Why Do Offshore Wind?

TRIDENT WINDS

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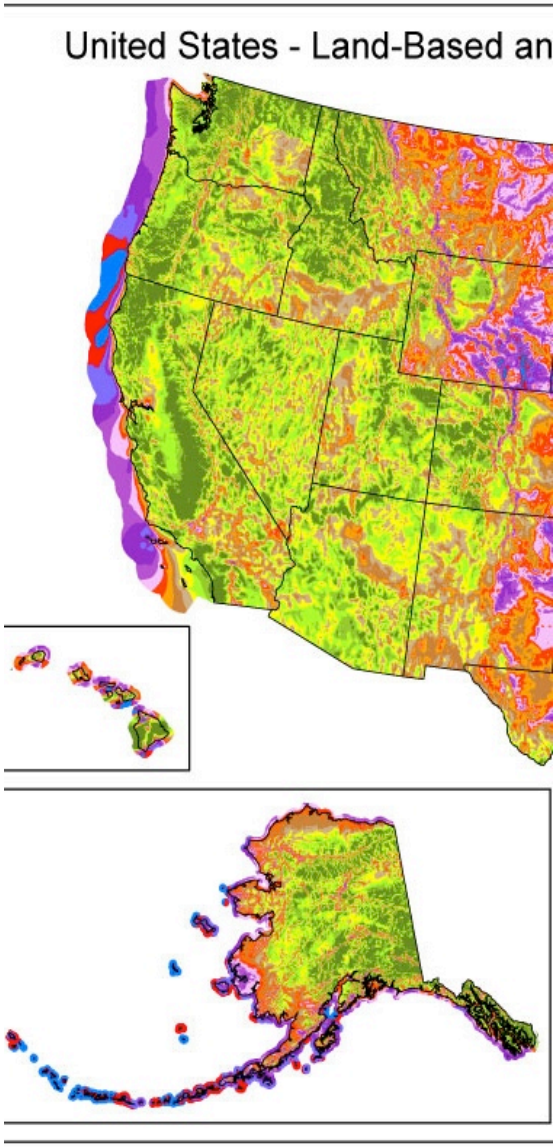
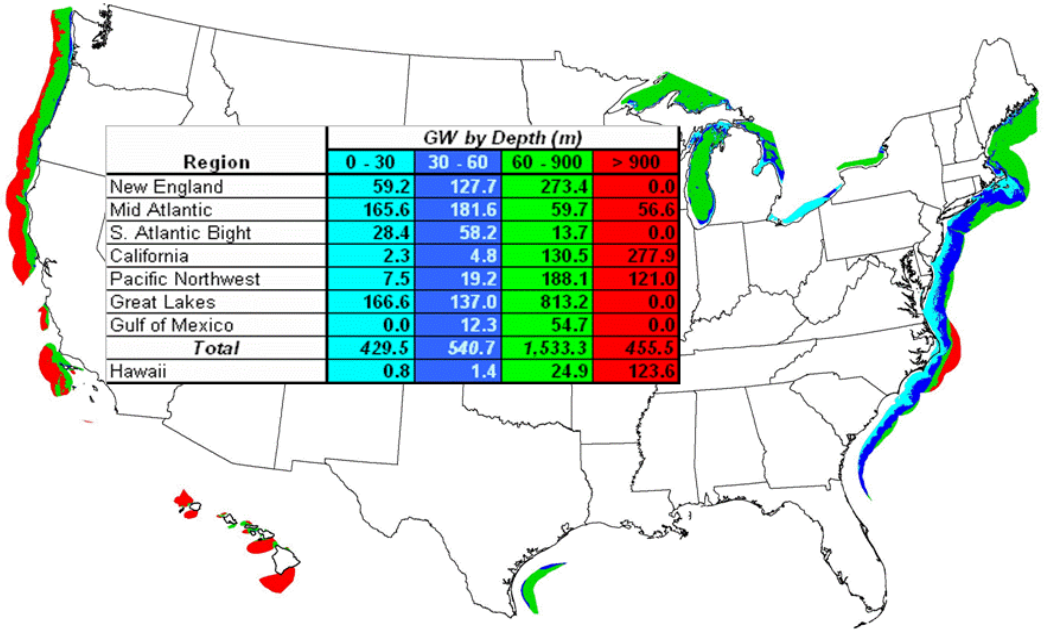
Founder

