# California Energy Commission, California Public Utilities Commission, and California Air Resources Board

## SB100 Technical Workshop

Presentation by Adam Stern, Executive Director
Offshore Wind California

San Francisco, CA
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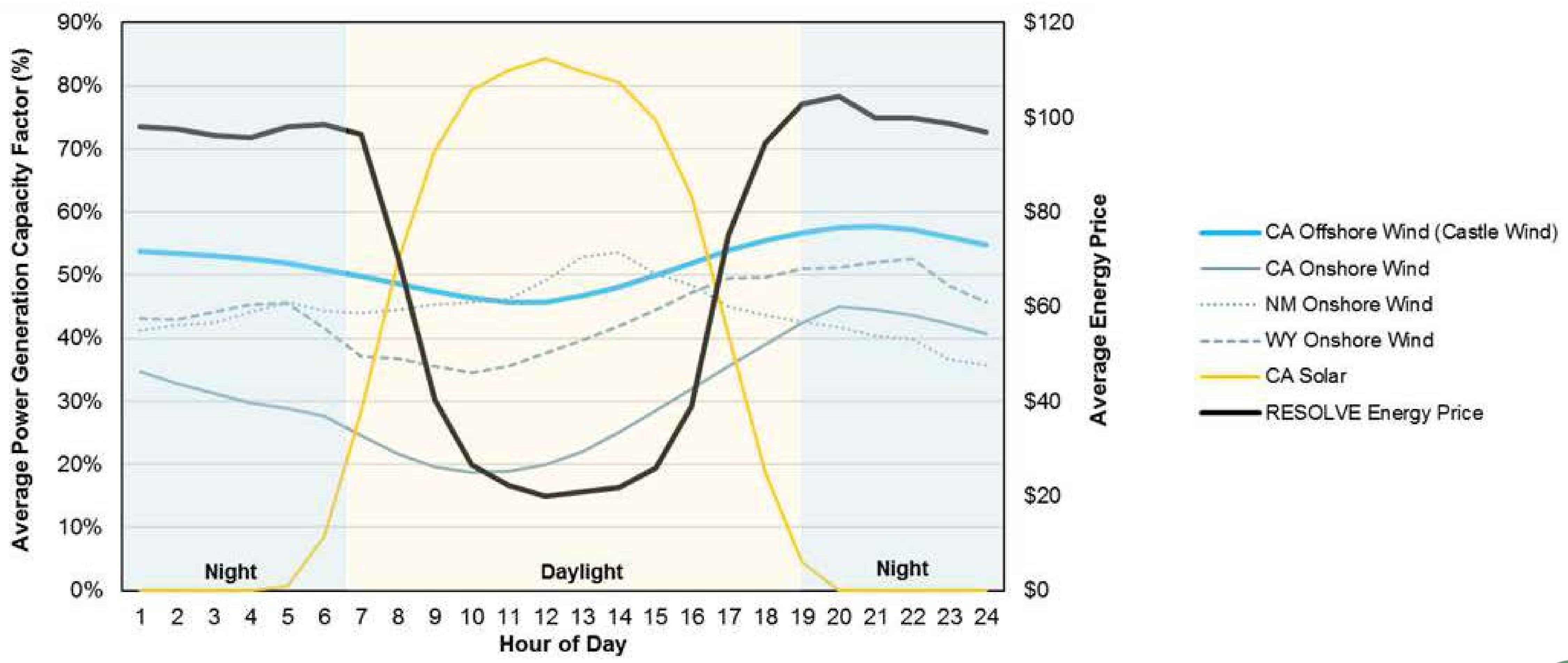
# Offshore Wind Generation Profile Relative to Alternatives, 2030




Source: The Economic Value of Offshore Wind Power in California, E3, August 2019, p. 21

