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California Energy Commission, California Public Utilities Commission, and California Air Resources Board
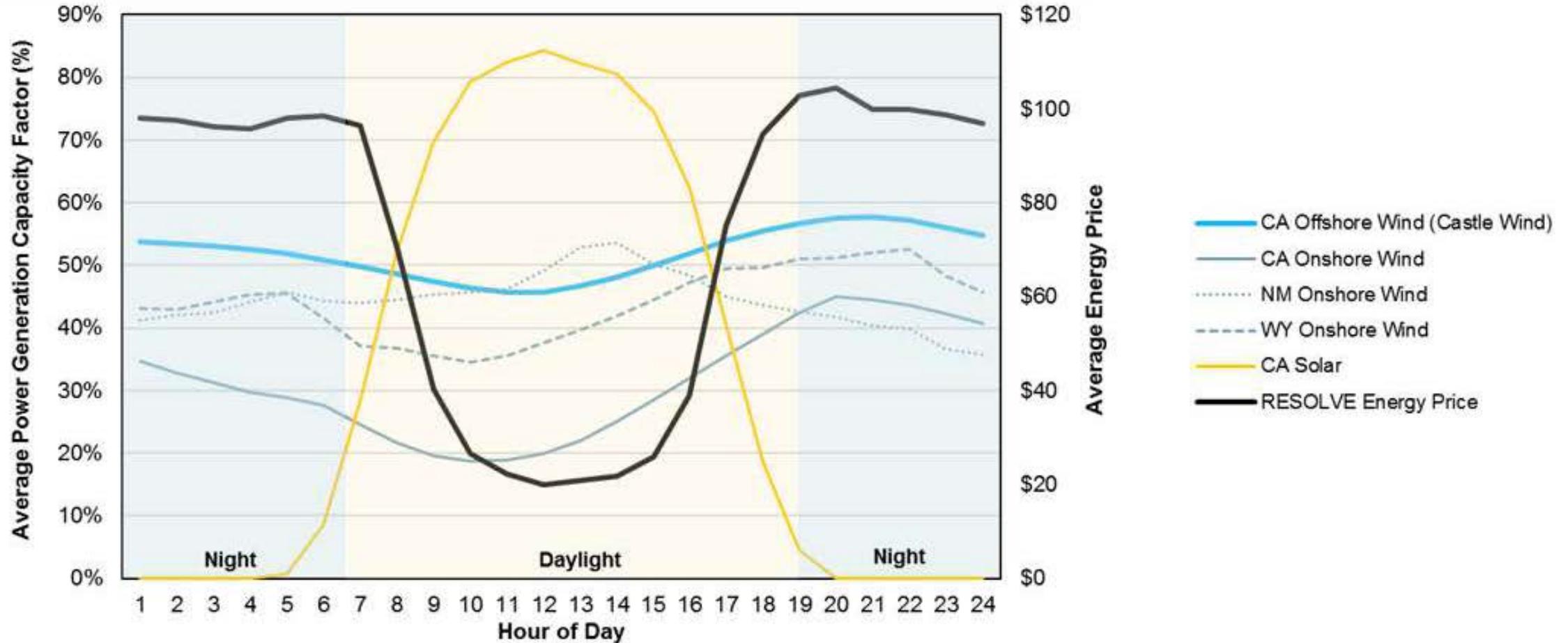
SB100 Technical Workshop