Offshore Wind Resource

- West Coast has excellent offshore wind resource
  - Can deliver energy directly to densely-populated coastal areas
  - Corresponds to peak demand periods
- Offshore Wind Resource Potential
  - CA > 112 GW
  - Pacific Northwest >188 GW

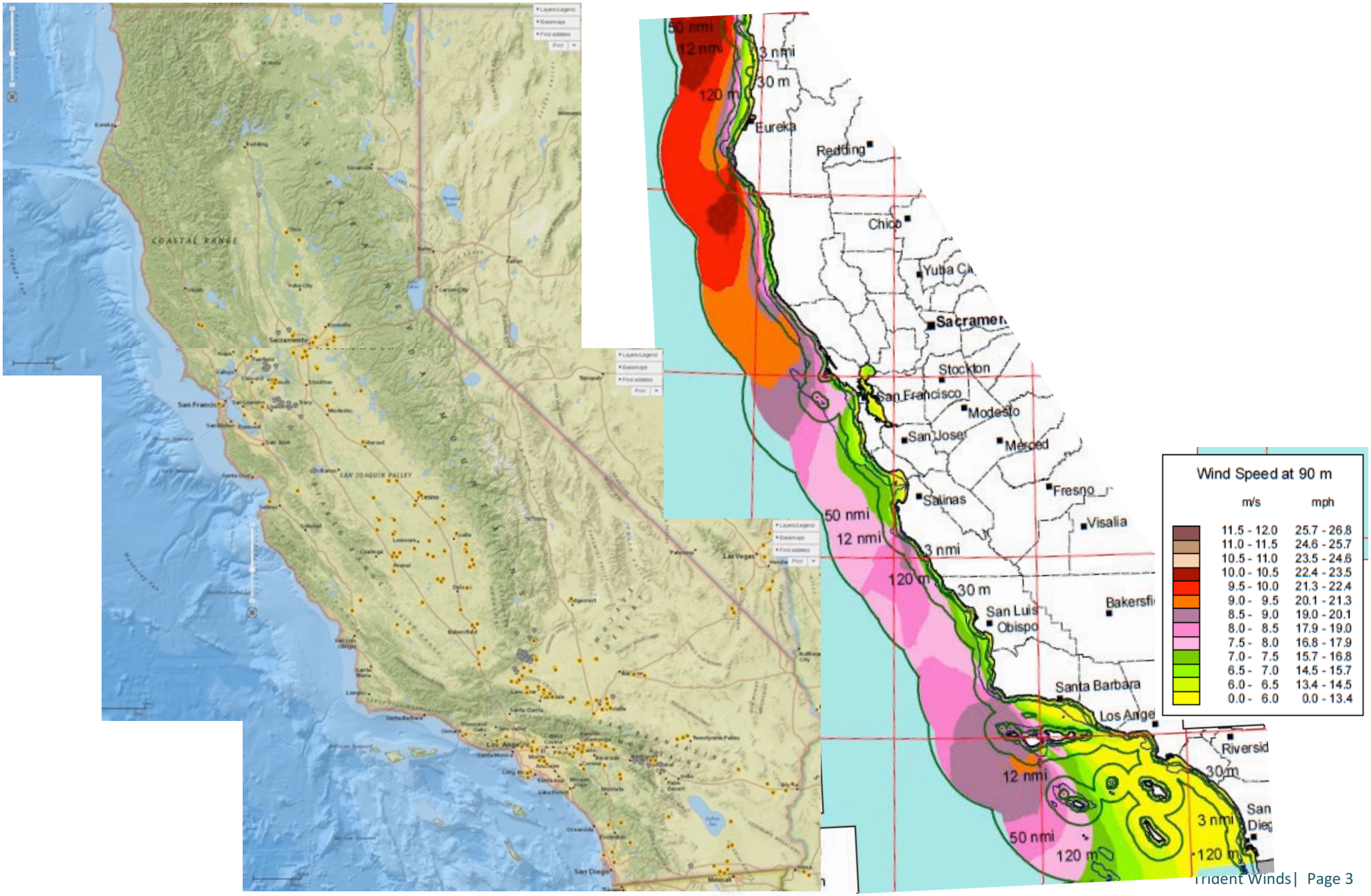




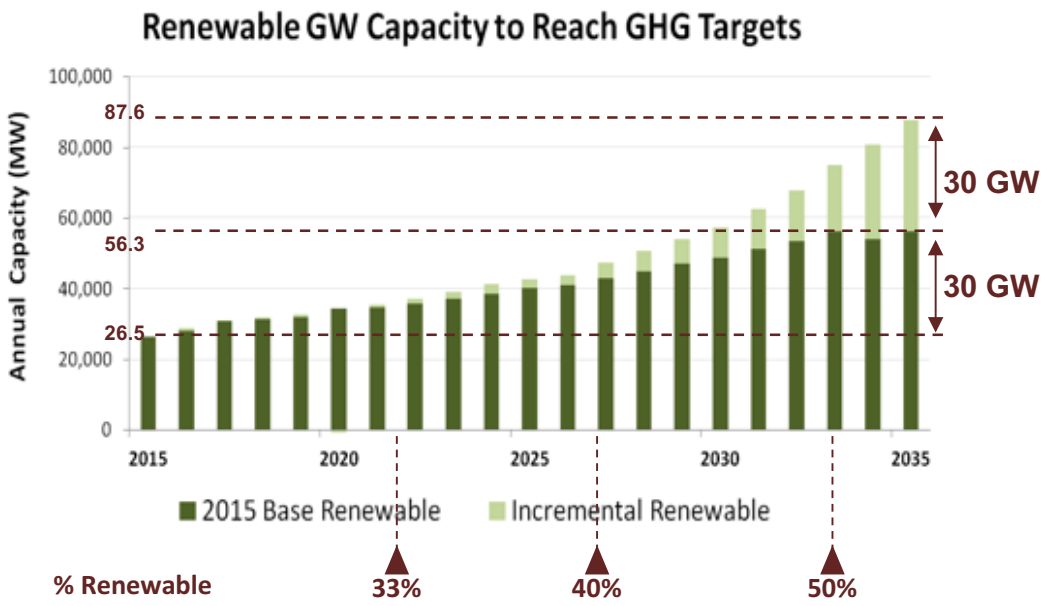
Region	GW by Depth (m)			
	0 - 30	30 - 60	60 - 900	> 900
New England	59.2	127.7	273.4	0.0
Mid Atlantic	165.6	181.6	59.7	56.6
S. Atlantic Bight	28.4	58.2	13.7	0.0
California	2.3	4.8	130.5	277.9
Pacific Northwest	7.5	19.2	188.1	121.0
Great Lakes	166.6	137.0	813.2	0.0
Gulf of Mexico	0.0	12.3	54.7	0.0
Total	*429.5*	*540.7*	*1,533.3*	*455.5*
Hawaii	0.8	1.4	24.9	123.6

