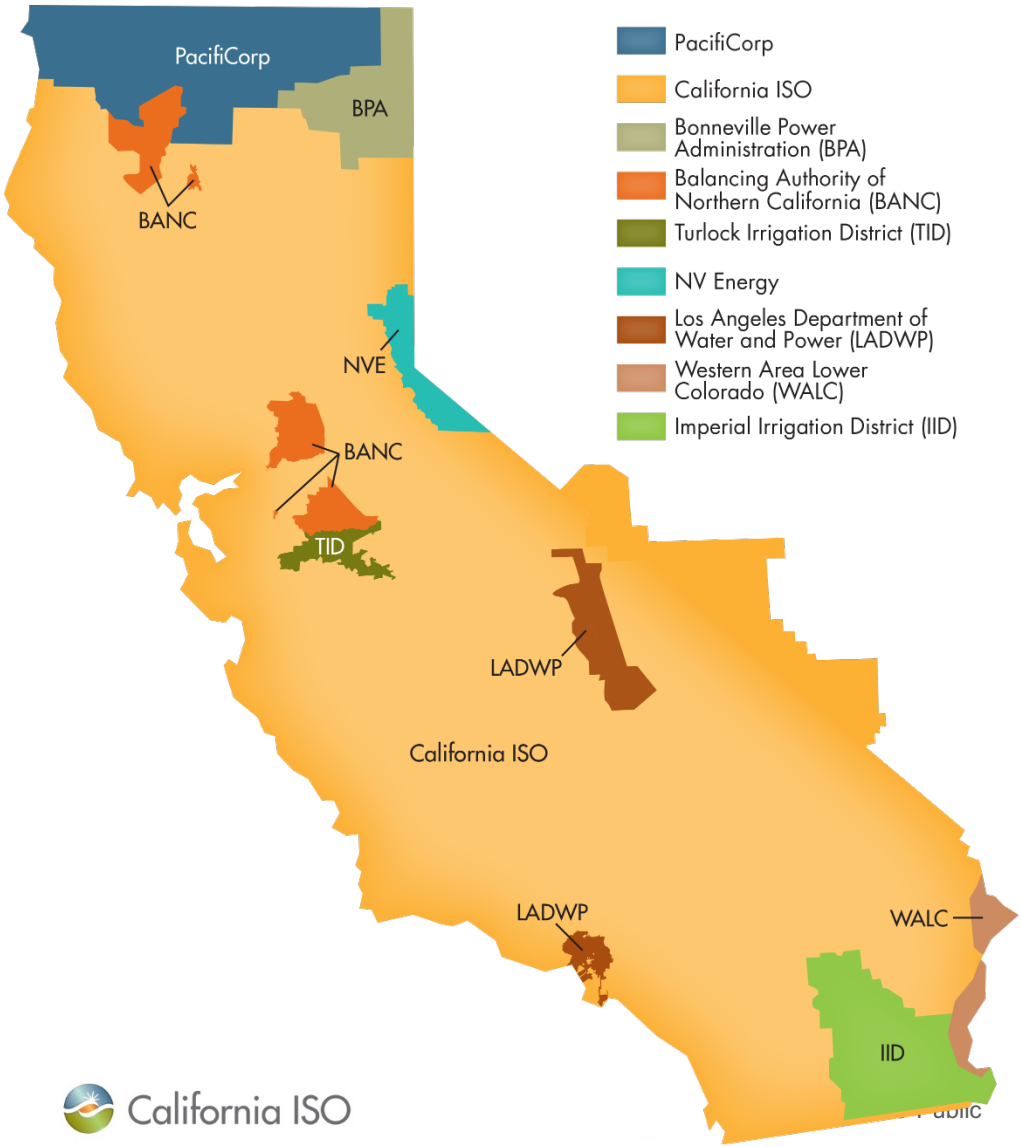
Storage Technologies – Solutions to Support Renewable Energy Integration

