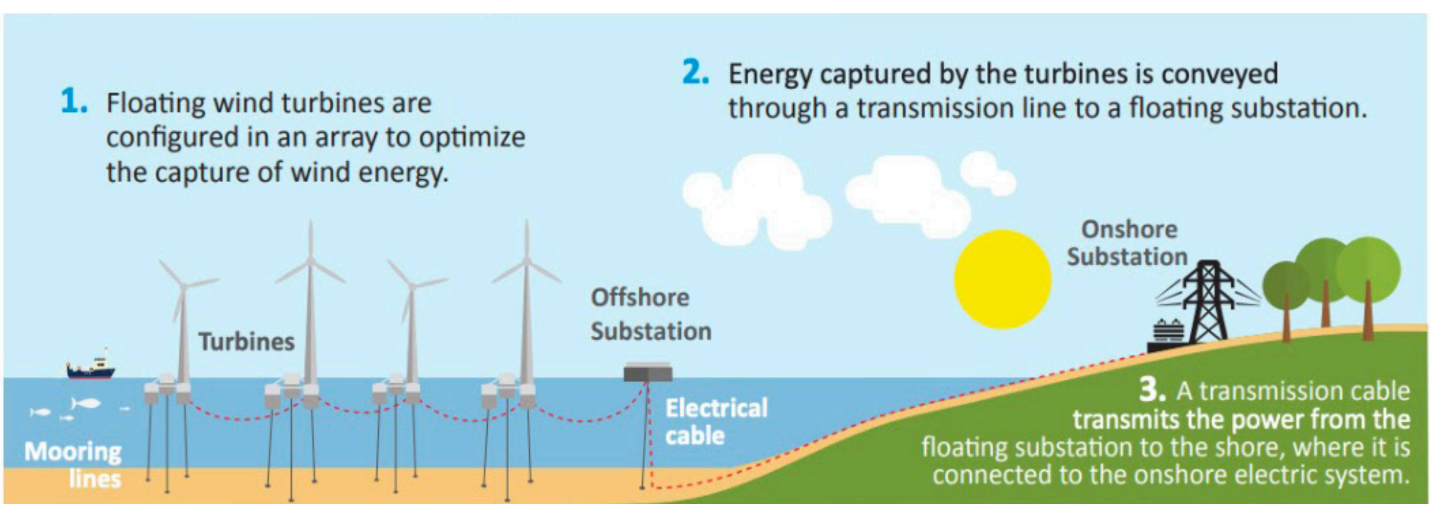
Introduction

As the COVID-19 pandemic has devastated California's public health and economy, offshore wind will serve two goals: improve the health of environmental justice communities and create local jobs through shovel-ready projects.[1] Given the complexity and scale of offshore wind in California, this rapidly evolving technology can create tens of thousands of good-paying jobs for local underemployed and unemployed communities.[2] Moreover, offshore wind energy will meet California's renewable energy goals and supply energy during peak demand hours typically supplied by peaker plants.[3] Consequently, offshore wind creates promising opportunities for economic recovery as well as improves air quality in California's communities disproportionately burdened by environmental pollution.

Offshore Wind Can Be Built to Scale in California

Offering enormous potential workforce and environmental benefits, offshore wind can be built to scale in California. According to the National Renewable Energy Laboratory (NREL), California's offshore technical resource capacity is about 112 gigawatts (GW).[4] The Bureau of Ocean Energy Management (BOEM) has already initiated the leasing process for three potential offshore wind sites off the coast of California: Humboldt Bay, Morro Bay, and Diablo Canyon.[5] Two more sites for potential future development include Del Norte and Cape Mendocino, both identified in studies by BOEM and NREL.[6] Unlike the fixed bottom offshore wind projects built on the East Coast of the United States and Europe, California's geography requires floating wind turbine technology (Appendix A; see also Figure 1).[7] Floating offshore wind can provide California with reliable round-the-clock electricity and is an essential renewable energy source to meet the state's peak energy demand.[8] If all five identified offshore wind sites were built to their total generation capacity of 21 GW, they could provide approximately 25% of the state's future electricity needs.[9]

Figure 1: How Offshore Floating Wind Farms Work



Source: BOEM, California Offshore Renewable Energy Fact Sheet. February 22, 2017.

Economic Recovery, Workforce Benefits, Equity

Offshore Wind Creates Jobs for Years to Come

Near-Term Shovel-Ready Projects Are Port Revitalization, Turbine Demonstration, and Transmission Line Projects.

Beginning with port revitalization and initial turbine demonstration, offshore wind immediately creates good-paying local jobs through shovel-ready projects. Before offshore wind platforms can be constructed, suitable ports must be established for complete assembly of floating turbines. Upgrading a single port for offshore wind could create up to 6,000 full-time equivalent jobs and add $449 million to the state's gross domestic product.[10] The most immediately viable port in California for offshore turbine assembly is the Port of Humboldt Bay.[11] In August 2019, the Humboldt Bay Harbor, Recreation and Conservation District issued a Request for Proposals to develop the Redwood Marine Terminal 1 as an offshore wind terminal.[12] A number of port renovations to Redwood Marine Terminal 1 are necessary to accommodate turbine assembly, these renovations offer the region a wave of jobs unseen since the area's lumber market collapsed in the 1990s.[13] Additionally, Humboldt port development will require improvements to nearby shipping lanes that must be dredged to allow heavy cranes to assemble the floating platforms and tow assembled offshore wind components.[14] Most port development work will be performed by skilled, unionized workers of the building, construction, and maritime trades.[15] Local unions, ranging from the Humboldt-Del Norte Building Trades Council to the Inlandboatmen's Union of the Pacific, have already expressed an eagerness for developing the offshore wind industry and assisting with workforce development.[16]

Aerial view of Redwood Marine Terminal 1, Humboldt Bay

Source: U.S. EPA

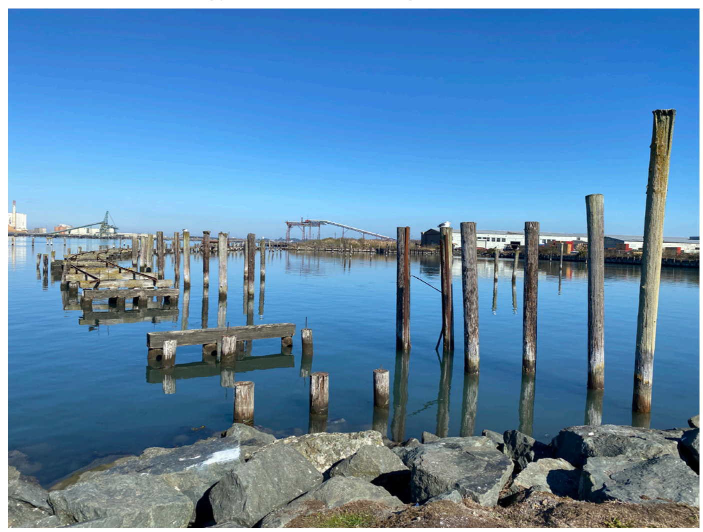
Beyond port revitalization and manufacturing, transmission line projects offer more immediate job creation. The North Coast lacks crucial transmission interconnection to the state grid, and this process is sure to be an important, early project that creates jobs.[17] The Humboldt Bay offshore wind site offers a resource potential of 1,607 MW; however, the existing PG&E Humboldt Bay Power Generation Station capacity is only 160 MW.[18] To support the integration of the offshore wind power into the grid, additional capacity upgrades to local power stations and transmission lines must be undertaken. Another option is a subsea cable connecting North Coast offshore wind farms to load centers in the San Francisco Bay Area.[19] Offshore wind will create transmission line jobs that require a prevailing wage backed by SB 350, a landmark 2015 law that required at least 50% renewable energy procurement.[20]

Laborers working on renewable energy.

Source: Laborers' International Union of North America (LiUNA!) Renewable Energy

While the offshore wind industry is still in its early stages in California, there has been considerable progress in planning prior to the pandemic. In 2018, BOEM had identified the state's most abundant wind resources and began their leasing process of obtaining nominations from companies interested in the commercial wind energy leases for Humboldt County, Morro Bay, and Diablo Canyon.[21] After BOEM leases have been granted, the research and development (R&D) phase of offshore wind can begin. This phase requires environmental impact assessments for each site, establishing project feasibility with deployment of floating turbine demonstrations and authorization of siting and permitting.[22] In order to meet these objectives, electrical engineers, metal workers, environmental scientists, lawyers and various laborers will be need to be employed. By 2025, the R&D phase could allot for 5,900 full-time equivalent (FTE) jobs and .4 GW of offshore wind deployment.[23] This progress will pave the way for thousands of offshore wind jobs in California.

