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The Role of Wind in California's 100% Clean Energy Portfolio

Northern California SB 100 Scoping Workshop
Redding, CA
October 25, 2019

AWEA® AMERICAN WIND ENERGY ASSOCIATION

California Wind Power – Past and Present

Wind Projects

Installed Wind Capacity (MW):	**5,840 MW**
State Ranking for Installed Capacity:	**4th**
Wind Projects Online:	**105**
Number of Wind Turbines:	**6,574**
Under Construction Wind Capacity:	**0 MW**
Advanced Development Wind Capacity:	**384 MW**

2018 Wind Generation

Share of In-State Energy Production:	**6.5%**
Equivalent U.S. Homes Powered:	**1,312,500**

2018 Jobs & Economic Benefits

Direct Wind Industry Employment:	**4,001 to 5,000**
Wind-related Manufacturing Facilities:	**13**
Cumulative Wind Project Investment:	**$14.8 billion**
Annual State and Local Tax Payments by Wind Projects:	**$87.5 million**
Annual Land Lease Payments:	**$15 - $20 million**

2018 Environmental Benefits

Annual Water Savings:	**2.9 billion gallons**
Equivalent Bottles of Water Saved:	**22 billion**
Annual CO2 Emissions Avoided:	**6.7 million metric tons**
Cars' Worth of Emissions Avoided:	**1.4 million**

Source: AWEA California Fact Sheet 2019: https://www.awea.org/resources/fact-sheets/state-facts-sheets