Renewable Grid Initiative
National Energy and Climate Plans Workshop

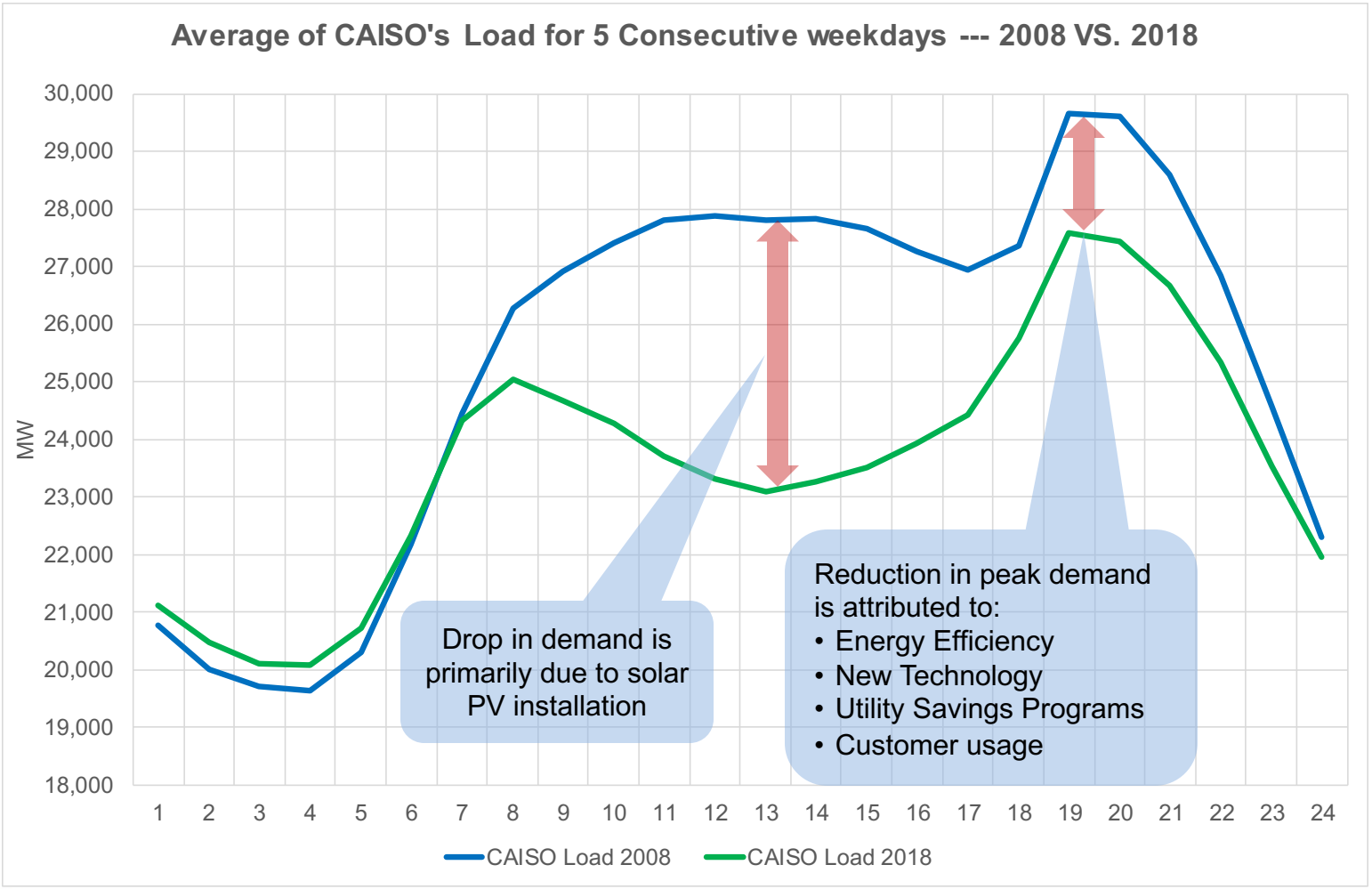
Roma Eventi Fontana di Trevi, Piazza della Pilotta 4
October 29, 2019