Humboldt Bay (left) and the shoreline of Eureka (right), a site of interest for offshore wind energy and manufacturing in California.



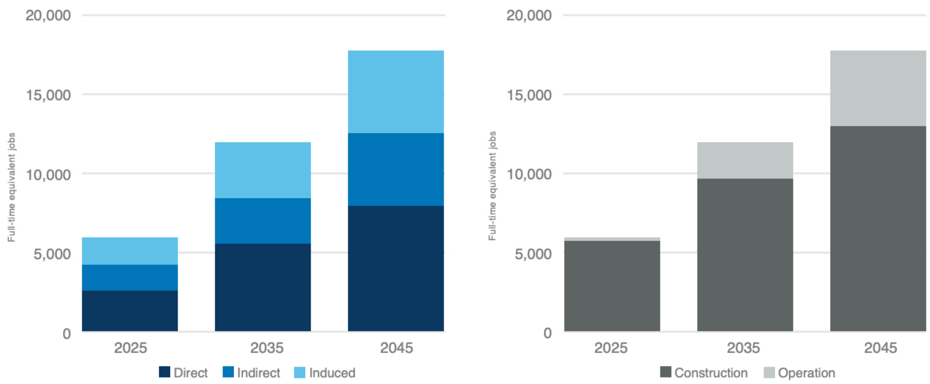
Source: Brightline Defense, October 2020

Medium- to Long-Term Projects Are Construction, Manufacture, and Installation of Floating Wind Systems.

The next major phase of hiring is estimated for 2026 to 2035 and will consist of the manufacture and construction of offshore wind systems in California.[24] Within ten years, California could deploy 8.1 GW of commercial-scale floating wind.[25] This stage will require collaboration between a wide range of occupations, ranging from skilled workers (pile divers/divers, millwrights, plumbers/pipefitters, welders, cutters, solderers, brazers, crane operators, electrical technicians, carpenters, health and safety specialists), engineers (environmental, mechanical, marine, research, subsea structure design), various laborers, vessel crews, plant managers, sales representatives, lawyers, administrative professionals, and marketing and communications professionals.[26] By the end of this phase, around 2035, offshore wind would provide as many as 12,000 annual FTE jobs.[27]

The next stage involves installation and commissioning, estimated to start in 2036 through to 2045.

Offshore Wind Job Estimates for 2025, 2035, and 2045
Under Strategic Growth Scenario: 18 GW in 2045



Source: American Jobs Project

This stage requires the continued deployment of commercial-scale floating wind with a ramp-up of an additional 9.5 GW, bringing the state total to 18 GW.[28] Wind turbine components will be transported to specific offshore sites, assembled, and connected to the electrical grid. Job types required for this phase are much the same as the previous phase. By the end of this phase, the offshore wind industry could support more than 17,500 annual FTE jobs.[29] Once the turbines are up and running, the industry will transition to a phase of operations and maintenance (O&M). This will additionally create jobs for regular inspection and repair; a recent study projected that a buildout of 9 GW of offshore wind would create an annual average of 5,000 O&M jobs for up to 25 years.[30] These O&M jobs will require environmental specialists, vessel crews, engineers, skilled workers, crane operators, and installation workers when repair and maintenance is needed.[31]

Offshore Wind Can Strengthen Workforce Development and Provide a Just Transition.

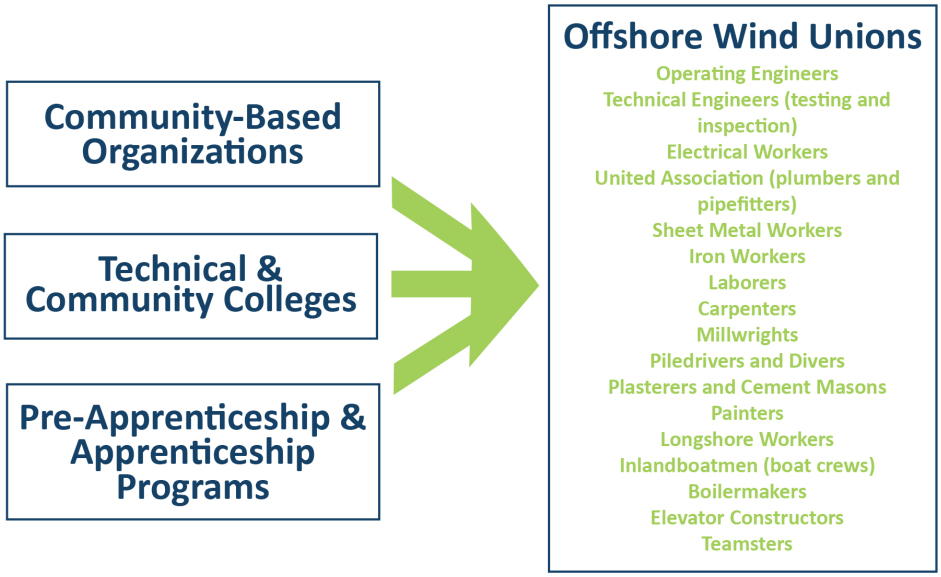
Local Hiring Increases Investment in Local Surrounding Communities.

UA Local 447 Training Center in Sacramento

Source: Sacramento Labor Bulletin

For Humboldt County, local hiring practices and workforce development can create thousands of good-paying jobs for local unemployed communities, as evident in prior projects. With the poverty rate at 36% in some parts of Humboldt County, investment in quality jobs for local residents, especially those in unemployed communities, can revitalize the state's economy.[32] Before the onset of the COVID-19 pandemic, the Humboldt area had a relatively small construction industry containing few workers with industrial skills or marine qualifications.[33] Offshore wind can also foster specific partnerships with universities, community and technical colleges, and industry leaders to both sustain existing training programs and create new ones. These partnerships will garner a sufficient workforce for offshore wind construction, installation, and operations. Apprenticeship programs for the construction trades and for Merchants Mariners/Seaman could collaborate with the College of the Redwoods, the CSU Maritime Academy, and the region's tribal governments to create a High-Road Training Partnership to fill these gaps and expand community access to offshore wind jobs.[34]

Local Training Programs for Offshore Wind



A number of policy tools can also ensure local hiring. For offshore wind, a Community Benefits Agreement (CBA) and Community Workforce Agreement (CWA) can be used by developers for infrastructure projects like port improvements. A CBA is a contract between community groups and the developer to provide specific amenities to the local community or neighborhood; some ensure that particular projects create opportunities for local workers and communities.[35] In comparison, a CWA is jointly developed among trade unions, developers, and community organizations to include an agreement on local hiring, apprenticeship programs, and other terms through Project Labor Agreements (PLAs).[36] PLAs are multi-union collective bargaining agreements negotiated to establish wage rates, hours, project length, and health and pension benefits. Past offshore wind projects like Block Island in Rhode Island have benefited from strong PLAs with local unions. In November 2020, offshore wind developer Ørsted signed a landmark workforce initiative with North America's Building Trades Unions (NABTU), which will lead to more local hiring and investment opportunities for workforce development.[37]

Transitioning Skills and Targeted Hiring Will Diversify and Strengthen the Clean Energy Workforce.

As industries such as oil, gas, and nuclear energy are exchanged for renewables, offshore wind will present a natural transition for many workers that possess relevant skills and knowledge in energy systems.[38] For instance, gas power plants and a nuclear power plant are planned for closure near the Morro Bay and Diablo Canyon sites. Jobs in construction and maintenance or general management and oversight, like plant operators and power dispatchers, are easily transferable to offshore wind projects. Hiring practices could prioritize these workers in order to ensure an equitable transition into renewable energy industries.