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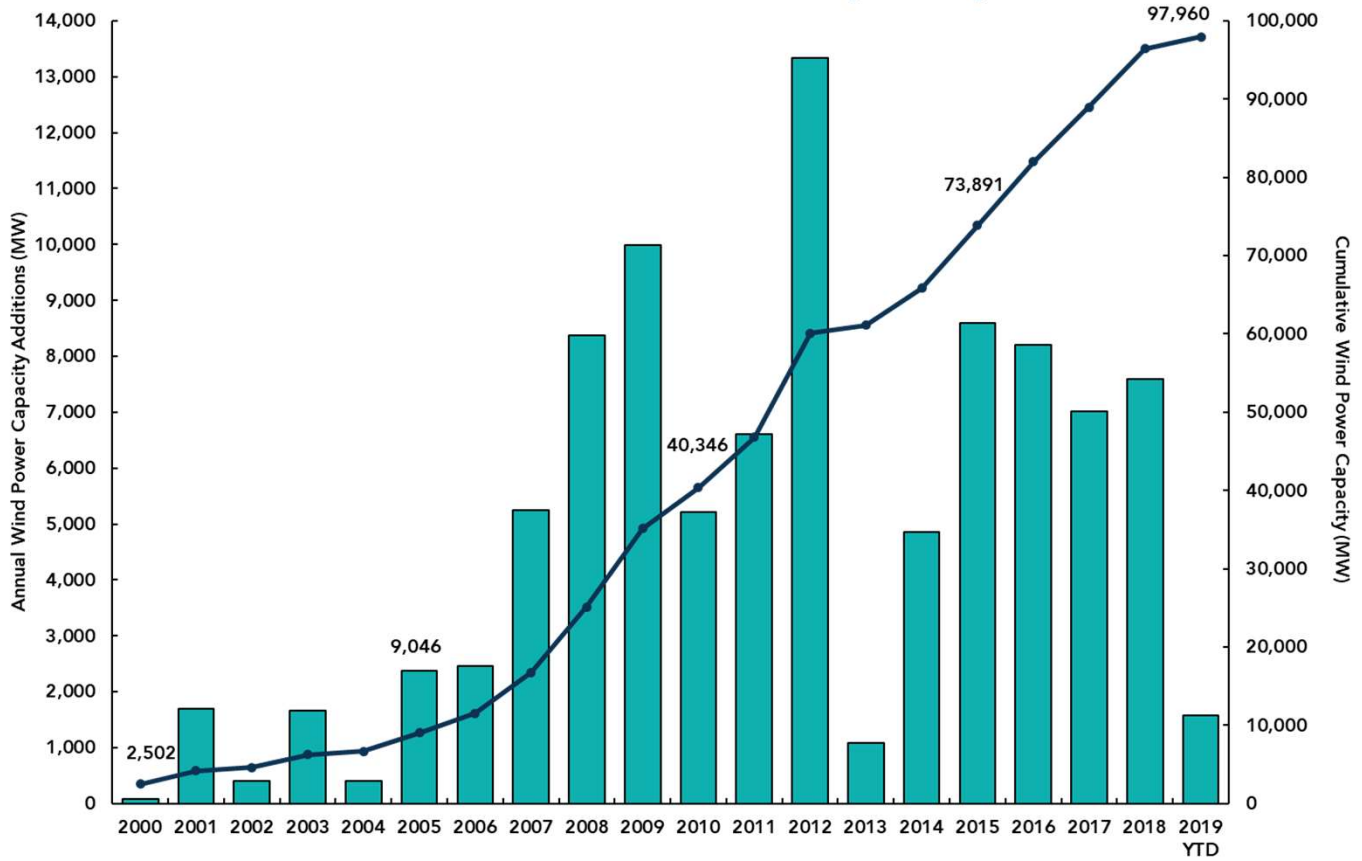
