The Evolving Hybrid Power Plant

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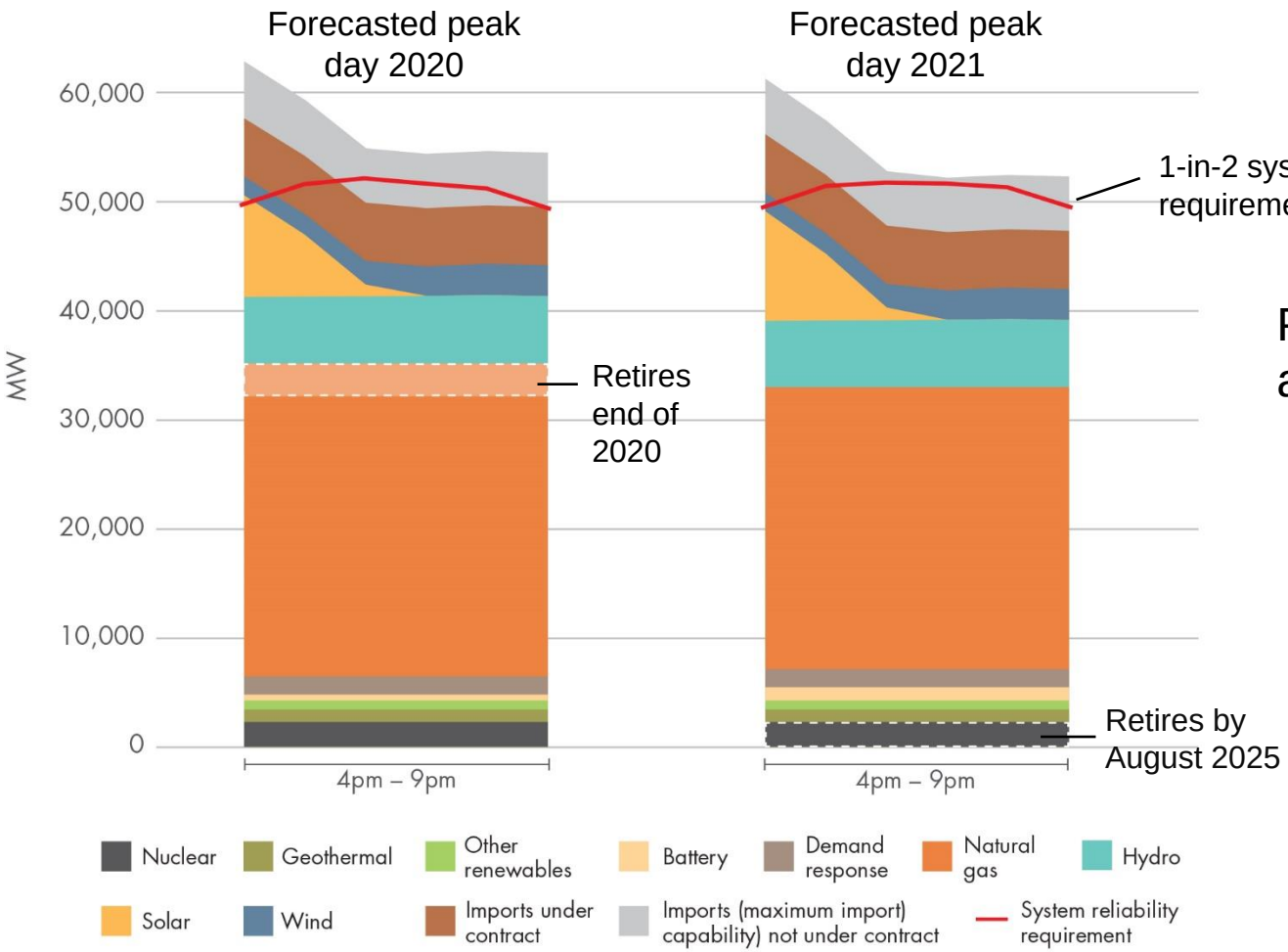
April 1, 2021
ESIG Spring Workshop

