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Additional submitted attachment is included below.

July 5, 2018

California Energy Commission
Dockets Office, MS-4
1516 Ninth Street
Sacramento, CA 95814-5512

Re: Docket No. 18-IEPR-06 / Comments of Trident Winds LLC and EnBW on June 20, 2018, Workshop on Renewable Integration and Electric System Reliability

Dear Commissioners:

Trident Winds LLC (Trident)[1] and its joint-venture partner, EnBW, submits these comments to highlight the integration, resiliency, and reliability benefits of offshore wind.[2] These benefits are substantial but have not been considered by the Commission in prior iterations of the Integrated Energy Policy Report (IEPR). The potential advantages of offshore wind are considerable and should be incorporated into future analyses and reports.

I. Resource Profile

Unlike other renewable, zero-emissions resources, offshore wind has a 24-hour generation profile that "closely resembles" California's load curve.[3] Specifically, offshore wind peaks in the afternoon and evening when California is beginning its evening ramp. Wind speeds are significantly higher and more consistent than inland winds, which results in a 24-hour production profile that is largely flat with an average peak-to-trough difference of only 15%. These attributes increase generation potential.[4] Though seasonal variation is limited, generation potential is greatest in late spring.

[1] Trident is an offshore wind project development company and was the first to apply for a lease to construct an offshore wind facility in California. It is one of the few developers with expertise in the technological and operational capabilities needed to develop California's offshore wind resources. Trident is in the early stages of developing a utility-scale offshore wind project off the coast of Morro Bay with EnBW, its joint venture partner, with an operational date of 2025.

[2] There are two broad categories of platform used to support offshore wind turbines: fixed-bottom and floating. Fixed-bottom platforms are anchored to the seabed. The vast majority of California's wind resources, however, are located over water too deep to affix the platform to the seabed; platforms must float instead. These comments describe offshore wind in general terms, as floating and fixed-bottom cost and performance should converge over time.

[3] BOEM, *Evaluating Benefits of Offshore Wind Energy Projects in NEPA*, 3-17 (2017) (BOEM 2017) (discussing offshore wind generally); Walter Musial et al., NREL, *Potential Offshore Wind Energy Areas in California: An Assessment of Locations, Technology, and Costs*, 3 (2016) (NREL 2016) (describing California's "diurnal characteristics that are complementary to the state's solar resource, where the average peak generation occurs at the end of the day and evening. . . . [and] could potentially enable higher penetrations of renewable energy").

[4] Walter Musial et al., NREL, *Energy from Offshore Wind*, 2 (2006).

California's offshore wind resources have the potential to provide "reliable [and] unconstrained capacity."[5] Overall generation potential is 112 GW,[6] as determined by a recent study prepared by the Department of Energy's National Renewable Energy Laboratory (NREL) at the request of the Bureau of Ocean Energy Management (BOEM). The study identifies six sites that could sustain a major commercial offshore wind project using available technology.[7] These sites have a potential capacity of at least 15 GW. If half of that capacity were installed, the sites would generate 35 TWh/year—approximately 13% of California's annual electric consumption.[8]

II. System Benefits

The Commission, California Independent System Operator (CAISO), and California Public Utilities Commission (CPUC) are exploring policies to integrate renewables, increase system resiliency, and ensure reliability.[9] These policies include:[10]

- Increasing the diversity of resources.
- Enhancing the performance of renewable resources.
- Using renewable resources to provide reliability services.
- Improving the integration of renewables and reducing curtailment.
- Optimizing the charging of electric vehicles.

Offshore wind can significantly support all of these policies.