Even with familiarity of older energy systems, new retraining may be necessary to close the skills gap and ensure the necessary expertise for the offshore wind industry.[39] Because certain careers are unique to the gas and nuclear sectors, such as

Offshore Wind Workforce Development Pathway

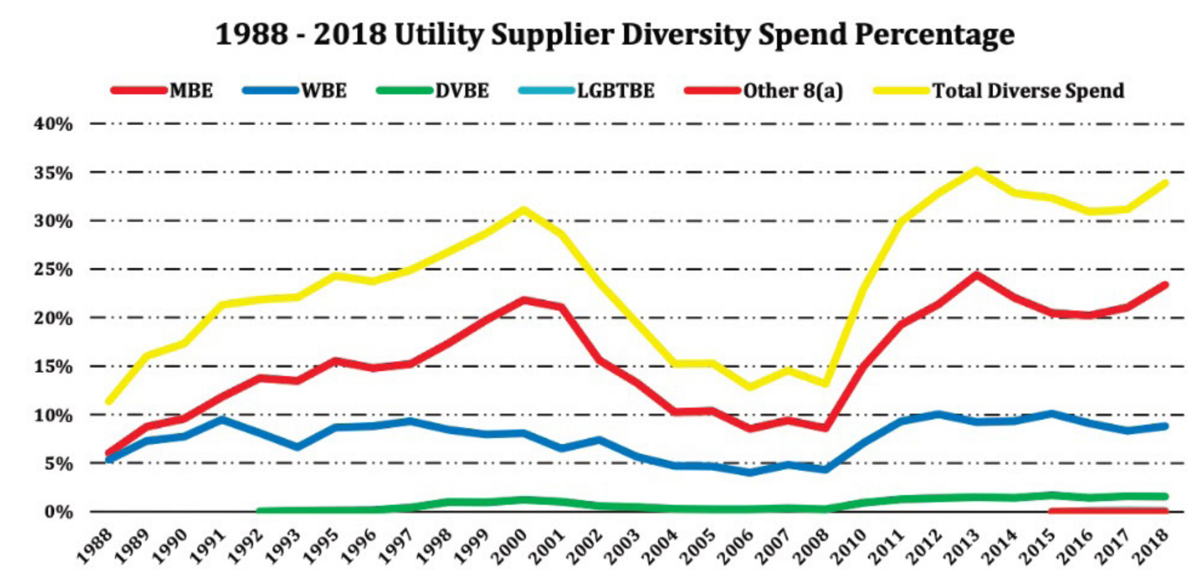
Sources: CityBuild Academy and Huntstock chemical engineering, these positions will require focused retraining for comparable positions in the renewable energy fields. The collective planning of the Diablo Canyon nuclear power plant decommissioning is an example of early employee transitioning and assistance, which includes an employee severance and development program.[40] Additional research should identify skill gaps and help mitigate job displacement.

Targeted hiring also presents an opportunity to diversify the offshore wind workforce, taking concrete steps to reach out to underrepresented communities of color and women. The development of an inclusive workforce can be accomplished through equitable wages, workforce outreach and recruitment grants, training centers and programs, Vocational English as a Second Language (VESL) programs, and targeted employment of veterans and women.[41] By 2045, about 12,958 annual full-time construction jobs will be supported from the deployment of 18 GW of floating wind, about 73% of the total offshore wind jobs.[42] With California's ambitious transition to renewable energy, offshore wind can increase workforce diversity through targeted hiring goals and ensure an equitable transition for fossil fuel industry workers.

Offshore Wind Can Incorporate More Projects for DBE & LBE.

To spur equitable economic recovery, offshore wind projects may also incorporate local business enterprise (LBE) and disadvantaged business enterprise (DBE) provisions, similar to ones used in current utility infrastructure projects in California. For instance, General Order 156 (GO 156) from the California Public Utilities Commission (CPUC) helps to stimulate participation of investor-owned utilities (IOUs) to procure or contract goods and services from women-, minority-, disabled veteran-, and LGBT owned business enterprises, in turn diversifying the bidding and procurement process (See Figure 2).[43] In 2018, the combined efforts of IOUs subject to GO 156 exceeded the overall procurement goal of 21.5% spend, reaching a new high of 33.9% ($12.3 billion) of their total procurement with diverse suppliers.[44] This was a 16.7% increase in diverse expenditure from 2017.[45] Programs for DBE are necessary to reduce discrimination and related barriers that pose significant obstacles for these businesses seeking federally-assisted work.[46] Offshore wind projects could provide opportunities to expand the incorporation of LBE and DBE contracts to the influx of public works projects which would further diversify the workforce and allow for more community-driven contracts.

Figure 2: GO 156 Impacts on Diversity Spend



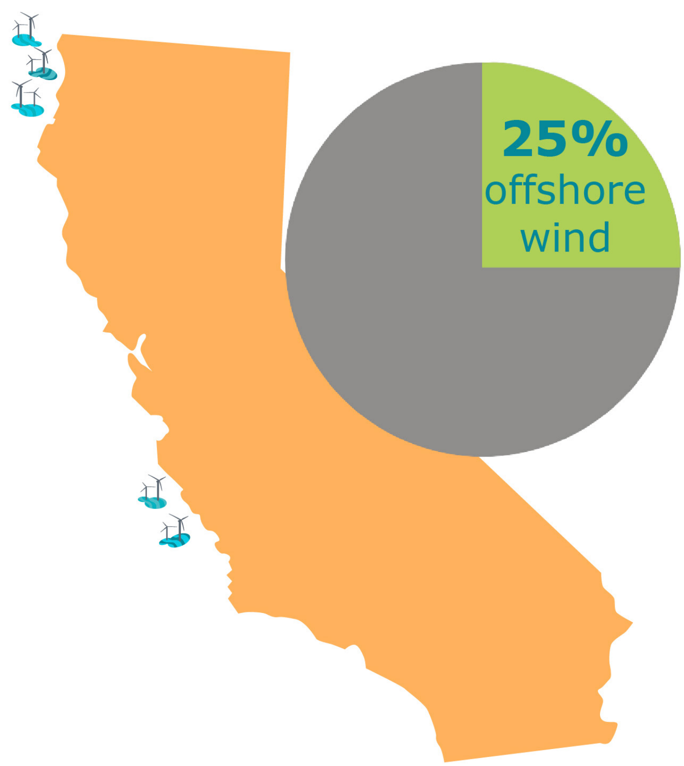
Source: California Public Utilities Commission

Offshore Wind Helps California Meet its 100% Renewable Energy Goal.

Committing California to 100% clean energy by 2045, SB 100 ambitiously accelerates the state's timeline for transitioning to carbon-free power sources.[47] Staying on track with newly elevated targets will require an added production of roughly 20 GW of renewable capacity by 2030.[48] If the combined five offshore wind sites identified by BOEM are developed to their maximum potential of approximately 21 GW, they could provide 25% of the state's future electricity needs.[49] Staying on track with newly elevated targets will require an added production of roughly 20 GW of renewable capacity by 2030.[50] Offshore wind would play a crucial role in California's decarbonization goals and climate change mitigation.

California's 2045 generation portfolio goals rely on quickly scaling up the generation capacity of solar, wind, and renewable storage technology. While some models and scenarios do not specifically include offshore wind technology, all scenarios do envision wind as generally essential for grid reliability.[51] Offshore wind is a critical resource to meet California's peak energy demand and also reduces the state's dependency on natural gas-fired power plants. To achieve California's climate goals, renewable energy technologies will need to provide strong and consistent energy between the peak hours of 4-9 pm.[52] Offshore wind is key to addressing this dilemma (Appendix B), as coastal winds are commonly most powerful between 5-7 pm.[53] Offshore wind can fill the supply gap when demand is high and generation from other renewable energy sources, like solar energy, is low.[54] Another valuable aspect of offshore wind is that the turbines are built 20-25 miles off the shores of California, which grows the wind sector without utilizing limited available plots for onshore wind or solar farms.[55] Since offshore wind systems are usually built beyond the visible horizon, the industry would minimize land use conflicts that typically exist onshore, such as sound or obstruction concerns.[56] It is still important to note environmental concerns for marine ecosystems disruption; uncovering these impacts with environmental impact reports and designing best practices for deployment will be essential for the offshore floating wind sector.

If developed to their maximum potential, the 5 identified offshore wind sites could provide **25% of California's electricity needs**.



Offshore Wind Cleans Up the Air Quality for Communities near Peaker Plants.