California ISO footprint is about 80% of California

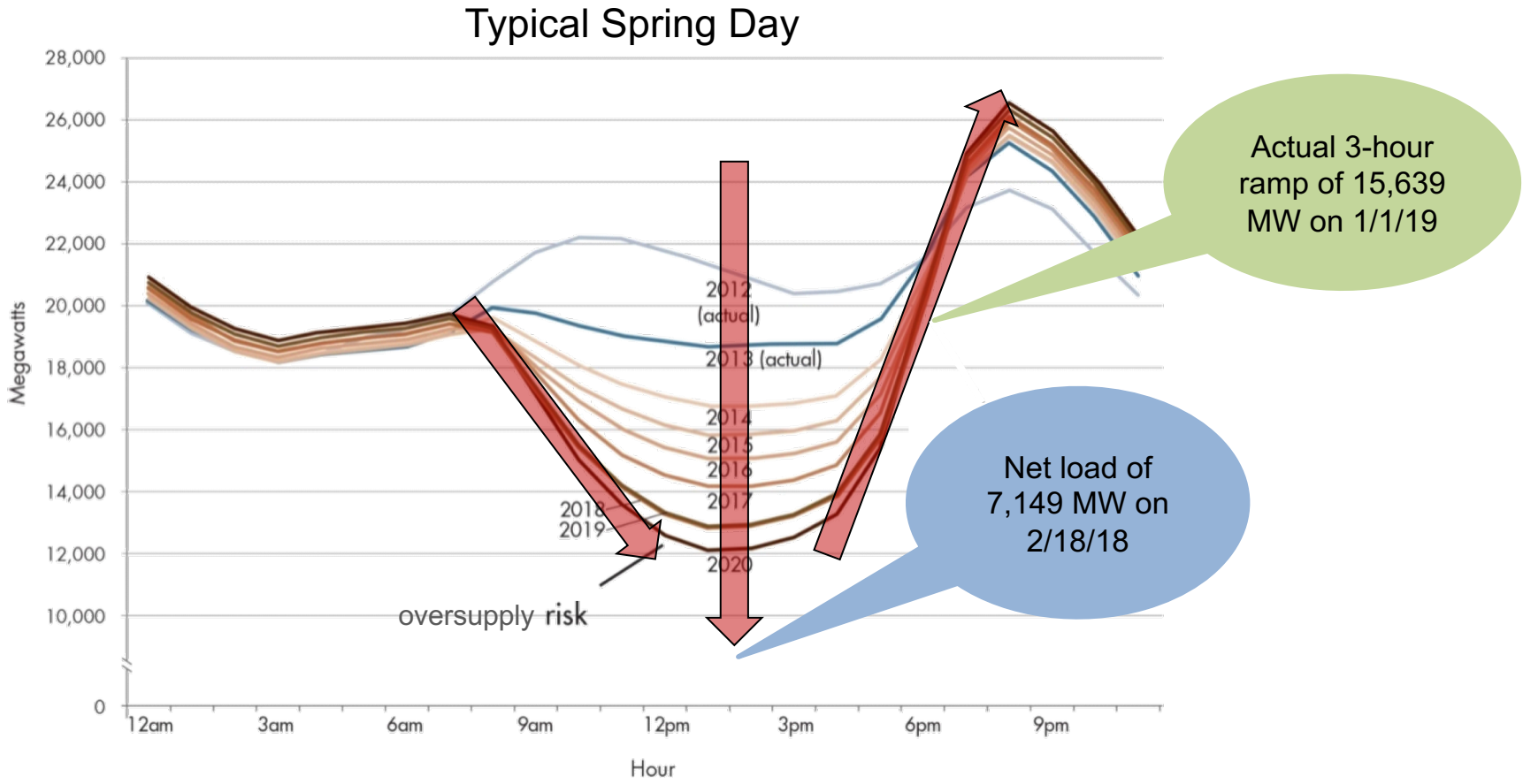


- **72,461** MW of power plant capacity (net dependable capacity)
- **50,270** MW record peak demand (July 24, 2006)
- **31,208** market transactions daily
- **~26,000** circuit-miles of transmission lines
- **30 million** people served
- **239 million** MWh annually