A. Diversity and Integration

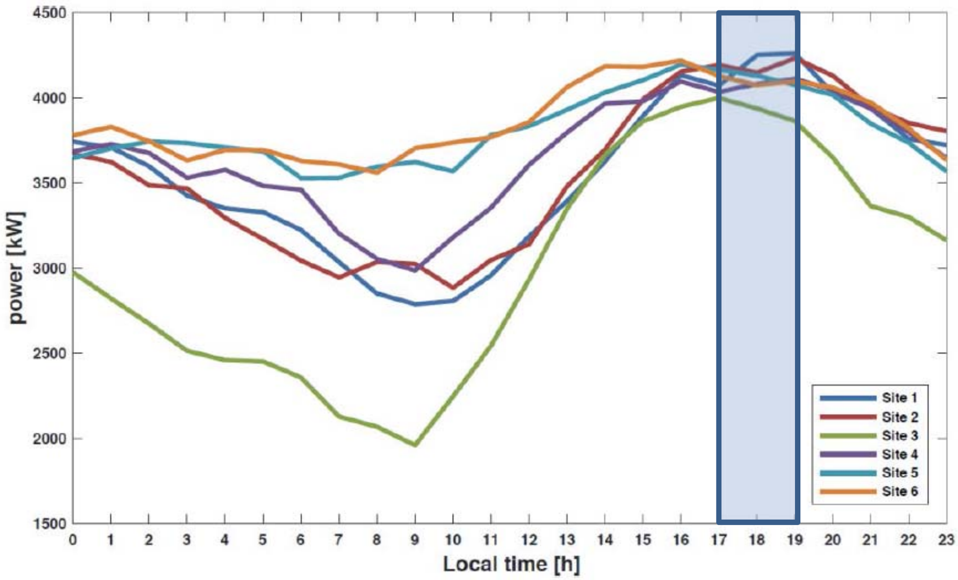
Offshore wind is an abundant renewable energy resource with a high capacity factor and a production profile that is complementary to solar. These diversity and integration benefits are visualized by the two charts presented on the following page and explained below.

The first chart shows the predicted generation profiles for March 31 for the six offshore sites identified by NREL. The March date is often used by CAISO to depict the duck curve at its most extreme, when spring weather—clear skies, longer days, and more sunlight—causes solar oversupply conditions and curtailment. The same weather, however, decreases electric demand by reducing the need for either air conditioning or heating.

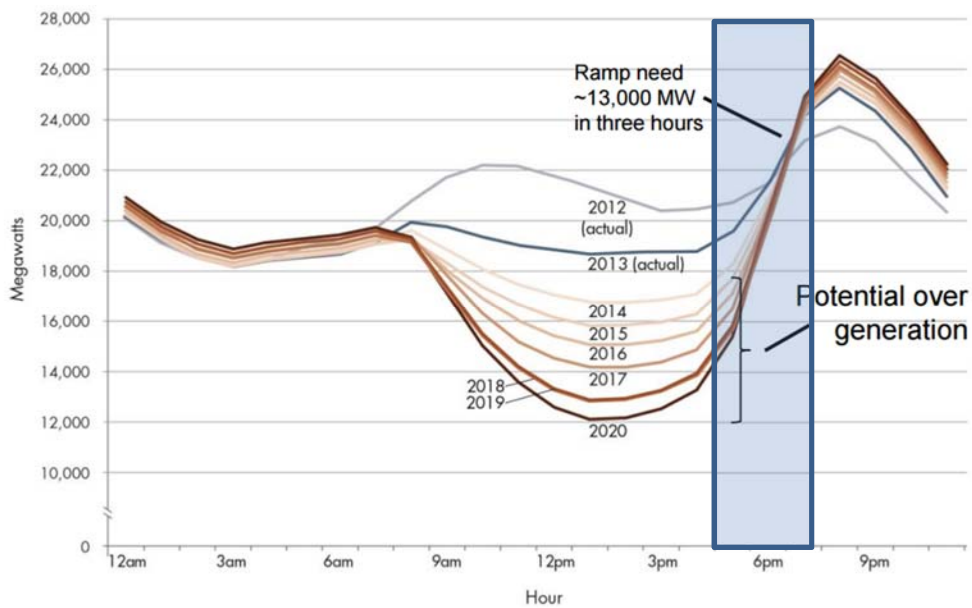
The second chart shows California's hourly net load on the same date. When compared, the charts reveal that the peak in offshore wind generation closely matches the increase in net load. The two-hour period from 5:00 p.m. to 7:00 p.m. is highlighted in blue for emphasis. By

[5] BOEM 2017 at 3-17.
[6] NREL 2016 at 5, 56.
[7] *Id.* at vi–vii, 5.
[8] *Id.* at 57.
[9] Clyde Loutan, CAISO, *Renewable Integration Update*, 17–24 (June 20, 2018) (Integration Update); CEC, *2017 Integrated Energy Policy Report*, 106 (2017) (2017 IEPR).
[10] Energy+Environmental Economics, *Deep Decarbonization in a High Renewables Future—Implications for Renewable Integration and Electric System Flexibility*, 15 (June 20, 2018).

integrating solar with offshore wind, California could reduce the magnitude of the evening ramp while also reducing emissions from thermal plants.



Diurnal power output for single 6-MW offshore wind turbine in sample month of March[11]



CAISO average net electric load (March 31), GW[12]

[11] NREL 2016 at 28 (blue overlay added).
[12] CAISO 2015 (blue overlay added).