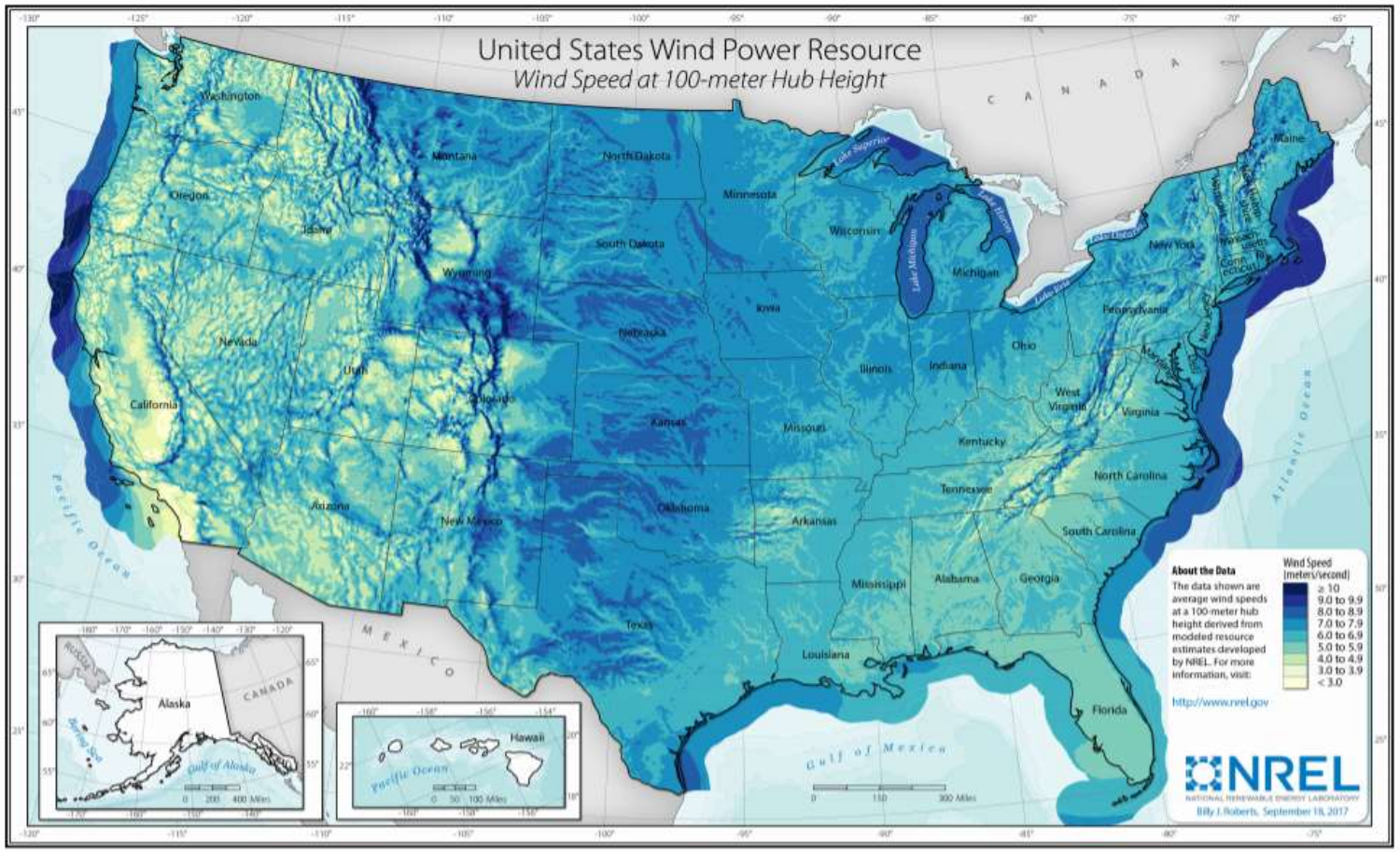
U.S. Annual and Cumulative Wind Capacity Growth