Presentation by Adam Stern, Executive Director
Offshore Wind California
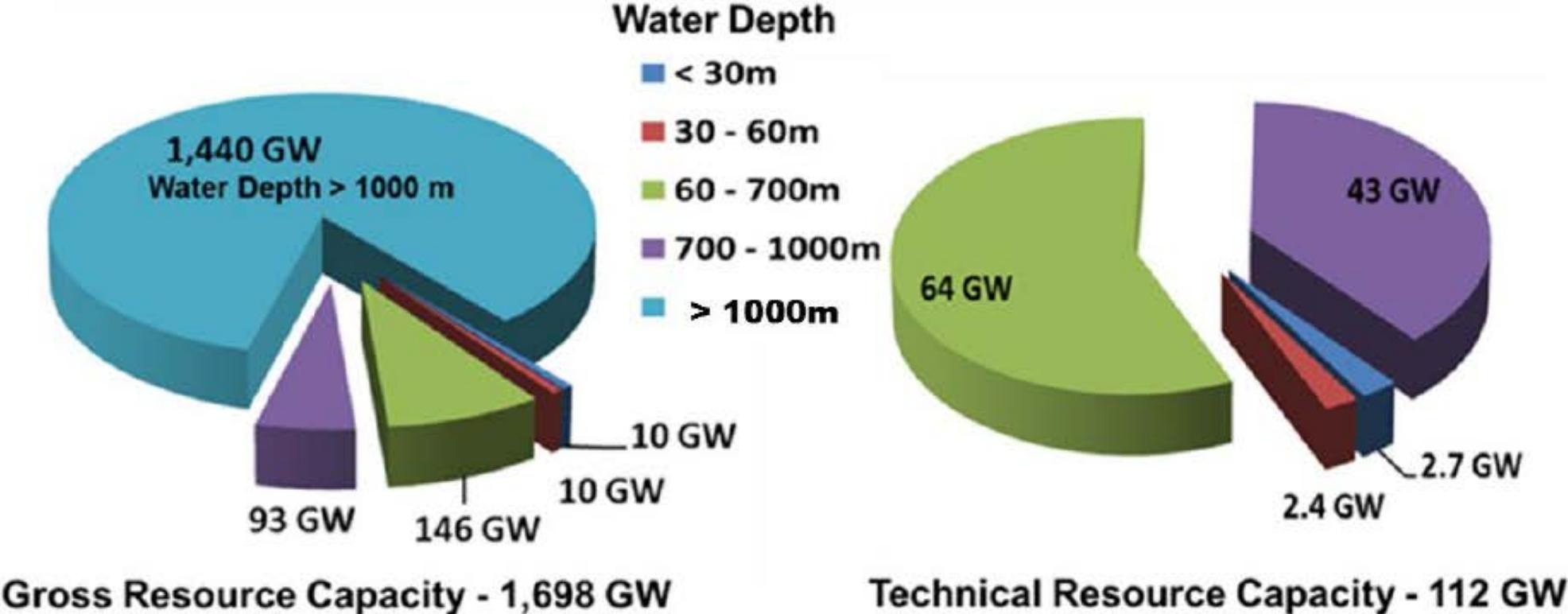
San Francisco, CA
November 18, 2019

Offshore Wind Generation Profile Relative to Alternatives, 2030

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.

CALIFORNIA OFFSHORE WIND CALL AREAS

The Bureau of Ocean Energy Management (BOEM) has designated three Call Areas for development of offshore wind power off the north and central coast of California.

- **Humboldt**
- **Morro Bay**
- **Diablo Canyon**

- Eureka

Humboldt Call Area

- San Francisco

Morro Bay Call Area

- Morro Bay

Diablo Canyon Call Area

- Los Angeles

More information at: https://www.boem.gov/California/

Offshore Wind
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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**