All six sites peak in the late afternoon and early evening, and some—especially sites 5 and 6—are predicted to provide very stable 24-hour generation profiles. The charts confirm that the peaks in offshore wind production closely correlate with California's evening ramp, though production is mostly flat otherwise. The consistency of offshore wind generation could help reduce midday oversupply, while the afternoon and evening peak provides predictable, zero-emissions capacity during the evening ramp.

The capacity factor of offshore wind also improves the integration of intermittent renewable resources. From 2015 to 2027, the gross capacity factor of offshore wind should increase from roughly 60% to as much as 73%.[13] These values are superior to the capacity factors of many candidate resources being considered for procurement through Integrated Resources Planning at the CPUC.[14] At 73%, offshore wind exceeds most forms of renewable energy and compares favorably with baseload resources such as natural gas.

Comparison of Capacity Factors by Resource Type[15]		
Resource Type	Net Capacity Factor (%)	Potential to Add In-State Capacity
Nuclear	92.2	No
Geothermal	76.4	Limited
Landfill Gas/Municipal Solid Waste	70.9	Limited
Offshore Wind	**65.0+**	**Substantial**
Natural Gas - Combined Cycle	54.8	No
Coal	53.5	No
Other Biomass	50.7	Limited
Inland Wind	36.7	Limited
Solar Photovoltaic	27.0	Substantial
Solar Thermal	21.8	Limited
Natural Gas - Steam Turbine	11.3	No
Natural Gas - Combustion Turbine	9.4	No

A high capacity factor increases offshore wind's capacity value as well as the ability of both offshore wind and other renewables to ensure resource adequacy. This ability, combined with the afternoon and evening peak, further enables offshore wind to reduce curtailment, offset reductions in baseload capacity, and decrease emissions from fast ramping thermal plants.

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[13] NREL 2016 at 32 (noting, at 25, that model may have over-selected for gross capacity factor).
[14] Energy and Environmental Economics, Inc., *RESOLVE Model Documentation (Inputs & Assumptions)*, 54-55 (2017).
[15] https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_a.

Offshore wind itself can be integrated with very little curtailment—in the United Kingdom, for example, curtailment rates are less than 1% and can even reach zero.[16]

B. Reliability

The stability and complementarity of offshore wind can provide critical reliability benefits, which will become increasingly important in the near-future. According to CAISO, ramp rates are increasing faster than anticipated,[17] the three-hour and one-hour net load ramps are rising in both magnitude and steepness,[18] and afternoon net load is moving in the opposite direction faster than anticipated.[19] At the same time, California's phase-out of once-through-cooling will result in the retirement of 6,200 MW of capacity by the end of 2020, and more retirements are expected because of the deteriorating economics of natural gas facilities.[20] Despite these loses, only 1,800 MW of new ramping ability will be added by 2020.[21]

The loss of these resources will be compounded by the increased installation of rooftop and utility-scale solar in California. California is expected to install approximately 9,700 MW of rooftop solar[22] and approximately 9,000 MW of utility-scale solar by 2030.[23] The addition of 18,000 to 20,000 MW of solar generation makes it essential to add diversity. Offshore wind, with its unique generation profile, offers the Commission a new and important resource to help satisfy the need for diversity and reliability.

C. Resiliency

Offshore wind can increase resiliency, capacity, and locational value by combining utility-scale facilities with decentralization. Typically, wind and solar resources require significant transmission capacity to wheel power to distant load centers.[24] Offshore wind facilities, however, can avoid congestion and eliminate the need for transmission upgrades by siting close to load centers.[25] Marine wind speeds rapidly increase with distance from shore, which, depending on the local wind resources, could allow a 1,000 MW facility with a high capacity factor to be sited only a dozen miles from a metropolitan load center. This location flexibility allows offshore wind to defer or avoid transmission upgrades and benefit from the increased locational value created by congestion. In part for these reasons, from 2007-2016, the value of East Coast offshore wind reached $110/MWh with a capacity value exceeding inland wind by $6/MWh-$20/MWh.[26]

