

Repowering 1980s-Vintage Turbines: Benefits & Barriers

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Workshop for Identifying Challenges and
Effective R&D Paths for Promoting Repowering
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Expiring 1980s PURPA Contracts & Estimated Repower Potential*

✦ **1,700 MW Wind Contracts Expiring 2014-2024**

- Most are 1980s-vintage PURPA contracts, 51-100 kW turbines, ~22% c.f.
- ~Half of these contracts expired prior to 2016
- ~Half will expire 2016-2023, most by 2020
- Primarily in Alameda, Contra Costa, Kern and Riverside counties

✦ **Already Repowered:**

- ~200 MW (?) occurred late-'90s (prior to PTC change)
- Approx. 300 MW repowered/in process of repowering since 2002 RPS

✦ **Not Repowered:**

- At least 700 MW (62 projects) under 50 MW
- Approx. 373 MW (38 projects) under 20 MW

*CalWEA estimates based on PG&E, SCE and SDG&E RPS Compliance Reports for 2014, filed with the CPUC; AWEA wind project database; and CPUC RPS Project Status Table (December 2015). Turbine size and capacity factors from 2008 CEC repower report (CEC-300-2008-004).



1980s-Vintage Technology





Benefits of Repowering (1)

- ✦ **Efficiently use California's best wind resource areas**
 - Raise capacity factors from low-20% range to mid-to-high-30% range
 - Preserve remaining ~1,000 MW of in-state “legacy” capacity, while increasing energy by ~330-MW equivalent, for California's 50% RPS
- ✦ **Modern turbines bring grid benefits**
- ✦ **Environmental & aesthetic benefits**
- ✦ **Tax & jobs benefits (next slide)**



Potential Benefits from Repowering Wind Projects

(<50 MW projects only, by County)*

	Alameda/ Contra Costa	Riverside	Kern	Total
Total Megawatts	104	251	350	705
Repower Investment Potential	\$177 million	\$427 million	\$594 million	\$1.2 billion
Associated Property Tax - Annual	\$2.2 million	\$5.2 million	\$6.0 million	\$13.4 million
Associated Sales Tax – Initial Turbine Purchase	\$11.5 million	\$26 million	\$45 million	\$82.5 million
Construction Jobs – Short-term (not including “induced” jobs)	133	320	445	898
Operations Jobs – Long-term (not including “induced” jobs)	40	97	134	271

*reflects all projects with PPAs expiring on or before 2020



New Technology





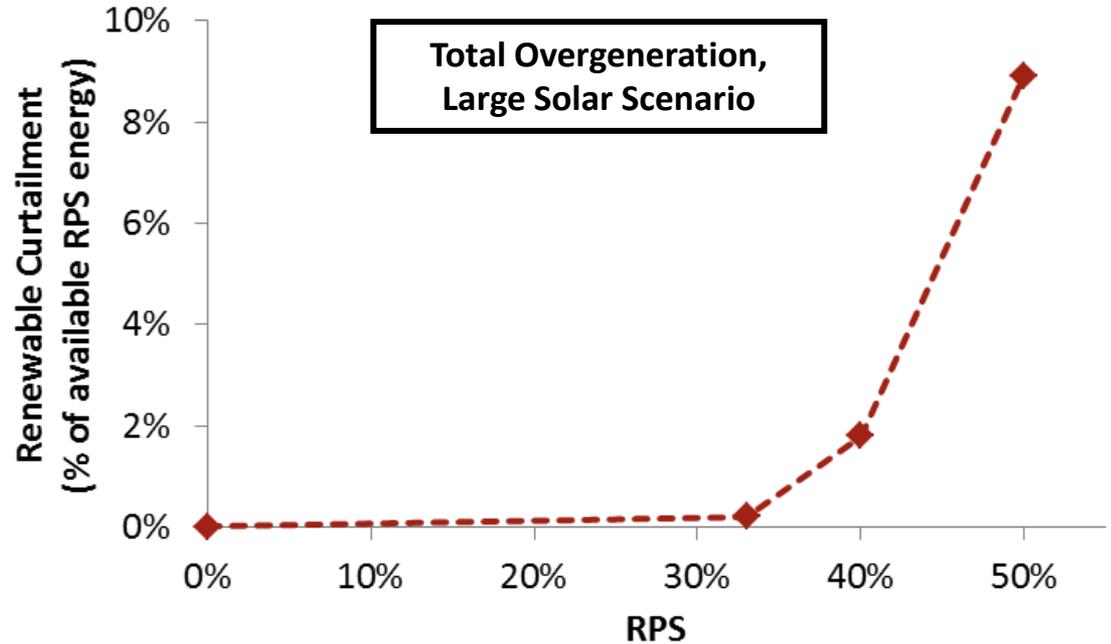
Benefits of Repowering (2)