Grid transformation operational challenges

- **Challenge 1: Capacity needed to meet summer evening peak load**
- **Challenge 2: Increased ramping needs**
- **Challenge 3: Low renewable energy production from multi-day weather events**

Challenge meeting evening peak



Projected shortfalls at 7 p.m.:

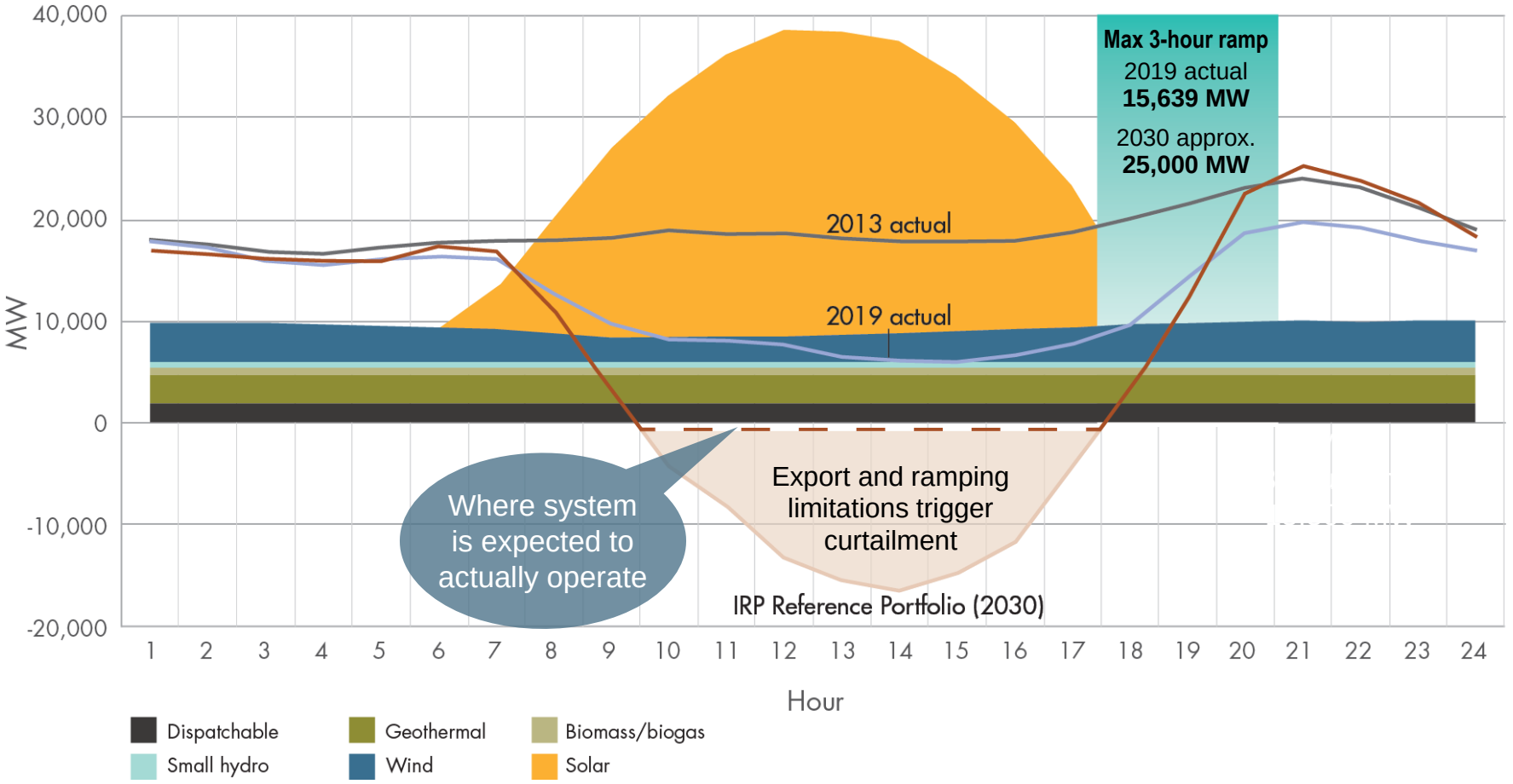
2020 = **2,300 MW**

2021 = **4,400 MW**

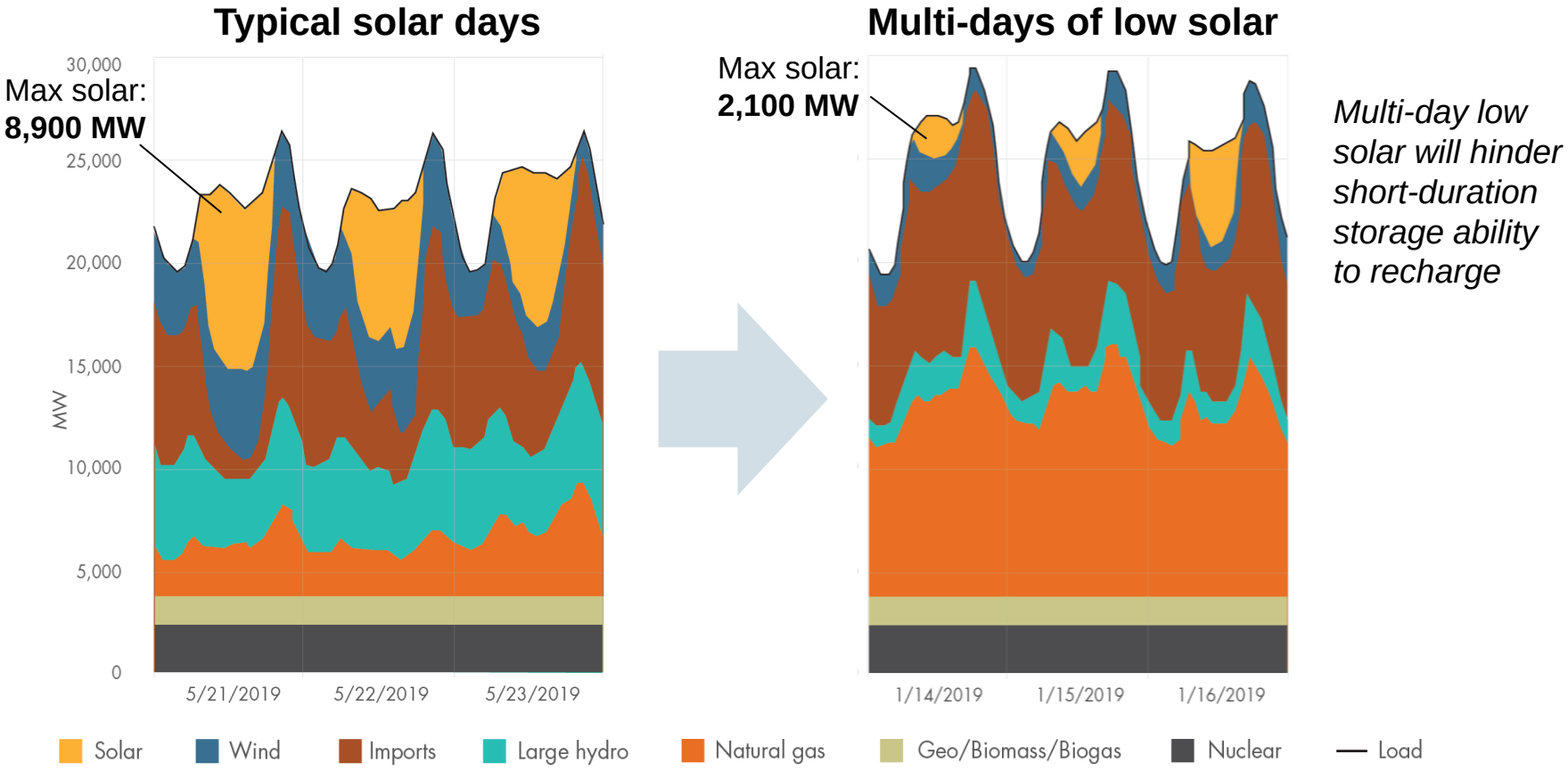
2022 = **4,700 MW**

[1] *Assumes no transmission outages or other significant events affecting availability of generation*