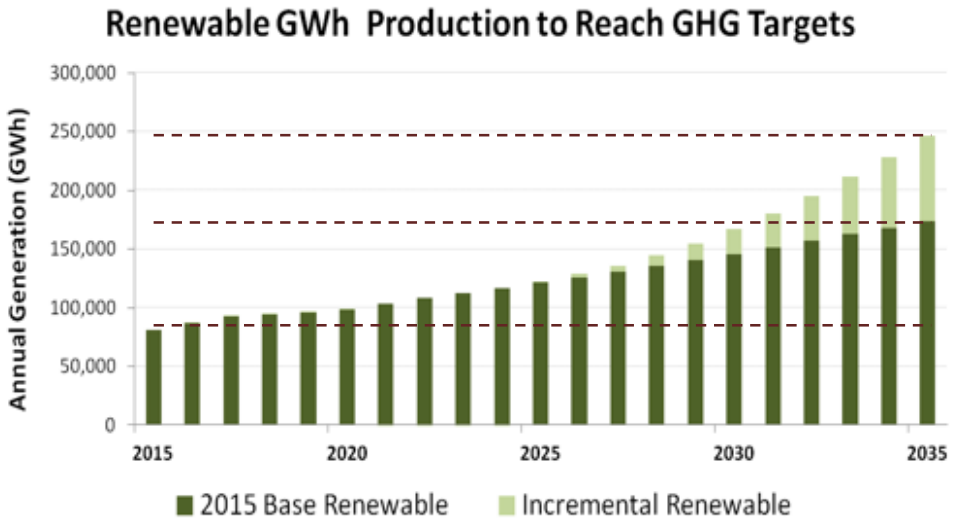
Source: NREL

CA Wind Resource / Interconnection Points



GHG policies create significant demand for renewable energy

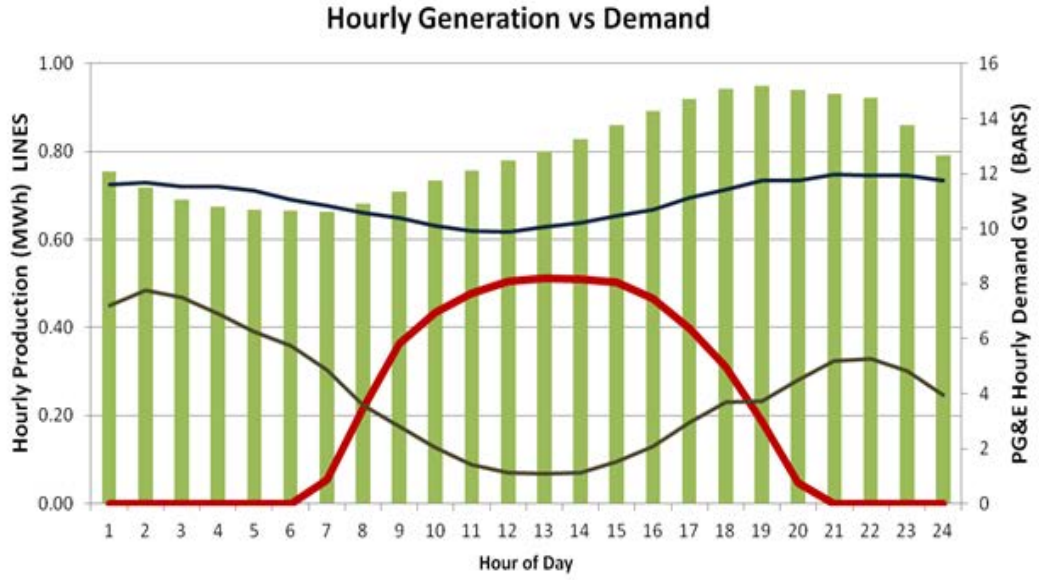


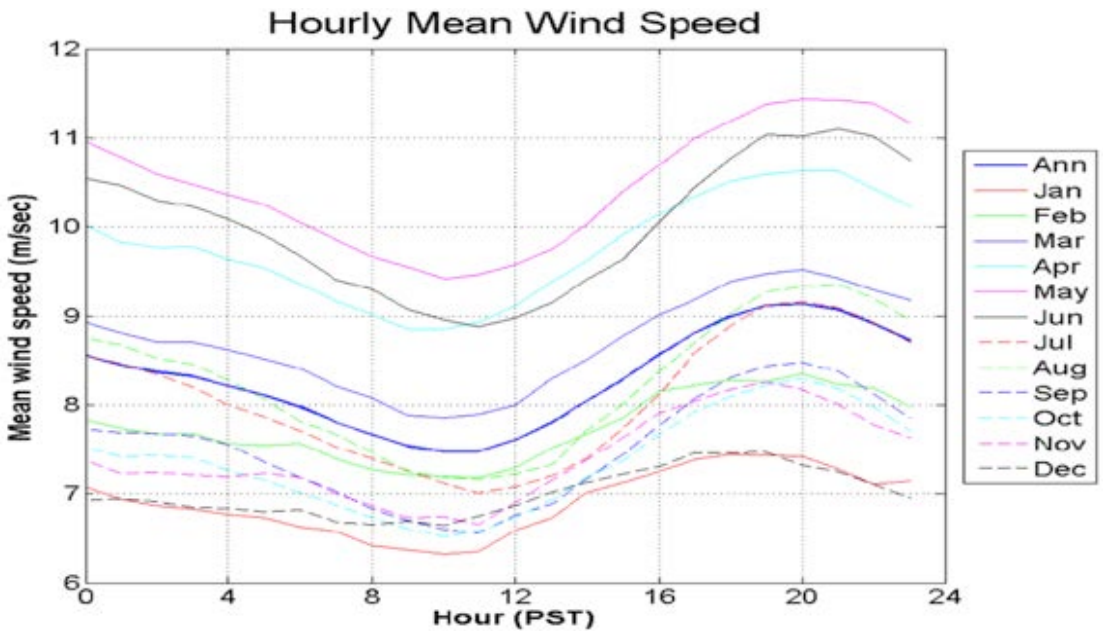


- Existing law in California (AB32) will require approximately 60 GW of new renewable capacity to be built in the next 20 years or ~3 GW/year
  - ~30 GW to transition the existing generation portfolio to renewables assuming zero load growth
  - ~30 GW for new renewable capacity to meet any load growth (economic growth, Electric Vehicles or other)
- A new bill (SB584) was introduced in February 2017, calling for 100% renewables by 2040