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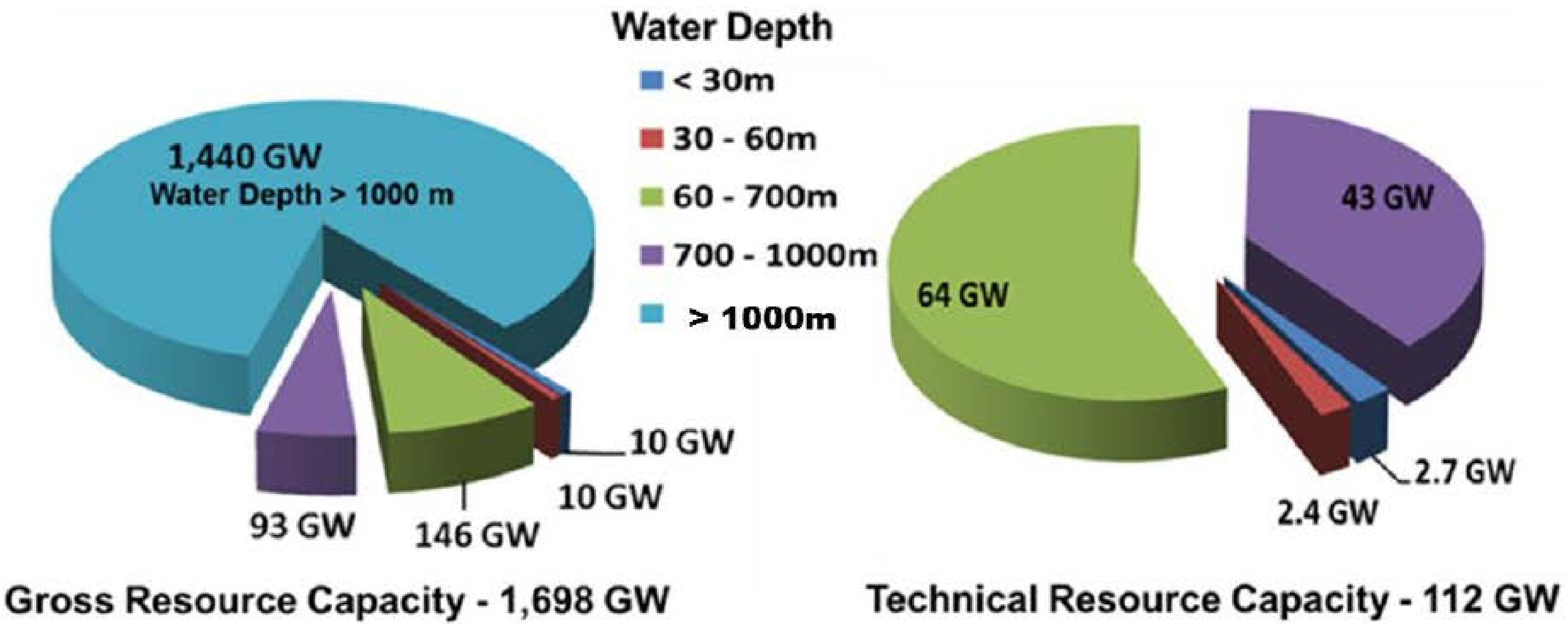
# California's Offshore Technical Resource Capacity is 112 GW




Source: Potential Offshore Wind Energy Areas in California: An Assessment of Locations, Technology, and Costs, Walter Musial, et. al., National Renewable Energy Laboratory, December 2016, p. 7.

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# Offshore Wind Call Areas in Northern and Central


Source: Bureau of Ocean Energy Management

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# Offshore Wind Potential from 5 Sites in California

| Offshore Wind Resource Zone | Resource Potential Area (Sq. km) | Resource Potential (MW) |
|---|---|---|
| Del Norte | 2,201 | 6,604 |
| Cape Mendocino | 2,072 | 6,216 |
| Diablo Canyon | 1,441 | 4,324 |
| Morro Bay | 806 | 2,419 |
| Humboldt Bay | 536 | 1,607 |
| **Total** | **7,051** | **21,171** |

Source: California Offshore Wind: Workforce Impacts and Grid Integration, UC Berkeley Labor Center and E3, September 2019, p. 57.

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# Floating Foundation Technology – Projected Deployments before 2022

| Technology Developer | Design Name | Class | Location | Commision-Decommission Dates | Number of Foundations | Total Capacity MW |
|---|---|---|---|---|---|---|
| Equinor | Hywind 1 | Spar | Norway | 2009- | 1 | 2.3 |
| Principle Power | WindFloat 1 | Semi-Sub | Portugal | 2011-2016 | 1 | 2 |
| Toda | Hybrid Spar | Spar | Japan | 2013- | 1 | 2 |
| Fukushima Consortium | Mirai | Semi-Sub | Japan | 2013- | 1 | 2 |
| Fukushima Consortium | Shinpuu | Semi-Sub | Japan | 2015- | 1 | 7 |
| Fukushima Consortium | Hamakaze | Adv. Spar | Japan | 2016- | 1 | 5 |
| Statoil | Hywind 2 | Spar | Scotland | 2017- | 5 | 30 |
| IDEOL | Floatgen 1 | Barge | France | 2018- | 1 | 2 |
| IDEOL | Hibiki | Barge | Japan | 2019- | 1 | 2 |
| Principle Power | WindFloat | Semi-Sub | Portugal | 2019 (est.) - | 3 | 25 |
| Stiesdal | TetraSpar | Spar | Norway | 2020 (est.) - | 1 | 3.6 |
| Principle Power | Windfloat | Semi-Spar | Scotland | 2020 (est.) - | 6 | 50 |
| Hexicon | Tri | Semi-Sub | Scotland | 2020 (est.) - | 1 | 10 |
| IDEOL | Floatgen 2 | Barge | France | 2021 (est.) - | 4 | 25 |
| Eolfi | Naval Energies | Semi-Sub | France | 2021 (est.) - | 4 | 24 |
| Principle Power | WindFloat | Semi-Sub | France | 2021 (est.) - | 3 | 24 |
| SBM | SBM | TLP | France | 2021 (est.) - | 3 | 24 |
| Equinor | Hywind 3 | Spar | Norway | 2022 (est.) - | 8 | 88 |