By 2030, solar is expected to contribute to increasing ramping needs

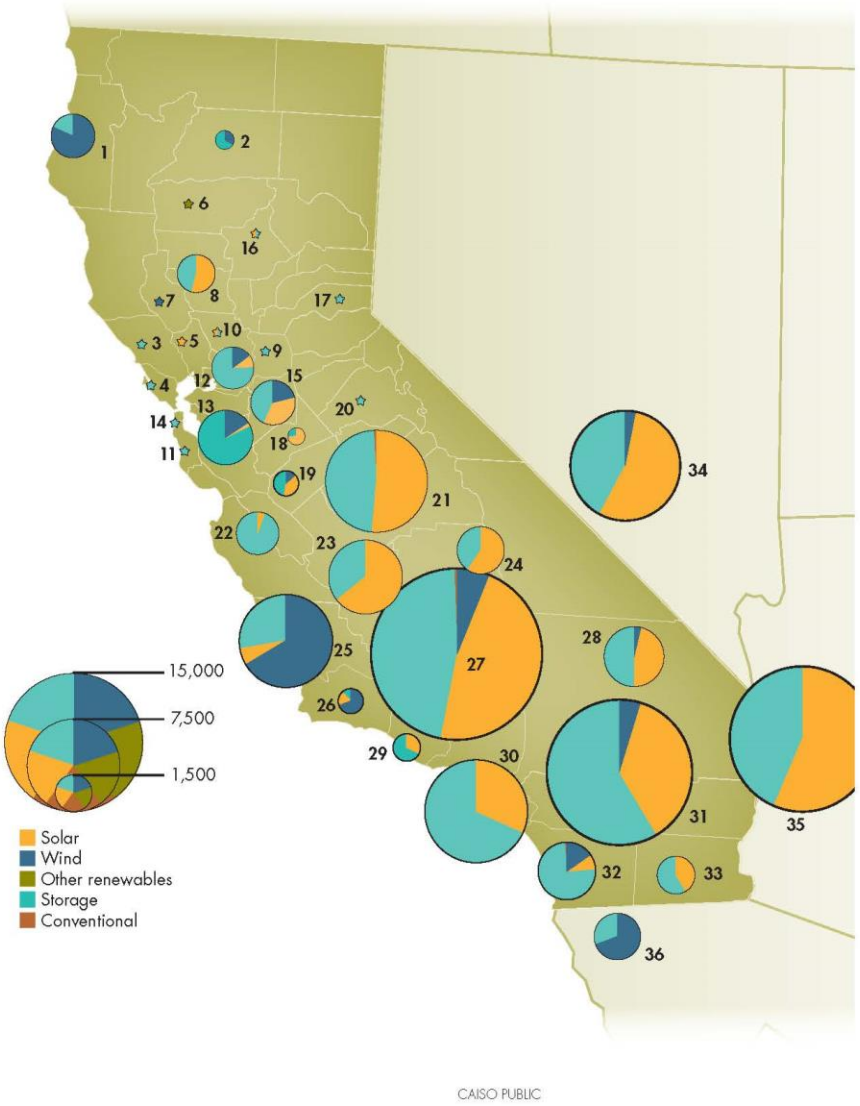


Low solar production across multi-day event – high reliance on natural gas and imports