- 97,960 MW of wind power as of 2Q 2019
- Over 57,000 wind turbines across the U.S.
- U.S. wind power capacity has more than tripled since 2008
- Wind is #1 renewable energy capacity source in U.S.
- Total installed wind capacity can power 30 million American homes

Source: AWEA U.S. Wind Industry Second Quarter 2019 Market Report

Resource Quality Affects Reliability, Affordability, and Land-Use



https://www.nrel.gov/gis/assets/pdfs/wtk_100_m_2017_01.pdf

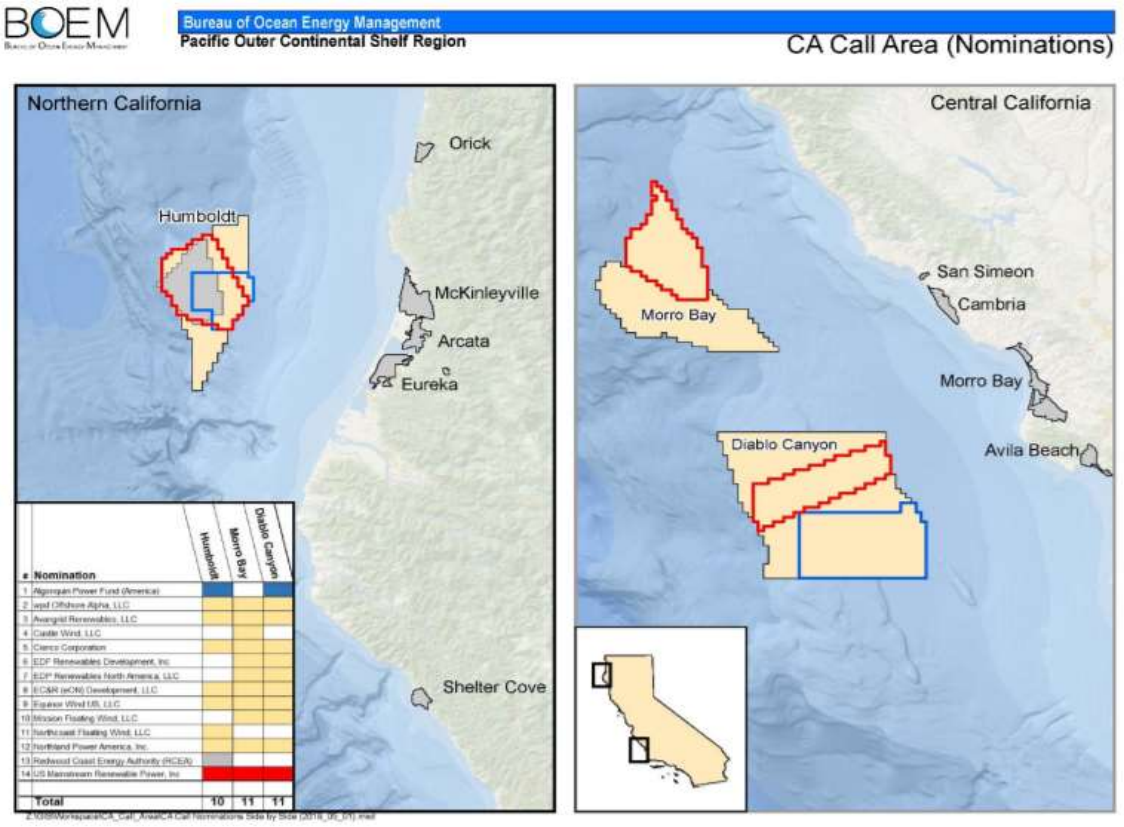
California Land-Based Wind Potential

~15 GW OF PROJECTS IN VARIOUS STAGES OF DEVELOPMENT THROUGHOUT THE WEST.