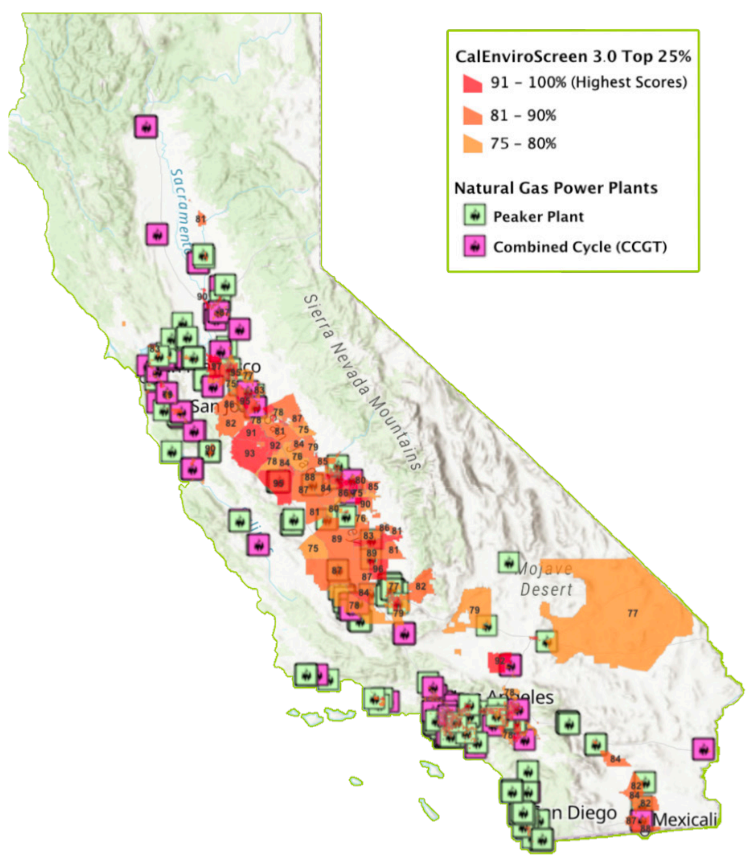
Currently, California's peak electricity demand is mostly met with simple-cycle natural gas combustion turbines known as "peaker plants" or "peakers."[57] Due to the storable nature of natural gas, peaker plant operators can quickly control when to turn on or shut off a plant, keeping supply matched to demand.[58] Peakers tend to be inefficient and expensive compared to combined-cycle gas turbine (CCGT) plants but are used only when energy demand is not met with baseload sources.[59] Additionally, peaker plants emit higher rates of carbon dioxide (CO_2) and nitrogen oxides (NOx) per unit produced than do baseload combined-cycle gas turbines because pollution emission rates during their start-up and shut-down are greater than during continuous operation.[60] Making matters worse, peaker plants are commonly run on days already experiencing poor air quality.[61] Even as natural gas power plant usage begins to phase out with SB 100, many may start and stop much more frequently than before, potentially resulting in more NOx emissions.[62]

Peaker Plants Impact Air Quality and Community Health.

Gas-fired power plant emissions create air pollution that causes serious adverse local and regional health effects.[63] Health impacts of natural gas power plants can happen hundreds of miles away from the source, and numerous studies have linked proximity to power plants with negative health effects, including adverse birth outcomes, hospital visits for respiratory illness, acute coronary issues, reduced lung function in children, and increased emergency room visits among the elderly.[64] The air and water pollution emitted by coal and natural gas plants is also linked to respiratory problems, neurological damage, heart attacks, cancer, premature death, and a host of other serious problems.[65] Most of these negative health impacts come from air and water pollution that wind energy technologies simply do not produce.[66]

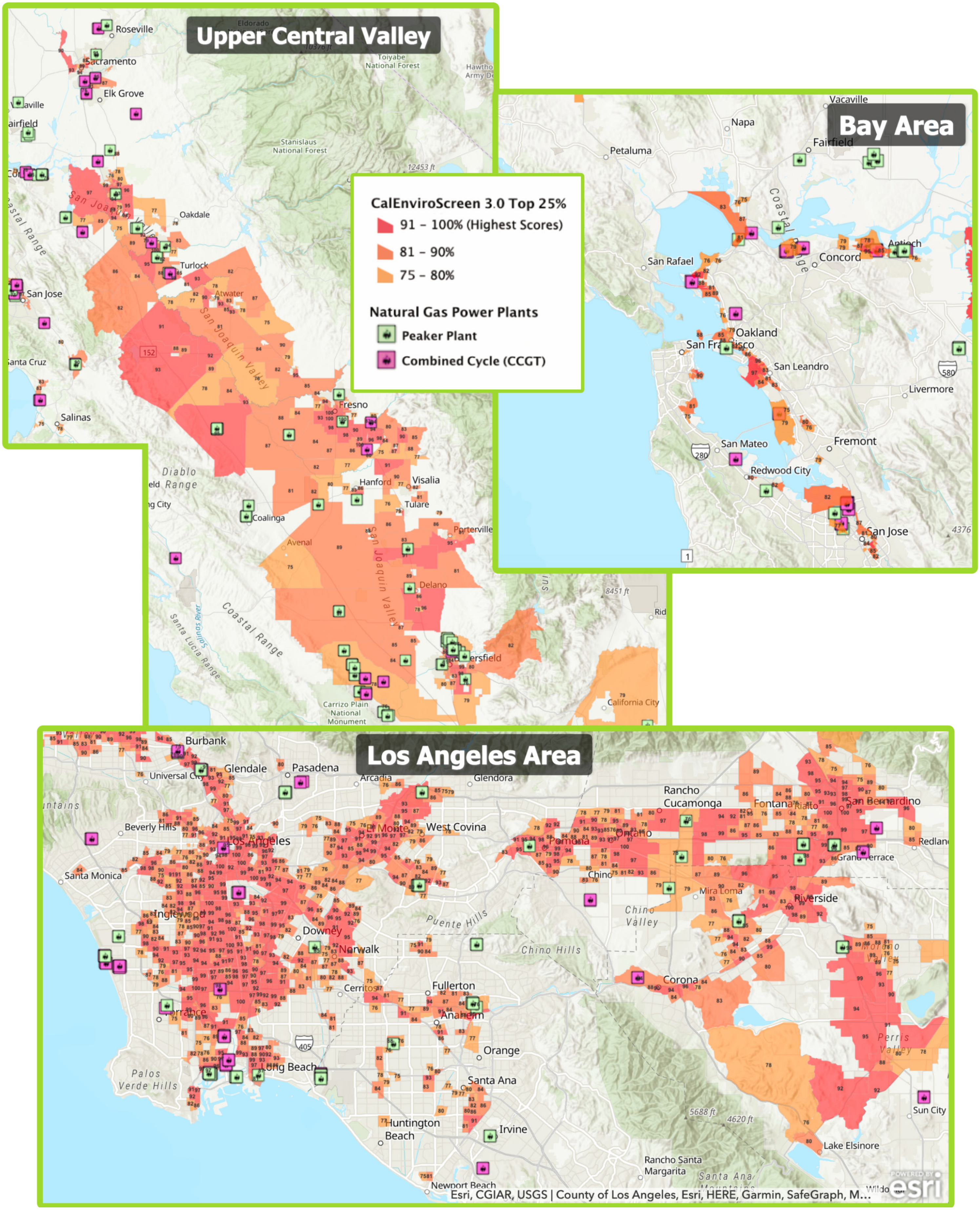
In addition to the many life-altering health impacts caused by peaker plants and CCGT emissions, environmental justice communities are now further at risk with the COVID-19 pandemic. In April 2020, a nationwide study from Harvard University identified that long-term exposure to air pollution from power plants, specifically fine particulate matter (PM2.5), is associated with an increased risk of death from COVID-19.[67] The COVID-19 health crisis has further highlighted the inequitable burden of health disparities these communities face. As of 2019, there were around 195 peaker and CCGT plants in California, providing approximately 32 GW of generation capacity to the grid.[68] 152 of the 195 plants are located within 5 miles of the top 25th percentile of CalEnviroScreen

Natural Gas Power Plants in California



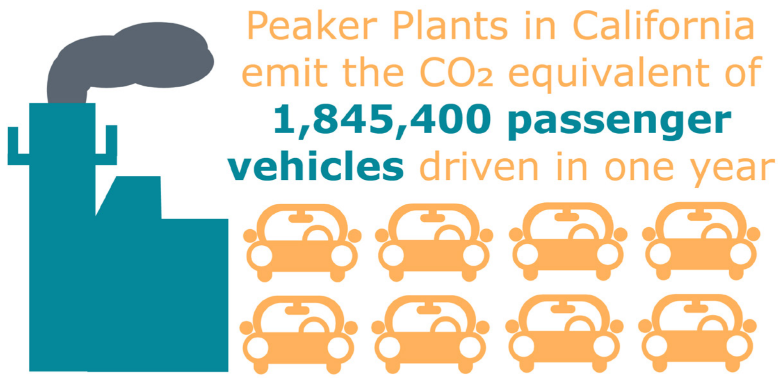
Source: Brightline Defense

Figure 3: Maps of Natural Gas Power Plants & Impacted Communities



Source: Brightline Defense

3.0 census tracts (See Figure 3).[69] This means that 78% of these power plants are located in communities identified as the most disadvantaged, whereas only 9% of power plants are located in the bottom 25th percentile of CalEnviroScreen 3.0, or near communities that are the least disadvantaged.[70] With neighboring CCGTs and peaker plants, these environmental justice communities will be exposed to much worse air quality and have an increased risk of illness, long-term health issues, and other potential disasters caused by gas power plants.[71] Environmental justice communities experience the most cumulative environmental health burdens, and when exposed to environmental health stressors, especially poor air quality, they are more likely to experience adverse health outcomes.[72] Reducing fossil fuel emissions is the only action to curb detrimental health impacts on frontline communities.