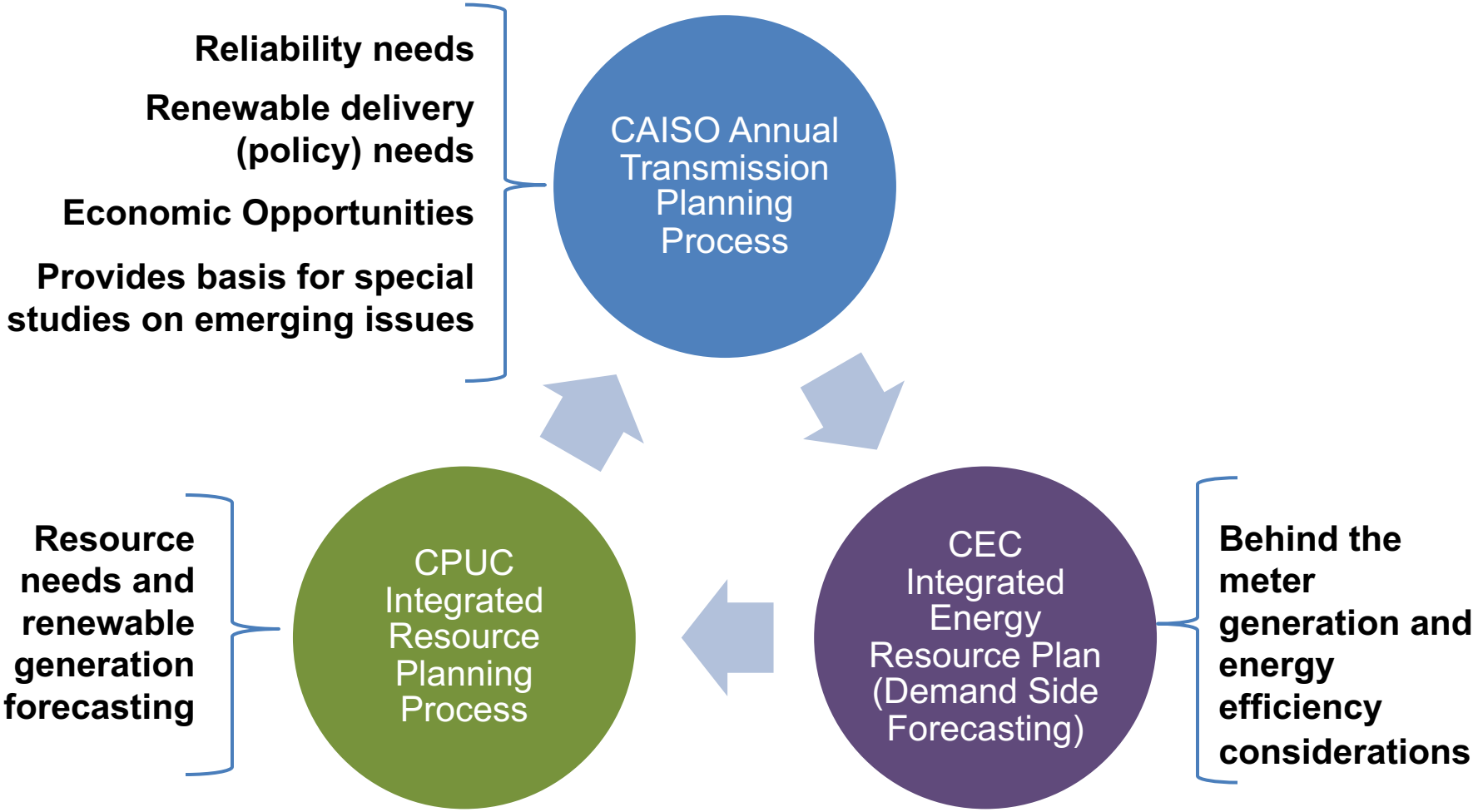
The CAISO's daily load shape shows the effect of behind the meter solar: March 2008 vs. March 2018