1-2 GW OF REPOWER AND GREENFIELD POTENTIAL IN CALIFORNIA

California Offshore Wind Opportunities

- Technical OSW potential: 112 GW
- Combined installed capacity potential of over 16 GW at 6 reference sites
- Global commercial-phase development expected by 2025
- BOEM 2018 Call for nominations: could support roughly 8 GW of offshore wind generation



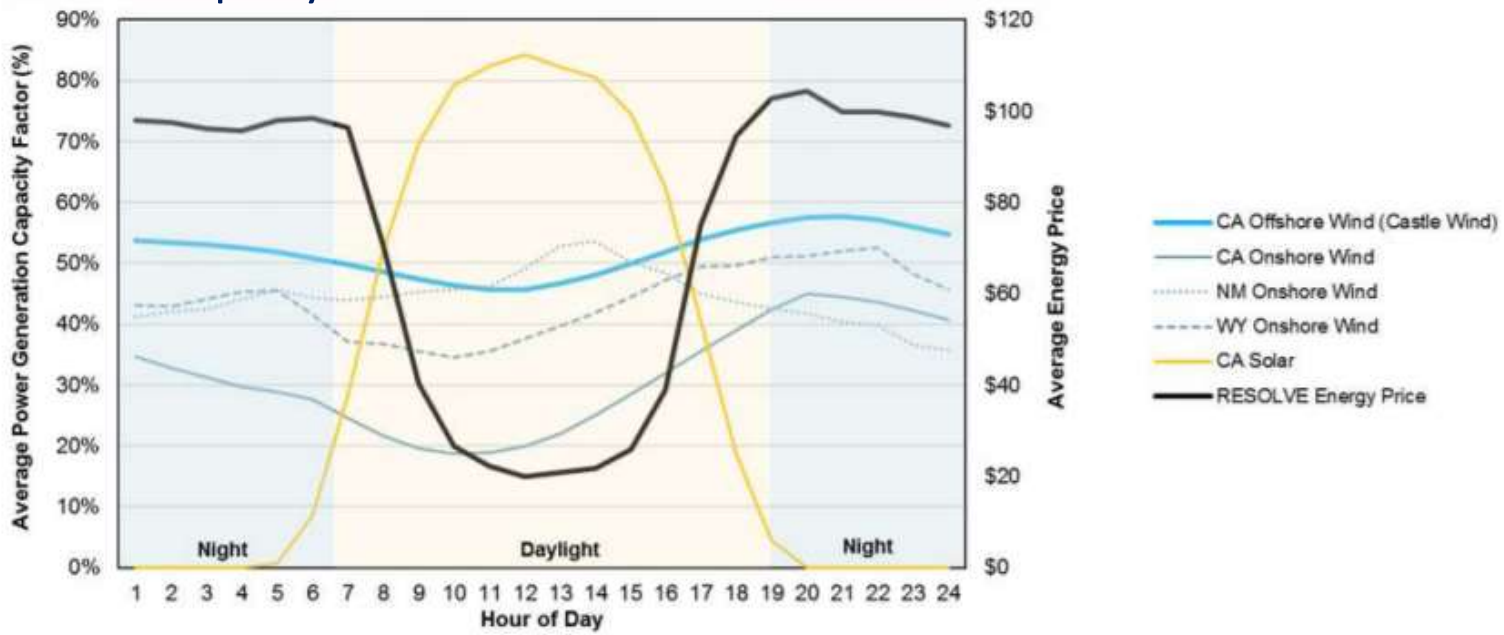
Note: California Call Areas are designated in yellow. The parties and the OCS blocks nominated for development are provided above.

https://www.boem.gov/California-Call-for-Nominations/

OCS Study BOEM 2016-074. May be downloaded from http://www.boem.gov/Pacific-Completed-Studies/

Reliability

High-capacity-factor wind, whether sited on land or offshore, generates consistent energy beginning in the evening hours when net load ramps up, and can provide system and flexible resource adequacy.



The Economic Value of Offshore Wind to California: http://castlewind.com/wp-content/uploads/2019/08/2019-08-08_E3-CastleWind-OffshoreWindValueReport_compressed.pdf

Reliability

- Offshore: Typical capacity factor of 45-60%
- Equinor's Hywind Project in Scotland, a 30 MW floating project, achieved an average capacity factor of 65% in its first three months of operation (November 2017-January 2018).

https://www.greentechmedia.com/articles/read/worlds-first-floating-offshore-wind-farm-65-capacity-factor