Offset calculations have been produced with peaker emissions data of 8,541,797 metric tons of CO_2 (from filtered EIA 2018 data: https://www.eia.gov/electricity/data/emissions/) and converted with EPA Greenhouse Gas Equivalencies Calculator. Passenger vehicles are defined as 2-axle 4-tire vehicles, including passenger cars, vans, pickup trucks, and sport/utility vehicles with an average fuel economy of 22.3 miles per gallon traveling 11,484 miles per year.

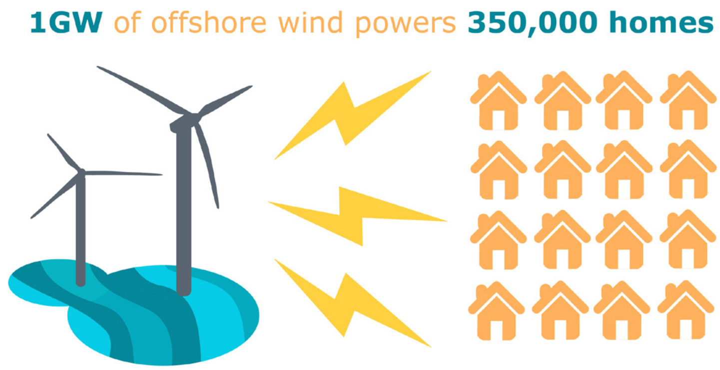
Offshore Wind Can Help Phase Out Demand for Peaker Plants.

To successfully phase out peaker plants, offshore wind and other renewable energy sources will need to be paired with energy storage technologies that are crucial for providing deployable round-the-clock electricity. Models applied by the Union of Concerned Scientists found that in 2018, 23% of CCGT generation capacity and 24% of peaker capacity could be retired within the same year without negatively affecting grid reliability.[73] The removal of even one peaker plant results in substantial air pollution reduction.

Peakers can economically be an ideal entry point for offshore wind and battery storage. Although peaker plants are cheap to build, they are costly to run–more expensive than larger "baseload" gas, coal, nuclear, and hydroelectric plants.[74] If battery prices come down, even modestly, about 82% of new peaker capacity could instead be replaced by batteries charged with renewables.[75] Reducing California's dependence on gas-fired power plants would result in significant health and economic benefits in environmental justice communities for generations.[76]

Offshore Wind Mitigates Climate Change through Decarbonization.

Advancing the state's climate change and renewable energy targets, offshore wind energy offers a bounty of untapped clean energy to address many of the state's most pressing matters related to climate change, including sea level rise, drought, higher wildfire risk, agricultural loss, public health impacts, and habitat and species loss.[77] To reduce these impacts of climate change, immediate decarbonization of our electric grid is needed. Offshore wind energy presents a way to meet the state's energy needs while also significantly reducing greenhouse gas emissions.[78] One GW of offshore wind energy could power 350,000 homes with clean renewable energy, and deploying 21 GW of offshore wind could power 7,350,000 homes.[79]



Opportunities for Successful Deployment of Offshore Wind

Offshore Wind Requires Unique Ports and Transmission Capacity.

Due to unique port requirements, Port of Humboldt Bay is likely the most viable port for assembling offshore floating wind turbines.[80] The port would need extensive rebuilding and upgrades, including dredging shipping lanes for heavy cranes to assemble the floating platforms.[81] Following the completion of the Humboldt Bay port, other ports along the coast of California could be developed to deploy offshore wind for local BOEM approved sites; however, fully assembled turbines may need to be transported from Humboldt Bay to these ports.

In August 2019, the Humboldt Bay Harbor District issued a Request for Proposals to develop a 100-acre site for an offshore wind terminal and manufacturing facility.[82] Interested developers struggled to form proposals because BOEM's leasing process had not been officially started, and there was no proposed state aid to develop the port. This port would also need extensive development including many updates to surrounding roads and increased transmission capacity.[83] Although transmission capacity in Humboldt will need to be expanded to serve more densely populated areas and coastal load centers, other offshore wind sites may reuse existing transmission infrastructure of retired coastal power plants.[84] For example, the Diablo Canyon nuclear plant is planned for retirement in 2025, freeing up many gigawatts of transmission capacity for the proposed Diablo Canyon offshore wind site. Additionally, several other coastal power plants are scheduled

Location of Potential offshore wind port, Redwood Marine Terminal 1 in Humboldt Bay for retirement or have already been shut down, creating available transmission infrastructure for offshore wind.[85]

To secure the future of offshore wind in California, the government must work with the energy industry and establish grid and port infrastructure. Even with physically sound ports, the BOEM proposed offshore wind sites may face federal challenges from the Department of Defense.[86] Collaboration between trade unions, environmental groups, the Department of Defense, local and state government officials, and state regulators will be crucial for the future success of offshore wind in California.

Transporting offshore wind turbine blades

Source: Jason Deign

California Supply Chain Will Allow for Maximum Economic Recovery.

In order to reveal the largest economic and employment benefits from the offshore wind industry, a California supply chain should be developed. A local supply chain for the primary components of wind turbine generators, towers, and floating platforms would create thousands of manufacturing and construction jobs.[87] Today, most of the offshore wind industry's supply chain is centered in Europe, and in the near future, China is likely to become a major exporter of wind components.[88] Offshore floating turbines are larger than land-based wind turbines, with expected heights exceeding 800 ft and large blades reaching up to 300 ft long.[89] These blades are too large to be transported on existing highways or rail lines and can only be manufactured quayside or delivered by ship from a manufacturer located at another nearby port.[90]

California's distance from global wind industry manufacturing centers could create an added opportunity to develop an in-state supply chain. To see this happen, there would need to be a state commitment of at least 10 GW of offshore capacity in order for turbine manufacturers and government officials to invest hundreds of millions of dollars to build high-tech factories.[91] If floating foundation manufacturing were initiated in California, the potential export demand from other states could result in West Coast shipyard unions regaining significant employment opportunities.[92] Policy for future offshore wind commitments is a crucial component needed to build successful long-term offshore wind projects and bring investment opportunities for manufacturing. Local content legislation and regulation are also important policy tools available to require developers to use in-state suppliers and support a local supply chain.[93]