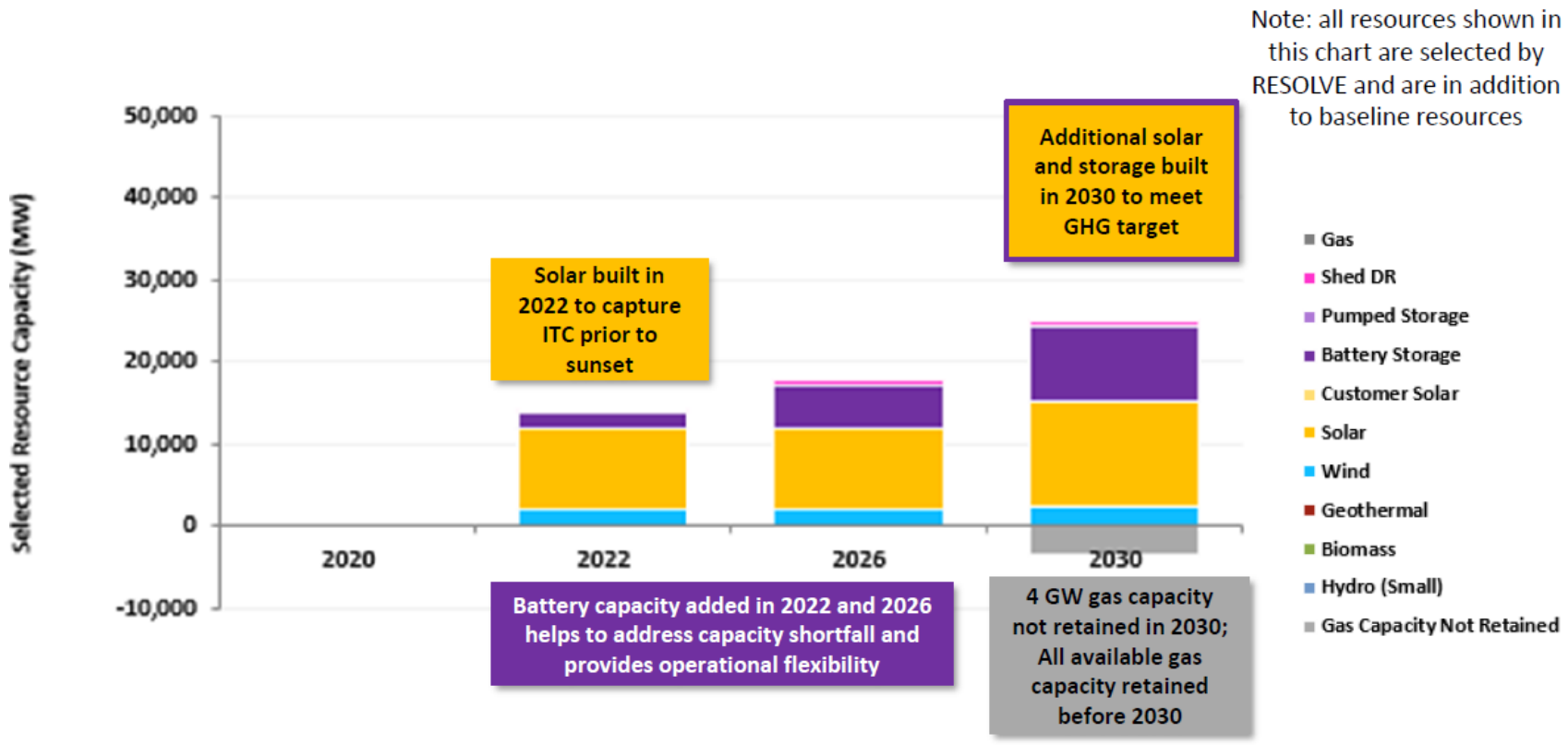
The “duck” is even more pronounced considering grid-connected renewable generation: Actual results are approximately four years ahead of original estimates