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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
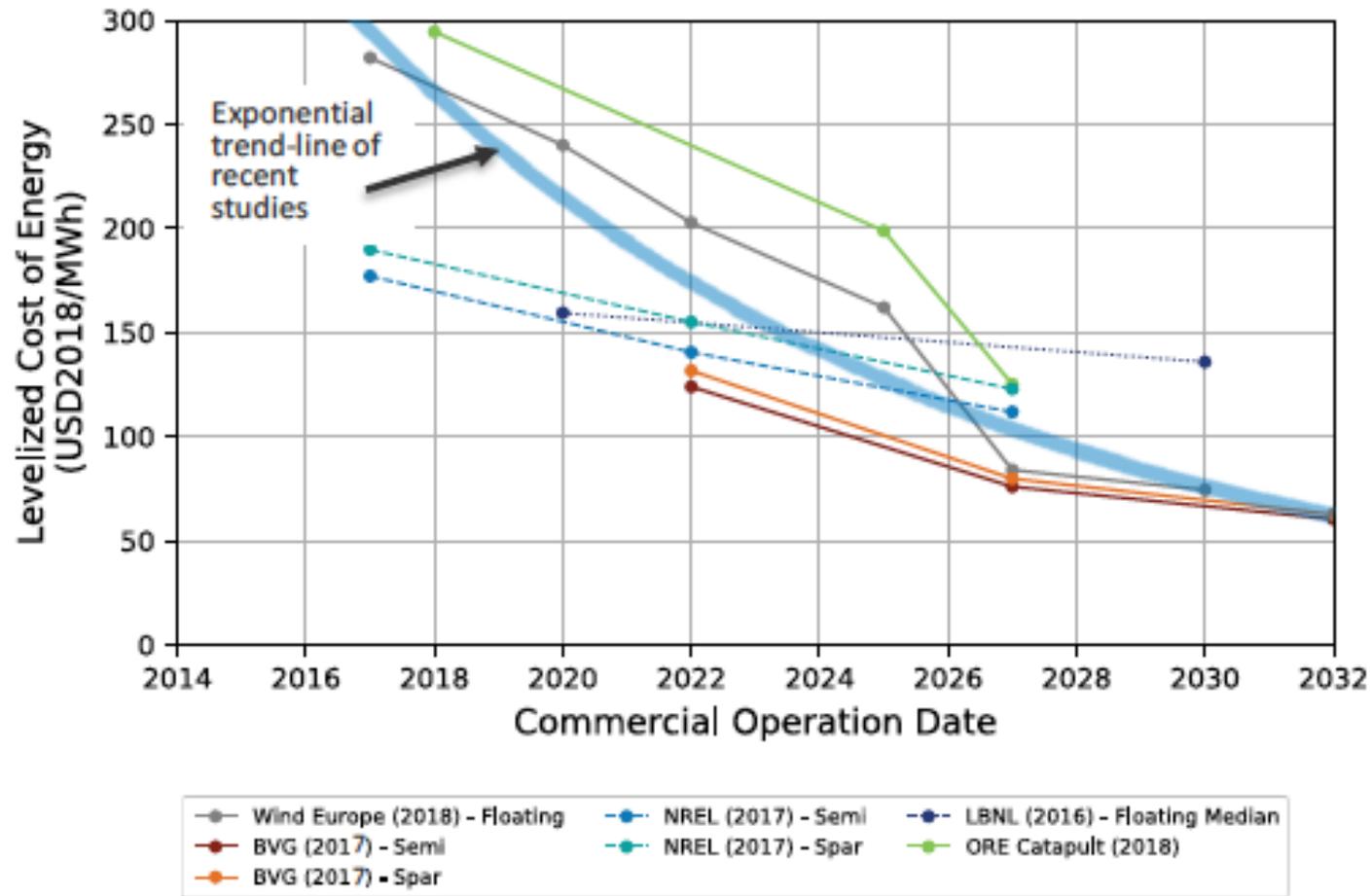
Source: 2018 Offshore Wind Technologies Market Report, U.S. Department of Energy, p. 64.
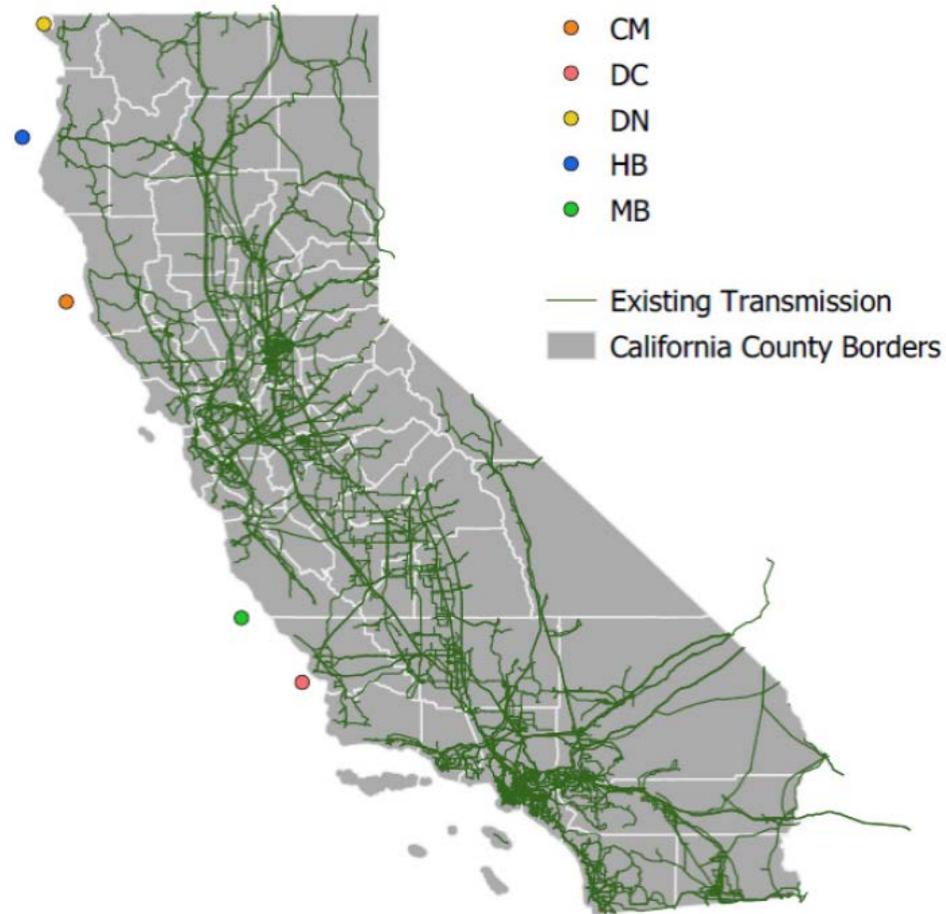
Comparison of Costs and Transmission Availability for 2030 by California Zone

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.

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Barriers to Scaling of Offshore Wind in California

Legend:
- CM (orange)
- DC (pink)
- DN (yellow)
- HB (blue)
- MB (green)

— Existing Transmission
⬛ California County Borders

- 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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