Wind Turbine Manufacturing in Arkansas

Source: US Department of Energy

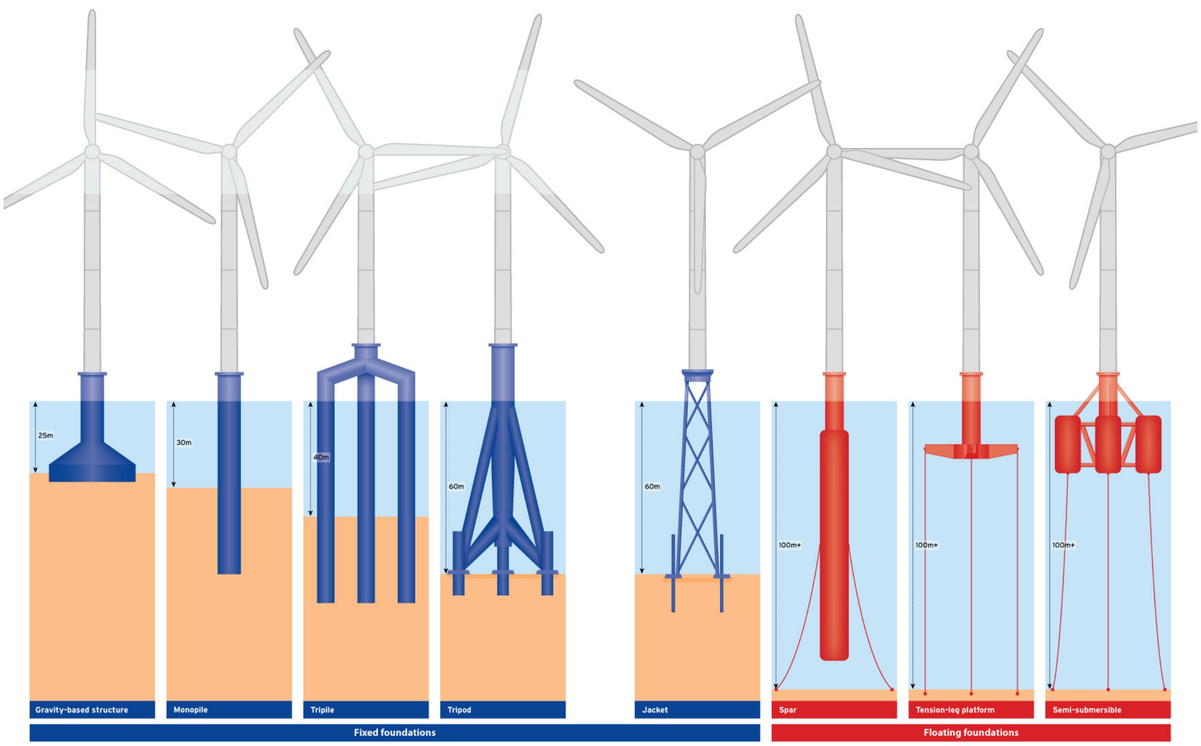
Conclusion

Offshore wind energy in California presents a multitude of benefits, from reducing greenhouse gas emissions and mitigating climate change to creating tens of thousands of green jobs and strengthening the state's renewable energy portfolio. As explored in this report, transitioning from polluting peaker plants toward offshore wind power generation improves public health and air quality, especially in environmental justice communities. Manufacturing and development for offshore wind infrastructure and projects offer both immediate and long-term job creation across many trades. Offshore wind can create local and equitable jobs across the state, revitalizing unemployed communities as well as communities dependent on employment from the fossil fuel industry. Considering the economic toll of COVID-19, these new jobs are now more important than ever. Offshore wind has immense potential to achieve California's renewable energy goals with swift investment in strengthening a green workforce – powering our shared, sustainable future.

Appendix A
Floating Wind Technology

Fixed bottom offshore wind foundations are not easily built on California's narrow continental shelf, and steep transitions from the shelf to the seafloor make these locations too deep.[94] Floating offshore wind foundations will thus need to be designed and constructed to meet California's bathymetric requirements. While fixed-bottom offshore wind is already a multibillion-dollar established industry, floating wind technology and manufacturing are still developing and provide interesting opportunities for expanding the renewable energy and green jobs sector.[95]

Figure A: Fixed Bottom vs. Floating Offshore Wind Technology



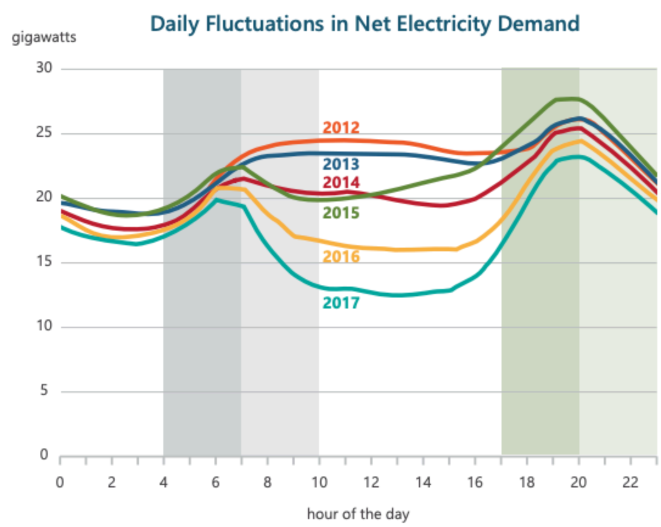
Source: Wind Power Monthly

Note: Fixed bottom foundation designs are shown in blue (left side), and floating foundation designs that may be deployed in California are shown in red (right side).

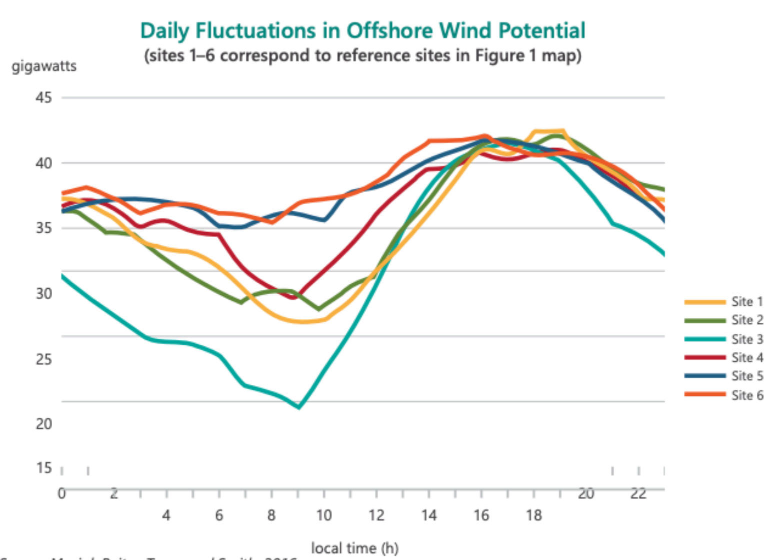
Appendix B
Peak Demand & "The Duck Curve"

As renewable energy has become a major source of California's electric generation, requirements and strategies for managing the timing imbalance between peak demand and renewable energy production has become a constant barrier to reaching a completely renewable grid. This barrier is known as the "duck curve." Offshore wind can provide energy at crucial peak hours with fast and steady wind speeds throughout the day and night during all four seasons, differentiating itself from onshore wind farms which produce energy with less consistent capacity.[96] The timing of peak offshore wind generation perfectly dovetails with peak electricity demand across California.[97]

Figure B: Offshore Wind Can Deliver During Peak Demand



Source: U.S. Energy Information Administration, July 24, 2017



Source: Musial, Beiter, Tegen and Smith, 2016

Source: UC Berkeley Labor Center, Green Economy Program

Endnotes

1 As the pandemic continues, the unemployment rate in California has continued to fluctuate significantly with the economic shutdowns and reopenings. As the pandemic surges again in Winter 2020, November 2020 job gains are also seeing a pronounced slowdown as California's unemployment rate still remains substantially higher from the pre-pandemic rate of 3.9% reported in February 2020. Although job recovery has happened, economic "scarring" has occurred, with job growth decelerating, and well over million workers are being laid off or fired each month.
Jeff Cox, *Employment growth slows sharply in November amid coronavirus surge*, CNBC, December 4, 2020, https://www.cnbc.com/2020/12/04/jobs-report-november-2020.html (last visited December 6, 2020).
Andrew V. Dam, *Job growth will slow during a Biden presidency: The easy gains are almost gone,* WASH. POST, November 11, 2020, https://www.washingtonpost.com/business/2020/11/11/slow-jobgrowthbiden/ (last visited December 6, 2020).
U.S. Bureau of Labor Statistics, *Employment Level - High School Graduates, No College, 25 Yrs. & Over* [LNS12027660], retrieved from FRED, Federal Reserve Bank of St. Louis, December 6, 2020, https://fred.stlouisfed.org/series/LNS12027660.

2 By 2035, offshore wind could create as many as 11,971 jobs and more than 17,500 jobs by 2045. *The California Offshore Wind Project: A Vision for Industry Growth,* American Jobs Project. February 2019. http://americanjobsproject.us/wp/wp-content/uploads/2019/02/The-California-Offshore-Wind-Project.pdf.