The CAISO's annual transmission planning process is coordinated with state forecasting efforts

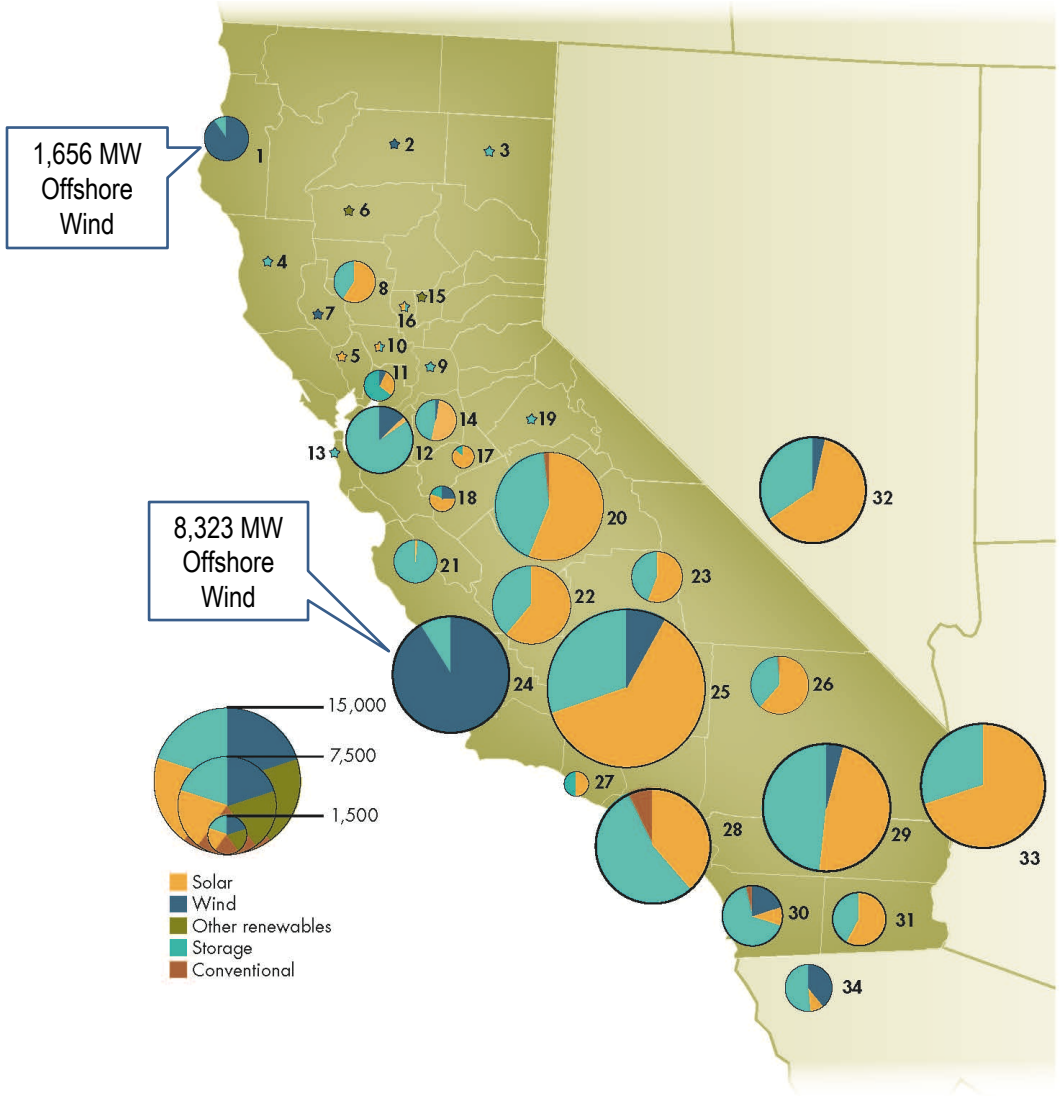


Current state resource planning processes favor even a stronger shift to solar and battery storage to meet state 60% renewables portfolio standard goals by 2030…