Source: Energy + Environmental Economics California PATHWAYS (v.2.3.1) scenario results

Morro Bay Offshore:
Wind Resource / Demand Profile



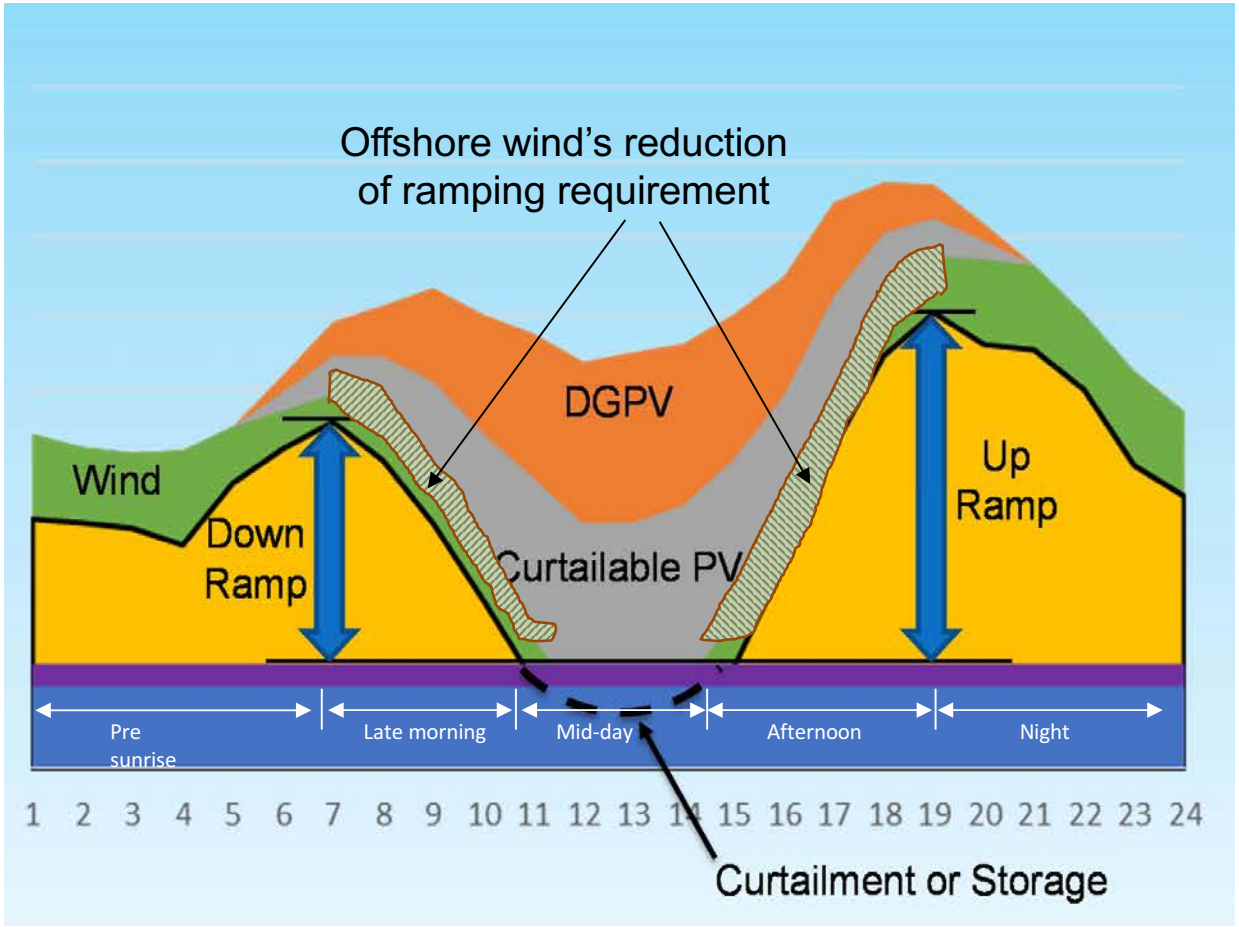


Morro Bay Offshore generation matches well CA demand

- Could get higher prices on the spot market
- Provides for the grid load balance