- ✦ **Significant wind energy will be required for cost-effective achievement of 50% RPS**
- ✦ **Adding wind to the RPS portfolio is much cheaper than all-solar or solar + storage combination**
- ✦ **Repowering is one of the few remaining opportunities for (preserving &) generating more wind energy in California**
- ✦ **County and DRECP land-use restrictions will severely restrict new CA wind development**



Overgeneration challenge gets worse at higher penetrations

- + Overgeneration is minimal at 33% RPS, but increases dramatically above 40%
- + Saturation drives marginal overgen to unsustainable levels for solar PV

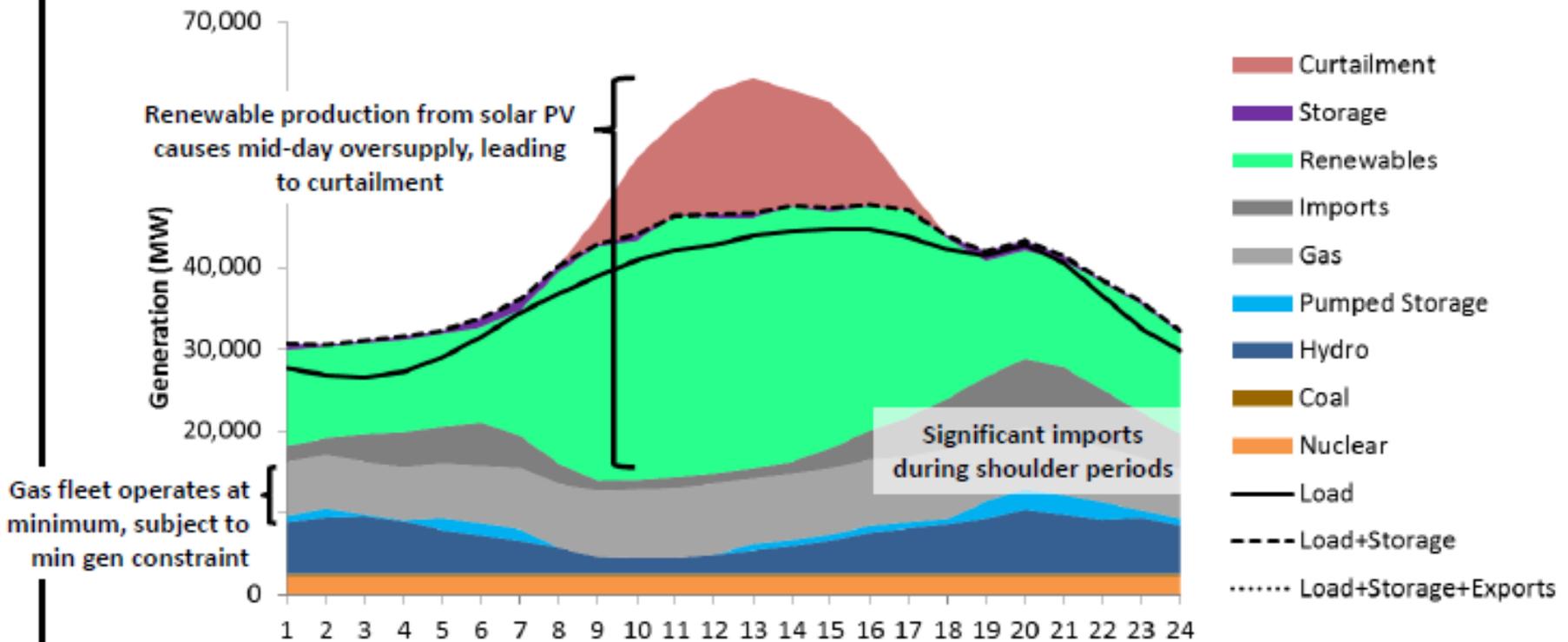


Overgeneration Statistics	33% RPS	40% RPS	50% RPS, Large Solar