CPUC IRP Workshop October 8, 2019 Presentation: https://www.cpuc.ca.gov/General.aspx?id=6442459770

Queue Map – Conventional & Renewables – July 24, 2019

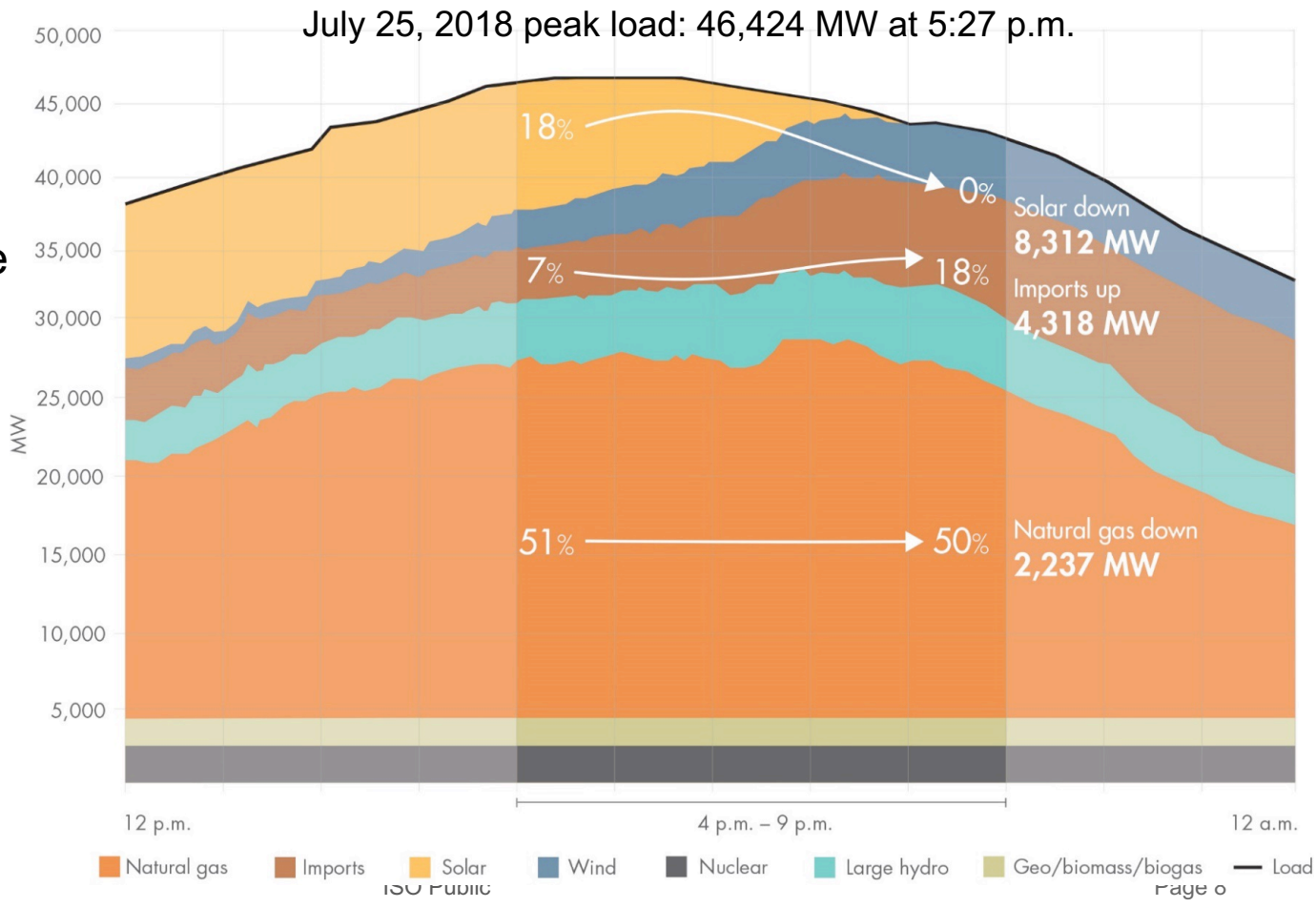


Interconnection queue by county

	County	# of Projects	Megawatts Renewables	Storage	Conventional	Total
1	Humboldt	6	1910	201		2,110
2	Shasta	1	200			200
3	Lassen	2	21	27		48
4	Mendocino	1		31		31
5	Napa	1	30			30
6	Tehama	2	6			6
7	Lake	3	145	39		184
8	Colusa	9	1,198	825		2,023
9	Sacramento	1		59		59
10	Yolo	2	12	12		24
11	Solano	5	454	821		1,275
12	Alameda-Contra Costa-Santa Clara	24	634	3,510		4,144
13	San Francisco	1		250		250
14	San Joaquin	14	994	862		1,857
15	Yuba	1	6			6
16	Sutter	2	100	100		200
17	Stanislaus	7	657	108		765
18	Merced	12	833	200		1,033
19	Tuolumne	1		10		10
20	Fresno-Madera	45	4,734	3,562	123	8,419
21	San Benito-Monterey	6	30	1,867		1,898
22	Kings	24	3,443	2,176		5,619
23	Tulare-Inyo	13	1,285	1,014		2,299
24	San Luis Obispo	11	8,994	856		9,850
25	Kern	81	11,633	5,022		16,655
26	San Bernardino	24	2035	1,232	38	3,306
27	Ventura	2	500	500		1,000
28	Los Angeles-Orange	28	3,893	5,469	700	10,062
29	Riverside	38	6,223	5,761		11,984
30	San Diego	35	1,233	2,709	141	4,082
31	Imperial	13	1,837	1,337		3,175
	In-state Totals	415	53,041	38,560	1,002	92,604
32	Nevada	28	5,235	2,738		7,973
33	Arizona	24	7,383	3,157		10,540
34	Mexico	6	1,057	1,128		2,185
	Out-of-state Totals	58	13,675	7,023		20,698
	TOTAL ALL PROJECTS	**473**	**66,716**	**45,583**	**1,002**	**113,301**

Imports and gas-fired generation are being relied upon to meet ramping and late afternoon peaks – storage is expected to play a larger future role

- Increasing behind the meter and grid connected solar driving up other requirements in late afternoon.
- Battery storage expected to play a larger role
- Example: gas was available, but wind appeared and met part of the need during declining solar output.



Solar *plus* battery storage is currently attractive as one of a suite of options needed for meeting energy-related goals, but *current technologies* have limitations

- Battery storage is expected to help with peak load requirements (challenge #1) and daily ramping (challenge #2) but more work is needed to understand the lifecycle cost of deep daily cycling.
- California experiences extended periods of cloud cover at moderate load levels (challenge #3) necessitating retaining the gas-fired generation fleet at least to achieve 2030 goals
- Inverter-based resources such as solar and batteries can provide excellent primary frequency response and ramping – market signals must incent the behavior

Other issues regarding transitioning to an inverter-centric future are also being investigated

- Transitioning to an inverter-centric system
  - Dynamic system performance
  - Implications of low fault current on protection
  - Reconsidering black start strategies
- Generator performance and characteristics
  - Voltage and frequency ride through
  - Momentary cessation and any other unique control features
  - Adequacy of resource modeling