Multi-day low solar will hinder short-duration storage ability to recharge

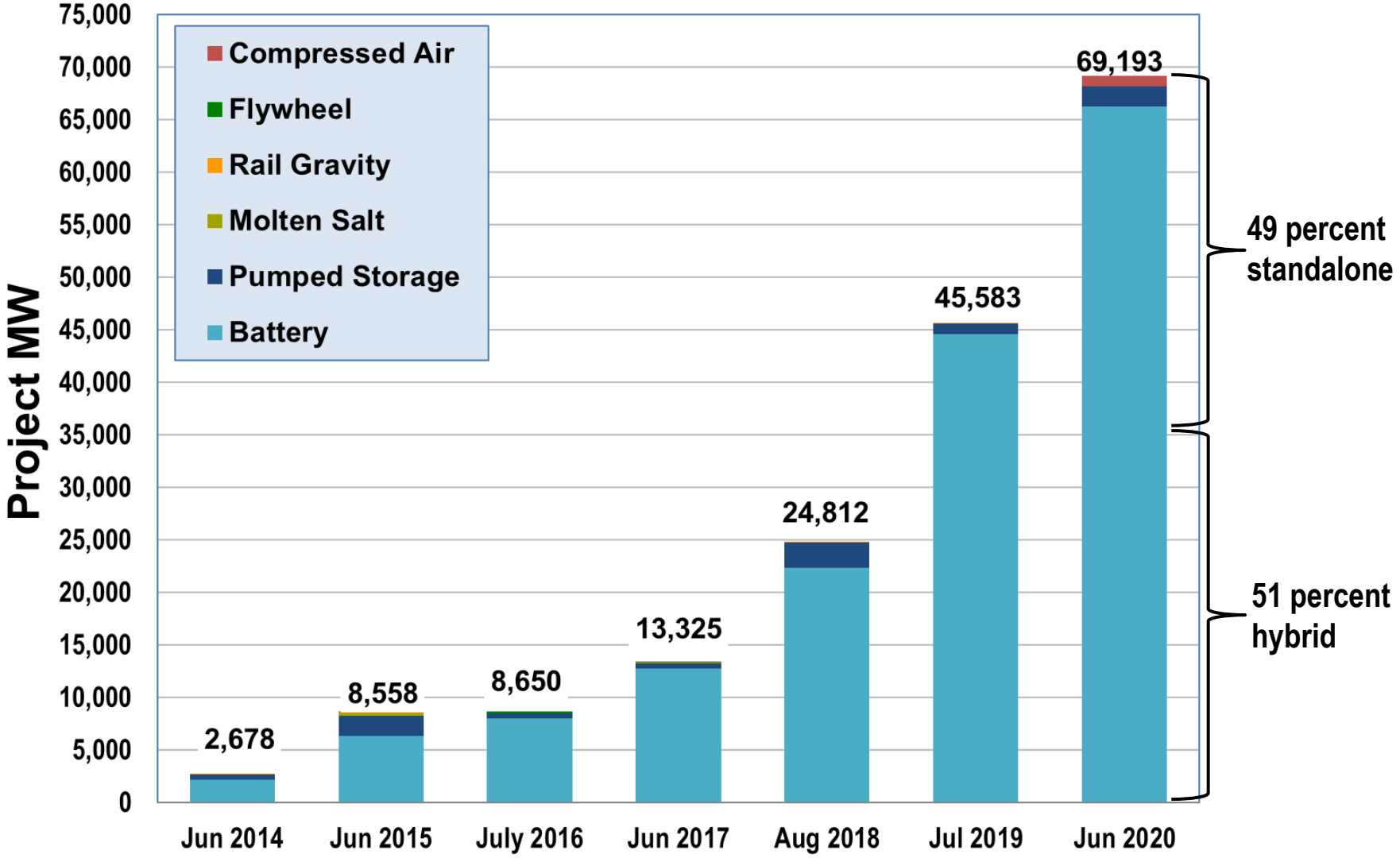
There are high levels of interest in generator interconnection