Total Overgeneration (GWh/yr.)	190	2,000	12,000
% of hours with overgeneration	1.6%	8.6%	23%
% of available RPS energy	0.2%	1.8%	8.9%
Marginal overgeneration for Solar PV	5%	26%	65%
Marginal overgeneration for Wind	2%	10%	22%



California Overgeneration Driven by Mid-day Solar Production

California dispatch, average net load day in May



Renewable Penetration: 50%
(% of load)

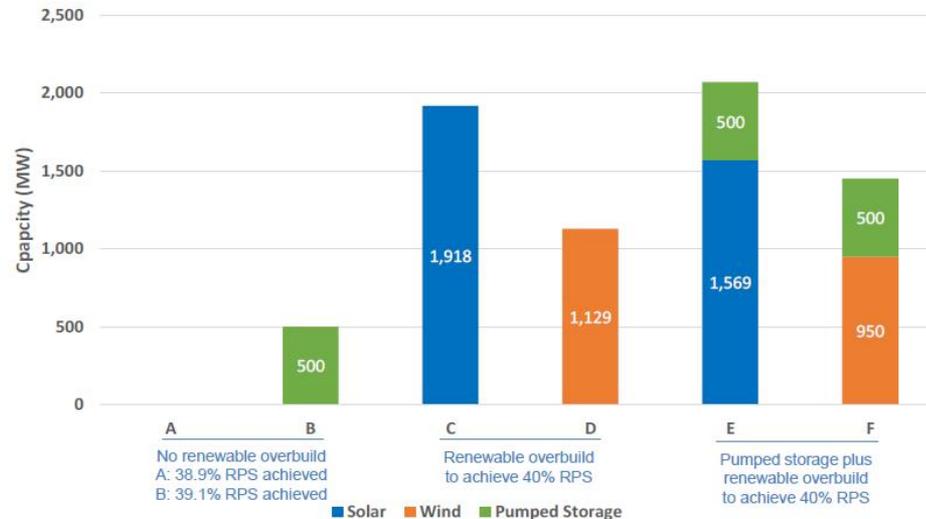
Renewable Curtailment: 8.7%
(% of annual renewables)

Curtailment Frequency: 20%
(% of hours per year)



Adding Wind Is Least-Cost Solution Compared to More Solar, Solar+Storage

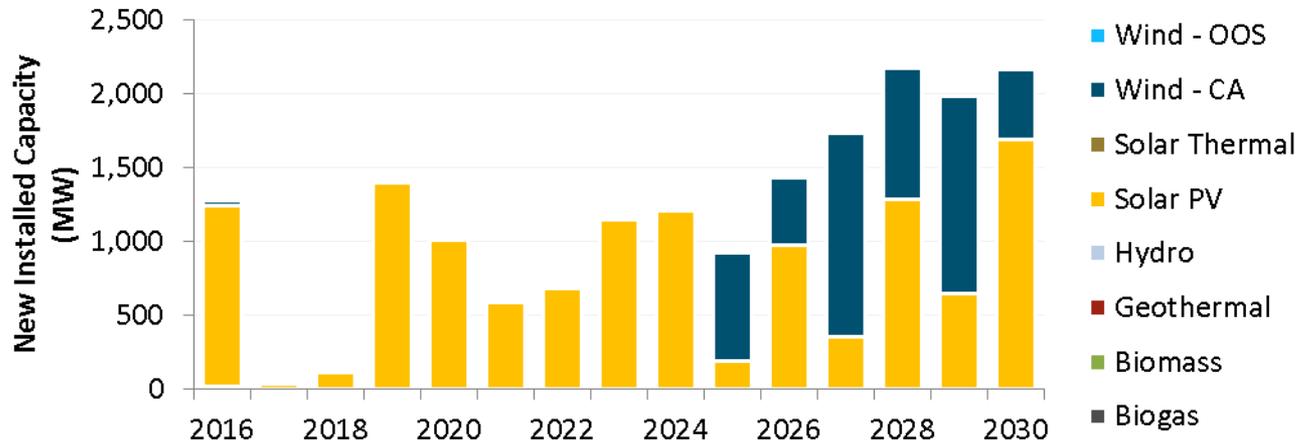
Capacity of renewable overbuild to achieve the 40% RPS target