3 Michael J. Dvorak, Cristina L. Archer, Mark Z. Jacobson. *California offshore wind energy potential. Renewable Energy 35* (2020) 1244-1254. December 9, 2009. https://web.stanford.edu/group/efmh/jacobson/Articles/I/Offshore/DvorakRenewEn2010.pdf.
Elena M. Krieger, and Joan A. Casey, and Seth B.C. Shonkoff. *A framework for siting and dispatch of emerging energy resources to realize environmental and health benefits: Case study on peaker power plant displacement*, 96 Energy Policy 302, 313 (2016).

4 Walter Musial, Philipp Beiter, Suzanne Tegen, and Aaron Smith. *Potential Offshore Wind Energy Areas in California: An Assessment of Locations, Technology, and Costs.* National Renewable Energy Laboratory. December 2016. https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Pacific-Region/Studies/BOEM-2016-074.pdf.

5 *California Offshore Wind Energy.* Bureau of Ocean Energy Management (BOEM). https://caoffshorewind.databasin.org/maps/4c86c5e61e044747ac010102c4787507/active.

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

7 Collier et al., *supra* note 6.
For an example of how components of floating offshore wind can be implemented into the electric grid, see Figure 1.
California Offshore Renewable Energy: BOEM California Intergovernmental Renewable Energy Task Force, Bureau of Ocean Energy Management (BOEM).

8 Dvorak et al., *supra* note 3.

9 Calculations based on each site built to a minimum of 1.6 GW capacity, and the simulated capacity factors range from 46% to 55%. Sites estimated capacity factors ranging from 46 percent to 55 percent. Collier et al., *supra* note 6.

10 American Jobs Project, *supra* note 2.

11 Collier et al., *supra* note 6.

12 *Request For Proposal: Lease of Redwood Marine Terminal 1.* Humboldt Bay Harbor, Recreation and Conservation District. August 21, 2019. http://humboldtbay.org/sites/humboldtbay2.org/files/RMT%20I%20Multipurpose%20Dock%20RFP%20final%208-20-19_reduced.pdf.

13 Ibid.
Humboldt Bay Maritime Industrial Use Market Study - Final Report. BST Associates. May 31st, 2018. https://humboldtgov.org/DocumentCenter/View/64265/Humboldt-Bay-Maritime-Industrial-Use-Market-Study-2018-PDF.

14 Ibid.

15 American Jobs Project, *supra* note 2.

16 Collier et al., *supra* note 6.

17 Ibid.

18 Schatz Energy Research Center. *Offshore Wind Feasibility Analysis California North Coast*. https://fisheries.legislature.ca.gov/sites/fisheries.legislature.ca.gov/files/190425_Offshore_Wind_Feasibility_Analysis_Background_Information.pdf (last visited June 16, 2020).

19 Ibid.

20 Amendments to Labor Code § 1720 specify that construction, alteration, demolition, installation, or repair work on the electric transmission system located in California constitutes a public works project. The prevailing wage provision can be found in Labor Code § 1771. Collier et al., *supra* note 6.

21 *California Activities,* Bureau of Ocean Energy Management. https://www.boem.gov/california (last visited May 19, 2020).

22 American Jobs Project, *supra* note 2.

23 Modeled scenario of 18 GW by 2045. Scenario assumes comprehensive state policies supporting offshore wind, no significant restrictions by the U.S. military, and in-state production of major manufactured inputs. Jobs total includes direct jobs such as construction, maintenance, and manufacturing of turbine components as well as indirect jobs from downstream services. Induced jobs are also included. Ibid.

24 American Jobs Project, *supra* note 2.

25 Ibid.

26 Ibid.

27 Job projections are based on a modeled scenario of 18 GW build out by 2045; scenario assumes comprehensive state policies supporting offshore wind, no significant restrictions by the U.S. military, and in-state production of major manufactured inputs. Jobs total includes direct jobs such as construction, maintenance, and manufacturing of turbine components as well as indirect jobs from downstream services. Induced jobs are also included. Ibid.

28 Ibid.

29 *Supra* note 28.

30 *Economic Impact Study of New Offshore Wind Lease Auctions by BOEM,* Wood Mackenzie. August 2020. https://www.eenews.net/assets/2020/08/06/document_ew_01.pdf.

31 *Supra* note 28.

32 Ibid.

33 Collier et al., *supra* note 6.

34 Ibid.

35 Partnership for Working Families. *Policy & Tools: Community Benefits Agreements and Policies In Effect.* http://www.forworkingfamilies.org/page/policy-tools-community-benefits-agreements-and-policies-effect.

36 Partnership for Working Families. *Policy & Tools: Community Workforce Agreements.* https://www.forworkingfamilies.org/page/policy-tools-community-workforce-agreements.

37 Collier et al., supra note 6
North America's Building Trades Unions (NABTU) and Ørsted Sign Landmark MOU for U.S. Offshore Wind Workforce Transition, Ørsted Offshore North America and North America's Building Trades Unions (NABTU). November 18, 2020. https://nabtu.org/press_releases/nabtu-orsted-sign-landmark-mou/..