Interconnection queue by county

	County	# of Projects	Megawatts Renewables	Storage	Conventional	Total
1	Humboldt	5	1,827	410		2,238
2	Shasta	2	206	415		621
3	Sonoma	7		103		103
4	Marin	9		305		305
5	Napa	1	25			25
6	Tehama	6	6			6
7	Lake	3	145	39		184
8	Colusa	9	1,048	890		1,938
9	Sacramento	1		59		59
10	Yolo	8	92	92		184
11	San Mateo	5		254		254
12	Solano	2	521	1,618		2,139
13	Alameda-Contra Costa-Santa Clara	26	734	3,335		4,069
14	San Francisco	40		250		250
15	San Joaquin	9	1,318	1,016		2,334
16	Butte	3	87	189		275
17	Placer	33		102		102
18	Stanislaus	7	341	116		457
19	Merced	6	554	499		1,053
20	Tuolumne	9		10		10
21	Fresno-Madera	38	4,221	3,903	63	8,187
22	San Benito-Monterey	5	115	2,042		2,156
23	Kings	25	3,476	1,937		5,413
24	Tulare-Inyo	12	1,562	1,055		2,618
25	San Luis Obispo	5	5,706	2,190		7,896
26	Santa Barbara	3	978	134		1,111
27	Kern	129	11,818	10,294	109	22,221
28	San Bernardino	29	3,151	3,146	15	6,311
29	Ventura	2	500	1,060		1,560
30	Los Angeles-Orange	20	2,536	5,452		7,988
31	Riverside	31	7,387	10,375		17,762
32	San Diego	30	1,235	3,912	49	5,195
33	Imperial	9	814	1,162		1,976
	In-state Totals	529	50,401	56,363	236	107,000
34	Nevada	32	5,673	4,123		9,796
35	Arizona	37	10,204	7,857		18,061
36	Mexico	8	1,910	850		2,760
	Out-of-state Totals	77	17,787	12,830		30,617
	TOTAL ALL PROJECTS	**606**	**68,188**	**69,193**	**236**	**137,617**

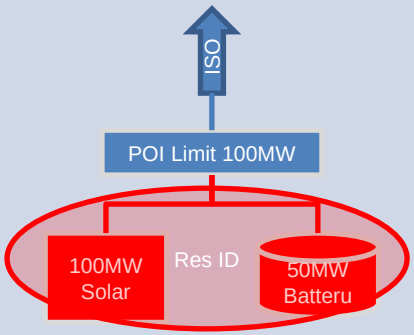
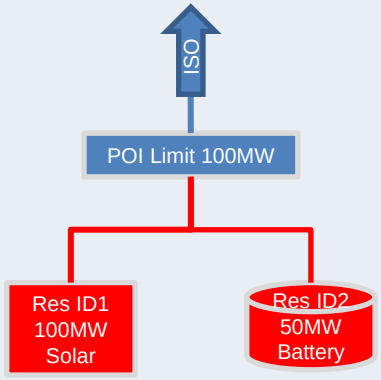
Energy storage capacity in ISO queue



Hybrid / Co-located resource opportunities

- Increasing value high penetration of solar
- Extends and smooths production of variable resource
- Efficient use of existing land developed for renewable
- Efficient use of interconnection capability
- Efficient source of charging energy

Hybrid vs. Co-located Resources

Hybrid vs. Co-located	Definition	Resource Adequacy Qualifying Capacity	Forecasting / Dispatch
Hybrid 	A Generating Unit, with a unique Resource ID at a single Point of Interconnection, with components that use different fuel sources or technologies.	QC of Hybrid Resource= ELCC (discounted for charging energy) + Battery: 4-hour sustainable Production	• No aggregate forecast for hybrid • Hybrid expected to follow dispatch
Co-located 	A Generating Unit with a unique Resource ID that is part of a Generating Facility with other Generating	QC of Renewable resource = ELCC (discounted by charging energy) QC of Battery= 4-hour sustainable production	• VER component will be forecast • VER dispatched rules • Battery will dispatched and state of charge managed

Additional opportunities and considerations

- Hybrid resources providing ancillary services
  - Managing point of interconnection constraint for energy and ancillary services
- Investment Tax Credit effect on charging storage
  - Charging from renewable production
  - DC-DC charging
- Distributed Energy Resource Hybrid resources
  - Distribution interconnection considerations
  - Counting rules
  - Measurement and Verification