Time Period	Mean Wind Speed (m/s)
Annual	8.29
Jan	6.91
Feb	7.74
Mar	8.69
Apr	9.76
May	10.45
Jun	10.01
Jul	8.06
Aug	8.24
Sep	7.51
Oct	7.37
Nov	7.41
Dec	7.00

The "Duck Curve" and Offshore Wind (OSW)

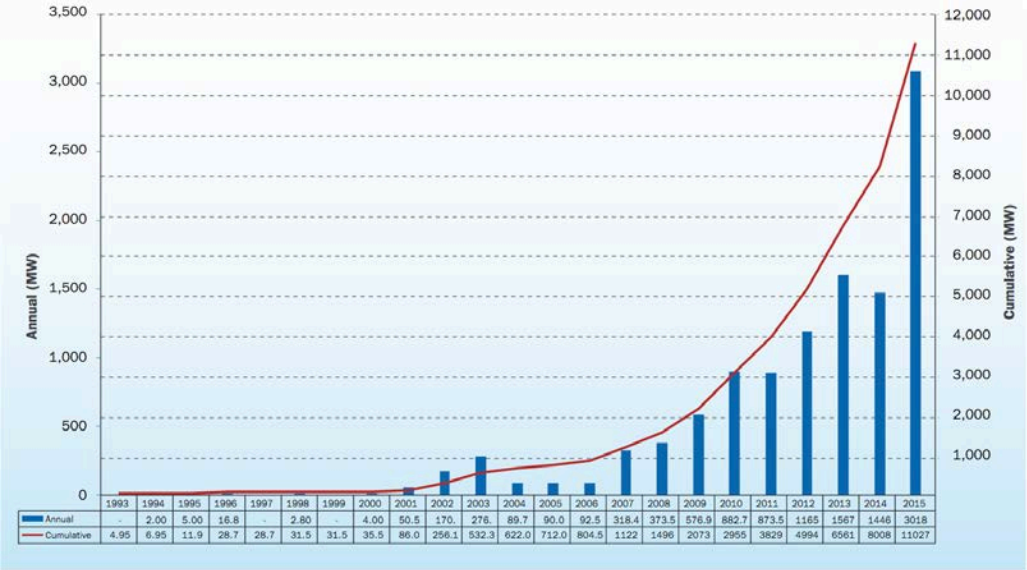


- OSW has a steady 24 hour load profile.
- OSW is ideally suited to counteract the "Duck Curve" issues (1):
  - Solar requires ramp-down & ramp-up (cross-hatch areas)
  - More solar leads to steeper ramps
  - Ramping challenges grid reliability due to physical limits to change thermal dispatch over a short period of time
  - Storage offers potential solution but still extremely expensive
- OSW benefits:
  - Production is predictable with a 24 hr look-ahead
  - Improves grid reliability as it reduces ramping needs
  - Generation during pre-sunrise and night periods reduces total MWhs required to meet RPS targets

(1) Offshore wind in this example, but the same benefits from any firm renewable generation supply (e.g. geothermal)

Offshore Wind Experience:
> 11 GW Fixed installed in Europe; 15 MW Floating worldwide

Fixed: 11,027 MW installed capacity in Europe as of the end 2015



	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Annual	-	2.00	5.00	16.8	-	2.80	-	4.00	50.5	170.	276.	89.7	90.0	92.5	318.4	373.5	576.9	882.7	873.5	1165	1567	1446	3018
Cumulative	4.95	6.95	11.9	28.7	28.7	31.5	31.5	35.5	86.0	256.1	532.3	622.0	712.0	804.5	1122	1496	2073	2955	3829	4994	6561	8008	11027

Source: EWEA

Floating: 15 MW installed capacity world-wide

Floating: > 200 MW projected by 2020 in UK, Portugal, Japan and France

Project Fundamentals

Market Demand

- State laws:
  - 2030 – 50% RPS - passed
  - 2040 – 100% RPS (proposed)
- CA needs to add 30-60 GW of Renewables to meet 2030 RPS requirements
- Market demand will grow significantly post 2020

Technology Readiness

- Floating offshore wind is now proven and a maturing technology
- A number floating support structures will be commercially available post 2020

Permitting

- BOEM permitting for floating offshore wind has now been validated
- CA state agencies may add some complexity, but fall under the BOEM umbrella per Federal regulations

"The Future for Offshore Wind is Bright…… and it will also be FLOATING"

DNV-GL – "10 Years, 10 Lessons", 2013