Affordability of renewable energy

LAZARD

LAZARD'S LEVELIZED COST OF ENERGY ANALYSIS—VERSION 12.0

Levelized Cost of Energy Comparison—Unsubsidized Analysis

Certain Alternative Energy generation technologies are cost-competitive with conventional generation technologies under certain circumstances[1]

Lazard's Levelized Cost of Energy Analysis – Version 12.0 https://www.lazard.com/media/450784/lazards-levelized-cost-of-energy-version-120-vfinal.pdf p.2

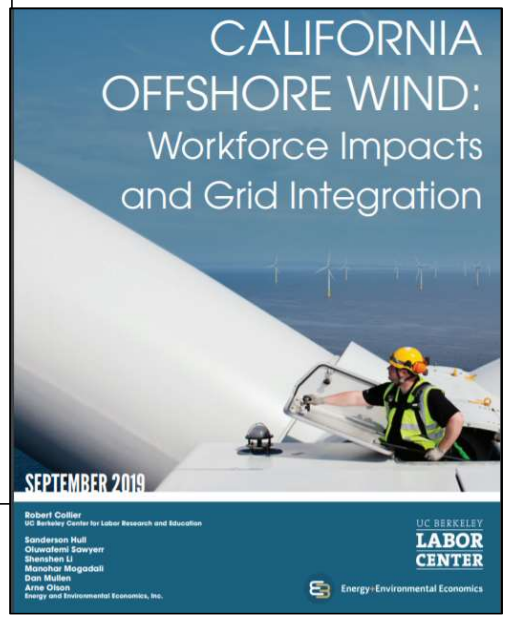
Affordability

- Costs of land-based wind have declined 69% over the past 10 years
  - Incorporation of 4,250 MW of regional wind could save ratepayers $315 million per year
- Economies of scale will drive costs down for floating offshore wind
  - 7-9 GW of Offshore Wind by 2040 could save ratepayers $1 billion-$2 billion on a net present value basis
  - Current LCOE for floating offshore wind: $.062/kWh to $.121/kWh
  - Installed costs for floating offshore wind: $2,250/kW to $3,800/kW

California Public Utilities Commission. April 2019
http://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/UtilitiesIndustries/Energy/EnergyPrograms/ElectPowerProcurementGeneration/irp/2018/IRP_TPP_PolicySensitivityCases_ToBePosted.xlsx
Department of Energy FY 2019 Congressional Budget Request. Volume 3–Part 2: 23. DOE. March 2018.
energy.gov/sites/prod/files/2018/03/f49/FY-2019-Volume-3-Part-2.pdf

Equity

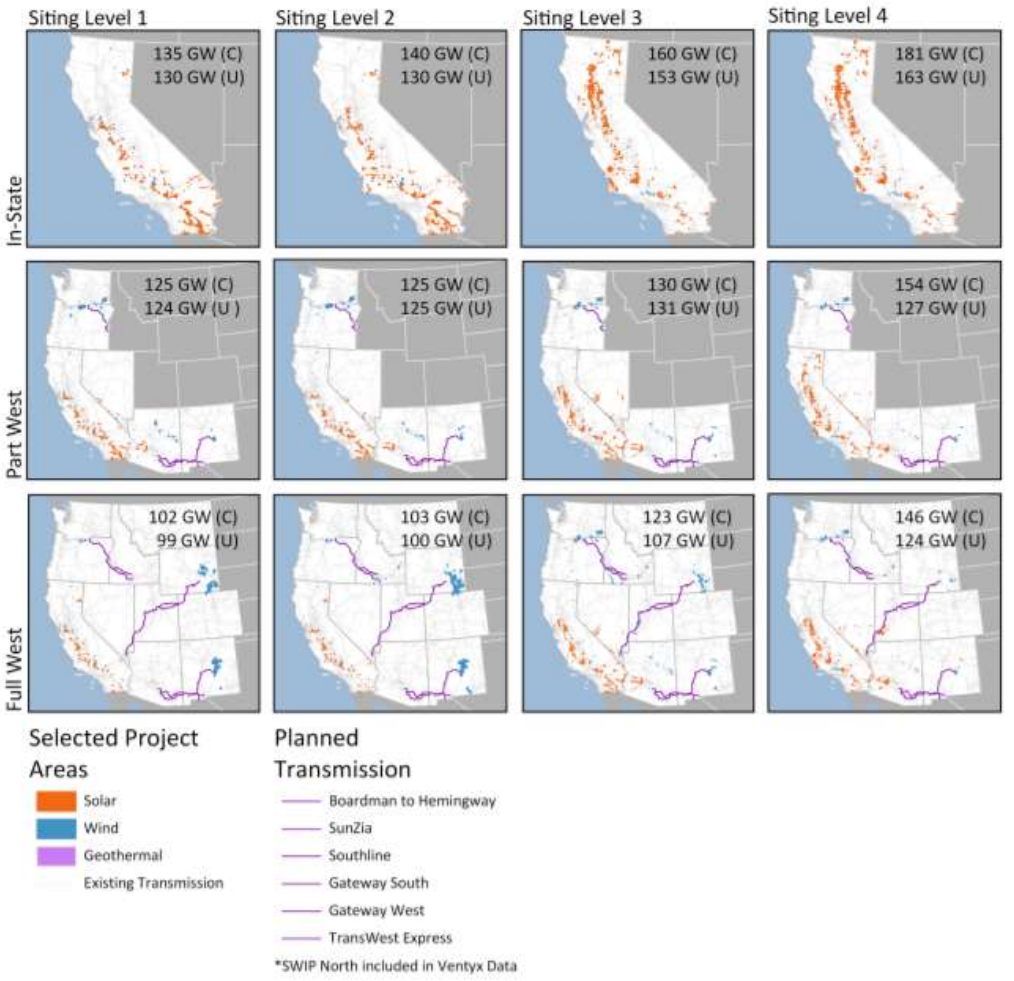
- 18 GW OSW by 2045 could support 17,500 jobs
- 8 GW of offshore wind would result in annual avoided costs of $73/MWh in the early 2030s and $88/MWh by 2045
- High Capacity-factor wind can displace in-basin fossil generation in the evening hours, improving air quality and reducing GHG emissions
- Building-out the OSW supply chain can revitalize California's economy and port communities