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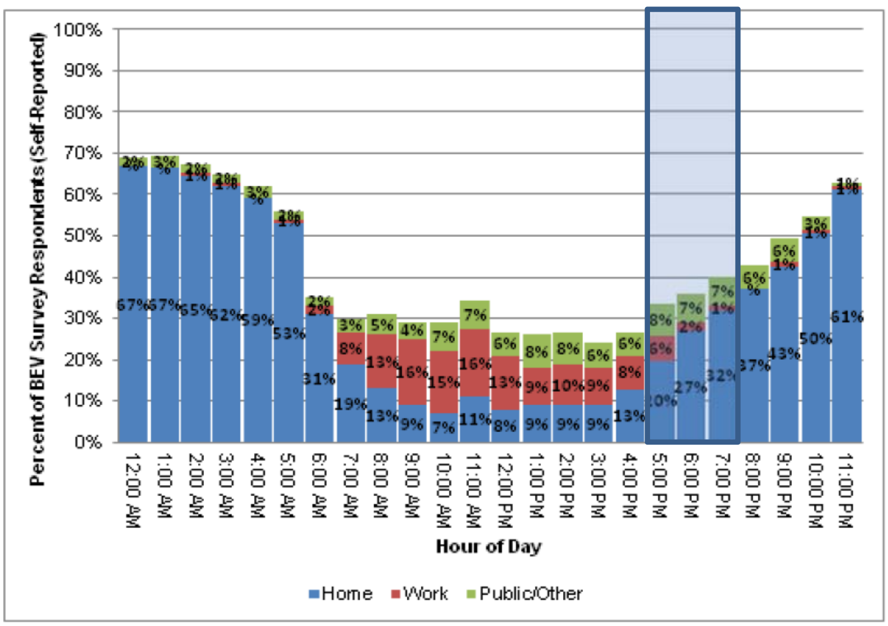
[16] Michael Joos and Iain Staffell, *Short-term integration costs of variable renewable energy: Wind curtailment and balancing in Britain and Germany*, Renewable and Sustainable Energy Reviews, Vol. 86, 45–65 (2018).
[17] Integration Update at 13; 2017 IEPR at 8, 99.
[18] 2017 IEPR at 102.
[19] *Id.* at 97–103.
[20] *Id*. at 115–16
[21] CAISO, *2018-2019 TPP Assumptions and Study Plan*, 21 (2018) (Table 4.7-5).
[22] 2017 IEPR at 101–02.
[23] CPUC, *Proposed Reference System Plan*, 9 (2017).
[24] BOEM 2017 at 3-19.
[25] *Id.* at 3-10.
[26] Andrews D. Mills et al., Lawrence Berkeley Nat'l Lab., *Estimating the Value of Offshore Wind Along the United States' Eastern Coast*, 9 (2018).

The first 2 to 3 GW of California offshore wind can serve in-state load using the existing transmission system. Offshore wind can take advantage of newly-available transmission capacity from the shutdown of natural gas and nuclear plants. As noted above, 6,200 MW of existing capacity will retire by 2020 as a result of California's phase-down of once-through cooling. California will also lose another 2,200 MW from the shutdown of the Diablo Canyon nuclear plant.[27] By relying on underutilized transmission assets and replacing the generation of retired plants, offshore wind can both avoid the expense of transmission upgrades as well as reduce stress on the grid by replicating the power flows for which the transmission assets were originally designed.

D. Electrification

Offshore wind can also play a key role in California's electrification of the transportation sector. A key integration solution will be increased demand-shifting, particularly for electric vehicle (EV) charging. Most EVs charge at home, which results in a significant increase in load as solar generation drops off. Offshore wind can help meet the ramping demands of EV charging. The following chart highlights EV charging demand for the three-hour period from 5:00 p.m. to 8:00 p.m., precisely when offshore wind is ramping up. Although offshore wind does not have the same load profile as EV charging, it could reduce overall ramping needs.



Plug-In Times and Locations of Battery Electric Vehicles for Personal Use[28]

[27] 2017 IEPR at 117.
[28] *Id.* at 133.

E. Other Benefits

In addition to statewide economic benefits such as reduced energy prices, offshore wind facilities will create jobs and businesses that provide direct economic benefits to local communities. The offshore wind industry requires a unique manufacturing, engineering, and logistics ecosystem to produce and install offshore wind platforms. NREL estimates, for example, that by 2030, offshore wind could produce approximately 5,800 construction jobs and 700 operations jobs in California.[29] The Commission should consider these additional benefits in future studies and policy decisions.

III. Request

Given its abundance and unique generation profile, offshore wind provides the Commission with a novel and potentially powerful tool to meet California's energy and climate change goals. Offshore wind should therefore be considered in subsequent studies performed by the Commission. Trident looks forward to assisting with these issues, especially the inclusion of offshore wind in future revisions of the IEPR.

Very truly yours,
Alla Weinstein

[29] Bethany Speer et al., NREL, *Floating Offshore Wind in California: Gross Potential for Jobs and Economic Impacts from Two Future Scenarios*, v, 15 (2016).