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

39 Collier et al., supra note 6.

40 Joint Proposal of Pacific Gas and Electric Company, Friends of

the Earth, Natural Resources Defense Council, Environment California, International Brotherhood of Electrical Workers Local 1245, Coalition of California Utility Employees and Alliance for Nuclear Responsibility to Retire Diablo Canyon Nuclear Power Plant at Expiration of the Current Operating Licenses and Replace It with a Portfolio of GHG-Free Resources, http://www.pge.com/includes/ docs/pdfs/safety/dcpp/JointProposal.pdf.
41 American Jobs Project, *supra* note 2.
42 *Supra* note 23.
43 California Public Utilities Commission. *Program History.* https://www.cpuc.ca.gov/General.aspx?id=1722
Figure 2: *Year 2018 Utilities Procurement of Goods, Services, and Fuel from Women-, Minority-, Disabled Veteran-, and LGBT-owned Business Enterprises.* California Public Utilities Commision. 2018. https://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/About_Us/Supplier_Diversity/Reports/2018%20GO%20156%20Leg%20Report%20Sept%201(2).pdf.
44 Ibid.
45 Ibid.
46 *Disadvantaged Business Enterprises.* California Department of Transportation. https://dot.ca.gov/programs/civil-rights/dbe.
47 Collier et al., supra note 6.
48 *The Economic Value of Offshore Wind Power in California.* Energy and Environmental Economics. August 2019. http://castlewind.com/wp-content/uploads/2019/08/2019-08-08_E3-CastleWind-OffshoreWindValueReport_compressed.pdf.
49 Ibid.
50 *The Economic Value of Offshore Wind Power in California*. Energy and Environmental Economics. August 2019. http://castlewind.com/wp-content/uploads/2019/08/2019-08-08_E3-CastleWind-OffshoreWindValueReport_compressed.pdf.
51 Presentation from Mark Kootstra, California Energy Commission, “SB 100 Analytical Approach,” Slide 32 source: TN232215_20200224T162627_SB 100 Joint-agency report overview and analytical approach - Staff present.pdf; E3 models : https://www.ethree.com/wp-content/uploads/2019/06/E3_Long_Run_Resource_Adequacy_CA_Deep-Decarbonization_Final.pdf.
AWEA-California Comments on SB 100 Inputs and Assumptions 3920. Source: TN232364_20200309T212314_AWEA-California Comments on SB 100 Inputs and Assumptions 3920.pdf.
CAISO has been supportive in identifying offshore and out-of-state wind resources as opportunities to reach SB 100 goals and should be incorporated in future modeled resource scenarios together. Source: Delphine Hou, CAISO, “Planning for reliability and resource adequacy under SB 100,” Slide 10.
52 *Matching time-of-use rate periods with Grid Conditions maximizes use of renewable resources.* California Independent System Operator. 2015. http://www.caiso.com/Documents/MatchingTimeOfUsePeriodsWithGridConditions-FastFacts.pdf.
53 Robert Collier. *High Road for Deep Water: Policy Options for a California Offshore Wind Industry.* UC Berkeley Labor Center, Green Economy Program. November 2017. http://laborcenter.berkeley.edu/pdf/2017/High-Road-for-Deep-Water.pdf.
54 Ibid.
55 *Offshore Wind Energy Development in Humboldt.* Redwood Coast Energy Authority. https://redwoodenergy.org/community-choice-energy/about-community-choice/power-sources/offshore-wind-energy/.
56 Energy and Environmental Economics, *supra* note 48.
57 *Turning Down the Gas in California: The Role of Natural Gas in the State’s Clean Electricity.* Union of Concerned Scientists. https://www.ucsusa.org/sites/default/files/attach/2018/07/Turning-Down-Natural-Gas-California-fact-sheet.pdf.
58 Ibid.
59 Ibid.
60 J. A. De Gouw, D. Parrish, G. Frost, M. Trainer. *Reduced emissions of CO2, NOx, and SO2 from US power plants owing to the switch from coal to natural gas with combined cycle technology. Earth's Future*, 2(2) (2014), pp. 75-82. https://www.scopus.com/record/display.uri?eid=2-s2.0-84906540227&origin=inward&txGid=89045a57fee3fd7861f3ffe136d596b2.
61 Elena M. Krieger, and Joan A. Casey, and Seth B.C. Shonkoff. *A framework for siting and dispatch of emerging energy resources to realize environmental and health benefits: Case study on peaker power plant displacement.* Energy Policy. Volume 96, September 2016, Pages 302-313. https://doi.org/10.1016/j.enpol.2016.05.049.
62 Union of Concerned Scientists, *supra* note 55.
63 De Gouw et al., *supra* note 58.
64 Living in a zip code containing a fuel-fired power plant increases the estimated rate of hospitalization by 11% for asthma, 15% for acute respiratory infection, and 17% for chronic obstructive pulmonary disease among individuals older than the age of ten.
X. Liu, L. Lessner, D.O. Carpenter. *Association between residential proximity to fuel-fired power plants and hospitalization rate for respiratory diseases.* Environ. Health Perspect., 120(6) (2012), p. 807. https://doi.org/10.1289/ehp.1104146.
Elena M. Krieger, and Joan A. Casey, and Seth B.C. Shonkoff. *A framework for siting and dispatch of emerging energy resources to realize environmental and health benefits: Case study on peaker power plant displacement.* Energy Policy. Volume 96, September 2016, pp. 302-313. https://doi.org/10.1016/j.enpol.2016.05.049.
Agostino Di Ciaula. *Emergency visits and hospital admissions in aged people living close to a gas-fired power plant.* European Journal of Internal Medicine. Volume 23, Issue 2, e53-e58, October 24, 2011. https://doi.org/10.1016/j.ejim.2011.09.013.
Frederica P. Perera. Multiple Threats to Child Health from Fossil Fuel Combustion: Impacts of Air Pollution and Climate Change. Environ Health Perspect. 2017 Feb; 125(2): 141–148. Jun 21, 2016. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5289912/#r58.
Avol EL, Gauderman WJ, Tan SM, London SJ, Peters JM. *Respiratory effects of relocating to areas of differing air pollution levels.* Am J Respir Crit Care Med. 2001; 164:2067–2072.
65 J.I. Levy, S.L. Greco, J.D. Spengle. *The importance of population susceptibility for air pollution risk assessment: a case study of power plants near Washington D.C*. Environ. Health Perspect., 110(12) (2002), p. 1253.
66 Ibid.
67 *Air pollution linked with higher COVID-19 death rates.* Harvard T.H. Chan School of Public Health. May 5, 2020. https://www.hsph.harvard.edu/news/hsph-in-the-news/air-pollution-linked-with-higher-covid-19-death-rates/.
68 From Brightline’s analysis based on data from CEC 2019 Annual Generation- Plant Unit report. https://ww2.energy.ca.gov/almanac/electricity_data/web_qfer/Annual_Generation-Plant_Unit_cms.php.
69 Figure 3 map and statistics generated based on Brightline’s GIS analysis of publicly available data sourced from California Energy Commission (CEC) 2019 Power Plant Generator Data (via ArcGIS Online) and 2019 CalEnviroScreen 3.0 data (via ArcGIS Online). CalEnviroScreen mapping tool incorporates cumulative environmental burden and socioeconomic data.
70 The CPUC considered “disadvantaged communities” those that are in the top 25th percentile of the CalEnviroScreen 3.0 (OEHHA 2017). Ibid.
71 Elena M. Krieger. *Natural gas power plants in California’s disadvantaged communities.* PSE Healthy Energy. April 2017 https://www.psehealthyenergy.org/wp-content/uploads/2017/04/CA.EJ_.Gas_.Plants.pdf.
72 R. Morello-Frosch, M. Pastor, J. Sadd. *Environmental justice and Southern California's “riskscape”: The distribution of air toxics exposures and health risks among diverse communities*. Urban Aff. Rev., 36(4) (2001), pp. 551-578.
L. Cushing, J. Faust, L.M. August, R. Cendak, W. Wieland, G. Alexeeff. *Racial/ethnic disparities in cumulative environmental health impacts in California: Evidence from a statewide environmental justice screening*

tool (CalEnviroScreen 1.1). Am. J. Public Health, 0(2015), pp. e1-e8.
Michelle L. Bell, Antonella Zanobetti, Francesca Dominici. *Who is more affected by ozone pollution? A systematic review and meta-analysis.* Am. J. Epidemiol. 180(1) (2014), pp. 15–28.
J.I. Levy, S.L. Greco, J.D. Spengle. *The importance of population susceptibility for air pollution risk assessment: A case study of power plants near Washington D.C*. Environ. Health Perspect., 110(12) (2002), p. 1253.
73 Union of Concerned Scientists, *supra* note 55.
74 Alan Neuhauser. *Where Batteries Are Replacing Power Plants.* US News. May 21, 2019 https://www.usnews.com/news/national-news/articles/2019-05-21/why-california-nixed-a-natural-gas-power-plant-in-favor-of-batteries.
75 Ibid.
76 *Turning Down the Gas in California: The Role of Natural Gas in the State's Clean Electricity.* Union of Concerned Scientists https://www.ucsusa.org/sites/default/files/attach/2018/07/Turning-Down-Natural-Gas-California-fact-sheet.pdf.
77 *Climate Change Impacts in California.* Office of the Attorney General: California Department of Justice. https://oag.ca.gov/environment/impact. (last accessed May 20, 2020).
78 *Environmental Impacts of Wind Power.* Union of Concerned Scientists. March 5, 2013. https://www.ucsusa.org/resources/environmental-impacts-wind-power.
79 *California Offshore Renewable Energy: BOEM California Intergovernmental Renewable Energy Task Force Bureau of Ocean Energy Management* (BOEM). https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/CA/BOEM-Offshore-Renewables-Factsheet--02-22-17.pdf.
80 Collier, Robert, Sanderson Hull, Oluwafemi Sawyerr, Shenshen Li, Manohar Mogadali, Dan Mullen, and Arne Olson. *California Offshore Wind: Workforce Impacts and Grid Integration*. Center for Labor Research and Education, University of California, Berkeley. September 2019. http://laborcenter.berkeley.edu/ offshore-wind-workforce-grid.
81 Ibid.
82 Humboldt Bay and Humboldt Bay Harbor, Recreation and Conservation District. "RMT 1 Multipurpose Dock RFP Final." August 23, 2019, 1, http://humboldtbay.org/sites/humboldtbay2.org/files/RMT%20I%20Multipurpose%20Dock%20RFP%20final%208-20-19_reduced.pdf.
83 Collier et al., *supra* note 6.
84 Ibid.
85 Energy and Environmental Economics, *supra* note 48.
86 David Iaconangelo. *Deal emerges to bring 1st offshore wind farms to Calif.* E&E News. Feb 20, 2020. https://www.eenews.net/stories/1062398125
87 Hamilton, J. & Liming, D. *Careers in Wind Energy : U.S. Bureau of Labor Statistics*. https://www.bls.gov/green/wind_energy/ (2010). American Jobs Project, *supra* note 2.
88 Collier et al., *supra* note 6.
89 Ibid.
90 Ibid.
91 Ibid.
92 New York , Massachusetts, Virginia, Connecticut, New Jersey, Maryland, and Rhode Island have all made offshore wind commitments totaling 20 GW by 2030. California has the opportunity to pioneer the offshore floating wind industry, and become a global exporter of manufactured floating wind technology. Ibid.
93 Ibid.
94 Collier et al., *supra* note 6.
95 Ibid.
96 Dvorak et al., *supra* note 3.
97 Yi-Hui Wang, Ryan K Walter, Crow White, Matthew D Kehrli, Stephen F Hamilton, Patrick H Soper, and Benjamin I Ruttenberg. *Spatial and temporal variation of offshore wind power and its value along the Central California Coast.* 1-12 Env. Resrch. Comm. (2019).
https://iopscience.iop.org/article/10.1088/2515-7620/ab4ee1#acknowledgements.