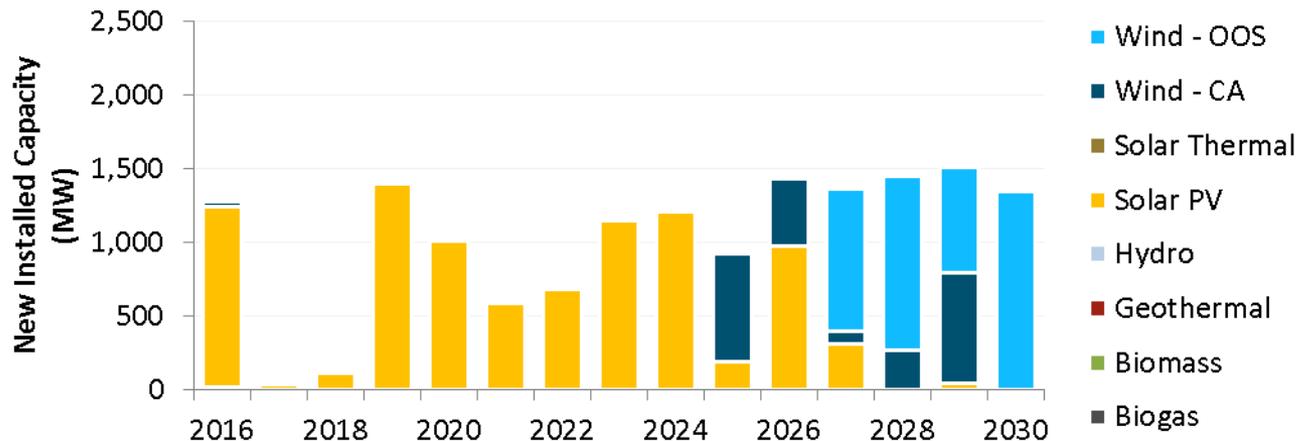


Out-of-state wind resources increasingly important after 2025

+ California-only case dominated by in-state solar



+ Model picks 4000 MW of out-of-state wind if allowed





Wind Repowering is One of the Few Remaining Opportunities for Wind in CA

Solano County

Wind moratorium north of Hwy 12 likely to be extended due to Travis AFB concerns

Los Angeles County

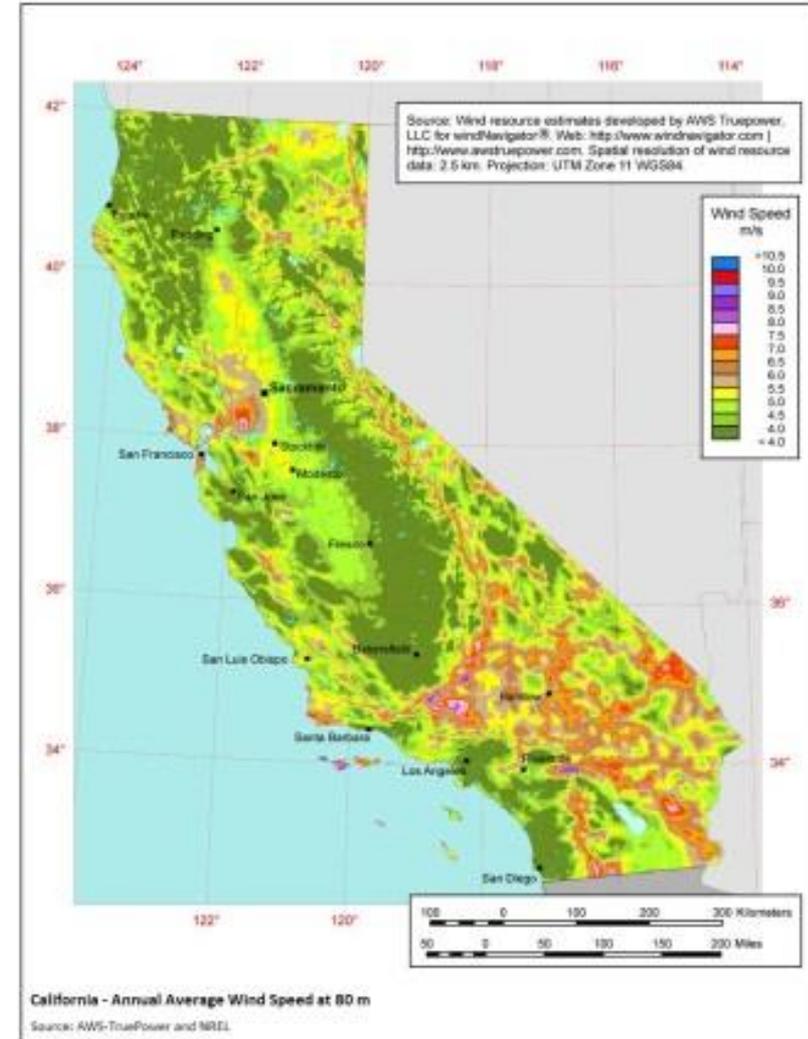
Wind energy to be prohibited in Antelope Valley area