Source: 2018 Offshore Wind Technologies Market Report, U.S. Department of Energy, and offshore wind trade press reports.

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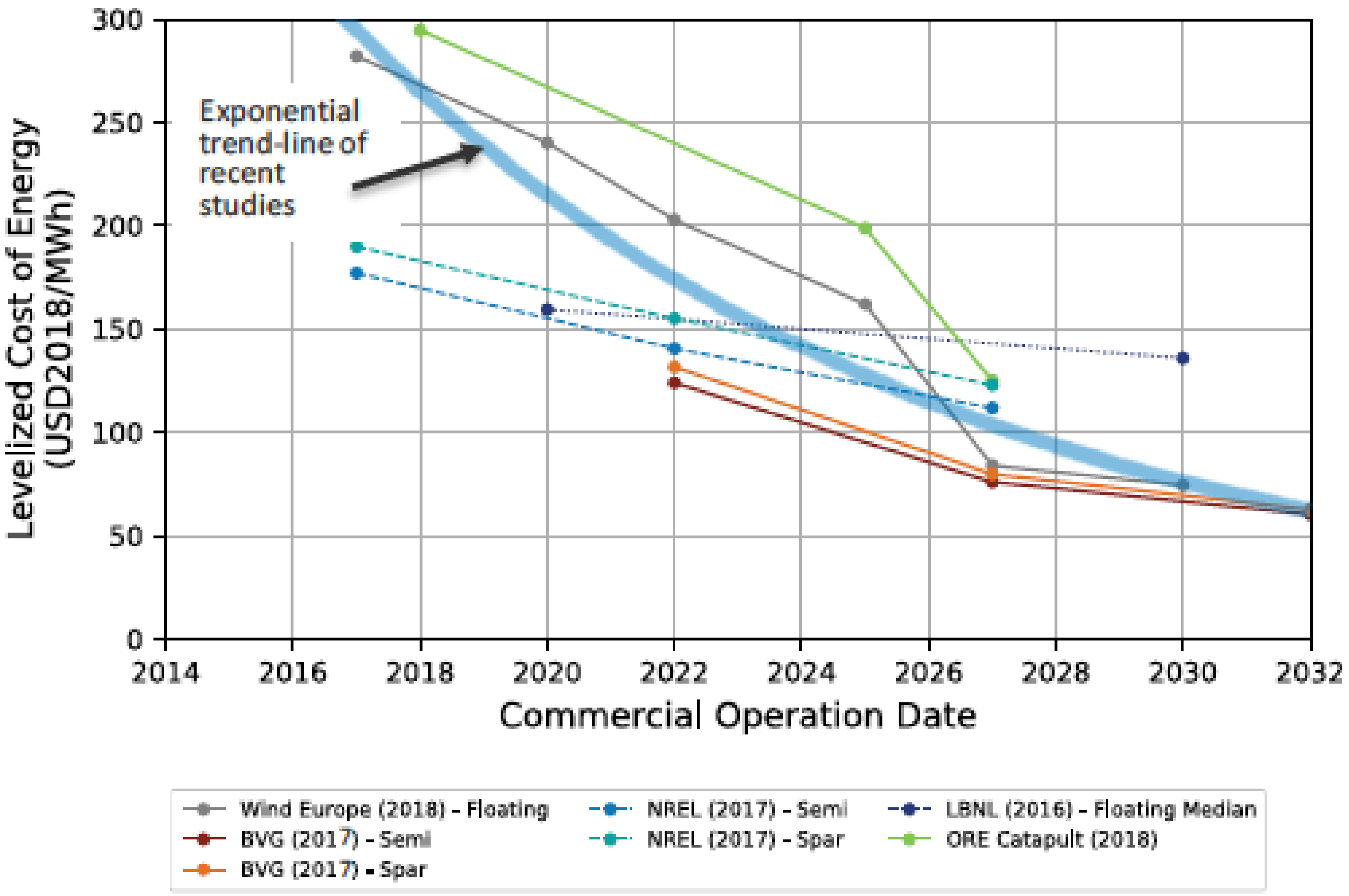
# Cost Trends for Global Levelized Cost of Energy Estimates for Floating Technology




Source: 2018 Offshore Wind Technologies Market Report, U.S. Department of Energy, p. 64.