http://americanjobsproject.us/wp/wp-content/uploads/2019/02/The-California-Offshore-Wind-Project.pdf
http://laborcenter.berkeley.edu/pdf/2019/CA-Offshore-Wind-Workforce-Impacts-and-Grid-Integration.pdf

Land-Use

- Geographic diversity is key
- Land-based high-CF wind can cost-effectively reduce environmental impacts associated with renewable development in California



The Power of Place: Land Conservation and Clean Energy Pathways for California
https://www.scienceforconservation.org/assets/downloads/Technical_Report_Power_of_Place.pdf

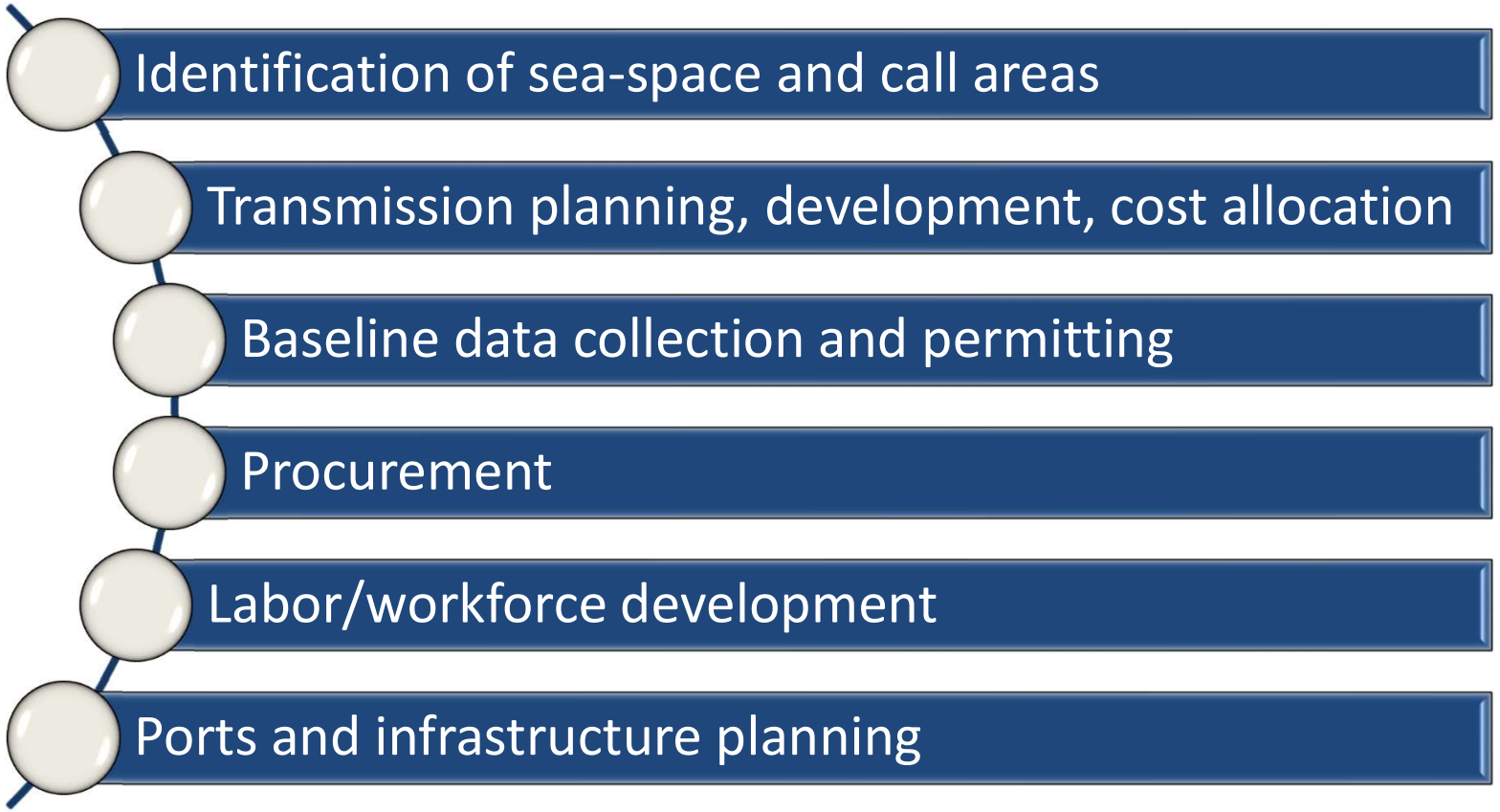
Land-Use

Offshore wind

- Large and highly scalable
- With transmission, can deliver directly to coastal load centers

California Offshore Wind considerations

Strong signal from State to initiate work



Market realization: 10+ GW OSW by 2040

THANK YOU

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AWEA AMERICAN WIND ENERGY ASSOCIATION
CALIFORNIA

Affordability of renewable energy

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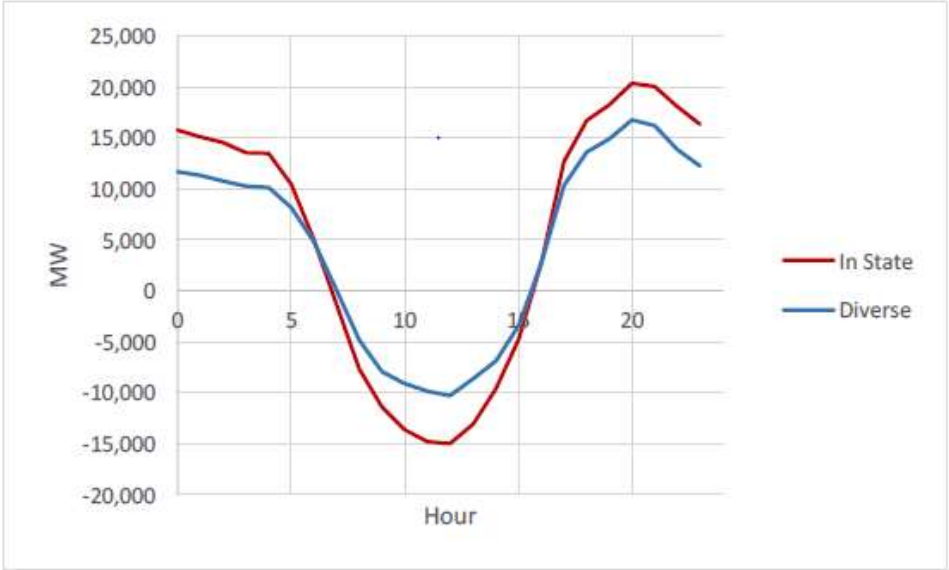
Reliability

- High-capacity factor wind can lower the overall cost, increase operational value, and enable higher quantity of solar and other renewable technologies
- Portfolios with regional wind reduce operational challenges and curtailments

Light Load Spring Day Net Load Curve



Source: http://lowcarbongrid2030.org/wp-content/uploads/2016/PDFs/160523_The-Value-Of-Regional-Wind.pdf