San Diego County

Unattainable sound standard

DRECP

Wind prohibited on 80% of BLM high-quality Wind Resource Areas





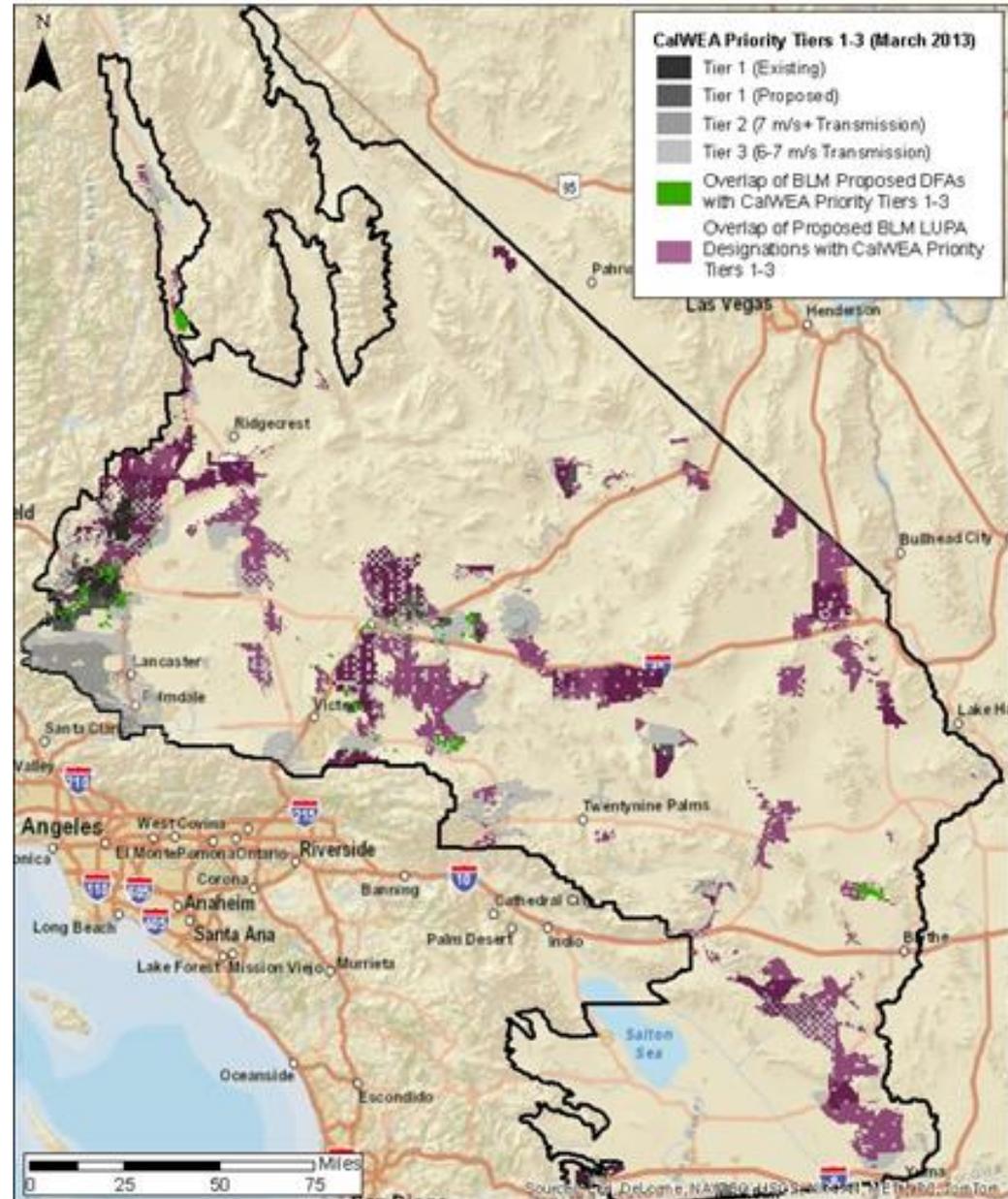
DRECP: BLM Wind Exclusions

The best wind resources within the DRECP region are shown in shades of gray.

BLM wind prohibition areas are shown in purple-overlay

Wind permitted in Development Focus Areas – green-overlay areas

CalWEA estimated DRECP max new wind potential = 1,000 MW. All CA = 2,000 MW





Barriers to Repowering (1)

- ✦ **Contracts expiring at a time of little RPS demand, low market prices**
- ✦ **Stiff competition from solar PV** (and larger wind projects, particularly out-of-state)
- ✦ **Significant tax policy disadvantages**
 - CA solar property tax exemption (worth 0.5 c/kWh)
 - Federal wind PTC phasing out faster than solar ITC



Wind PTC Phase-Out vs. Solar ITC

	WIND	SOLAR	OTHER
Projects "Starting Construction" By December:	% of Current (\$0.023/kWh) PTC Value*	% of Current (30%) ITC Value	% of Current Geothermal, Biomass, Landfill Gas PTC
2016	100%	100%	100%
2017	80%	100%	0%
2018	60%	100%	
2019	40%	100%	
2020	0%	87%	
2021		73%	
2022		33%	



Barriers to Repowering (2)

- ✦ **Lag on the least-cost, best-fit bid evaluation components likely to favor wind**
 - integration costs, capacity value, curtailment valuation
- ✦ **Small & fragmented projects**
- ✦ **Military height restrictions (Kern County)**
- ✦ **Timing gap:** despite clear long-term need for wind, it could be several years before repowers become competitive (if competitive vs. OOS)



The result: 70x more solar than wind repowers in development

IOU Projects - Approved in Development or Pending Approval*

<u>Technology</u>	<u>MW</u>	<u>Notes</u>
Wind	808	Includes: 438 MW out-of-state wind 312 MW new, in-state 40 MW repower, in-state 18 MW existing, in-state
Geo & Bio	339	Includes 275 MW existing Geysers
Solar PV	2,742	

* Calculated from data in CPUC RPS Project Status Table, December 2015. In addition, NextEra has contracted 86 MW of repowered wind capacity from its Golden Hills project to Google and Kaiser Permanente.



Ways to Encourage Repowers

- ✦ **Ease “QF Conversion” metering/telemetry requirements until repowering occurs (CAISO)**
- ✦ **Accelerate development of LCBF values, especially projected curtailment (CPUC)**
- ✦ **Facilitate the continued use of shared facilities – transformers (CPUC/IOUs)**
- ✦ **R&D – ? – Looking forward to your ideas**