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# Comparison of Costs and Transmission Availability for 2030 by California Zone

| Offshore Wind Resource Zones | Simulated Capacity Factor | Average Avoided Costs 2030-50 LACE, 2 GW scale* | 2025-2030 Cost Range LCOE, NREL ATB+E3 | Transmission Availability (MW) |
|---|---|---|---|---|
| Morro Bay | 55% | $80/MWh | $62 to $72/MWh | 668 |
| Diablo Canyon | 46% | $81/MWh | $74 to $88/Gh | 3,933 |
| Humboldt Bay | 51% | $88/MWh | $66 to $78/MWh | Minimal |
| Cape Mendocino | 53% | $82/MWh | $65 to $76/MWh | Minimal |
| Del Norte | 51% | $83/MWh | $66 to $78/MWh | Minimal |

**Each zone contains 1.6 to 6.6 GW of offshore wind potential. Offshore wind zones were modeled at the 2 GW scale to compare economics of a substantial or complete build-out of the resource potential in each zone.*

Source: California Offshore Wind: Workforce Impacts and Grid Integration, UC Berkeley Labor Center and E3, September 2019, p. 8.

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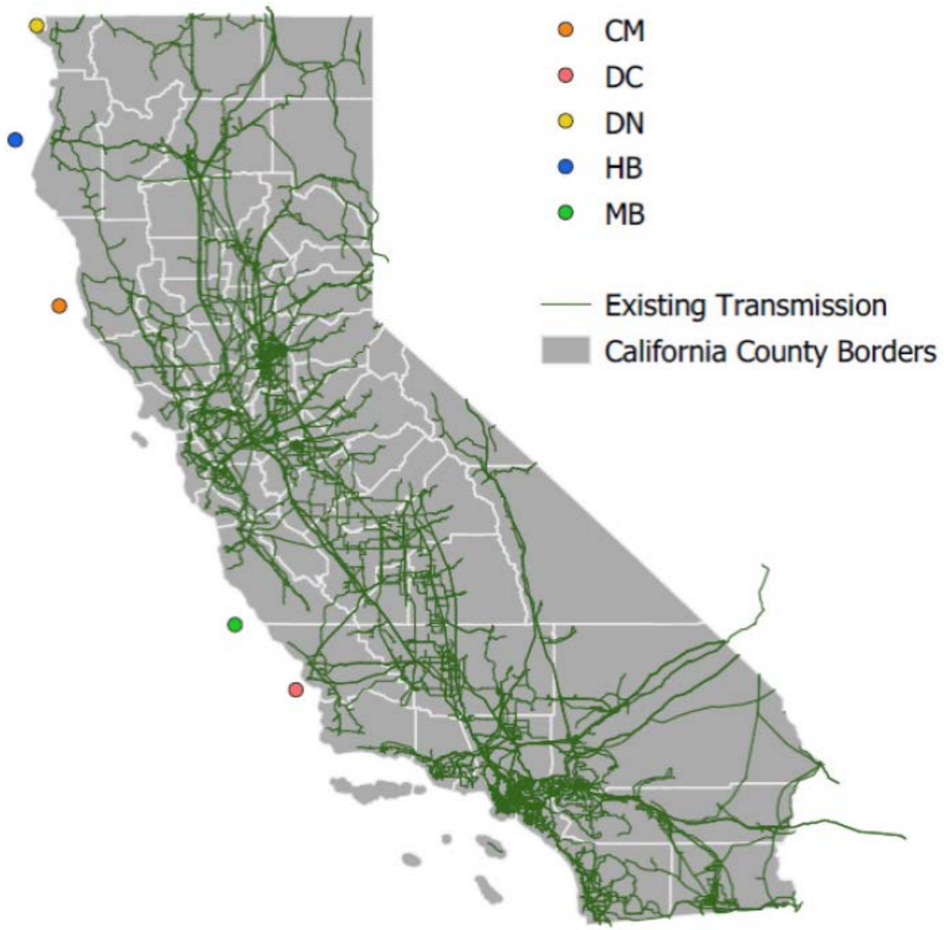
# Barriers to Scaling of Offshore Wind in California




- Transmission capacity not matched with best offshore wind resources
- Potential conflicts with Department of Defense activities in central California
- Need for creditworthy off-takers for large procurements
- Permitting roadmap

Source: Offshore Wind: Workforce Impacts and Grid Integration, UC Berkeley Labor Center and E3, p. 58

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