California ISO
Shaping a Renewed Future

Role and Opportunity for Storage in Integrating Renewable Resources

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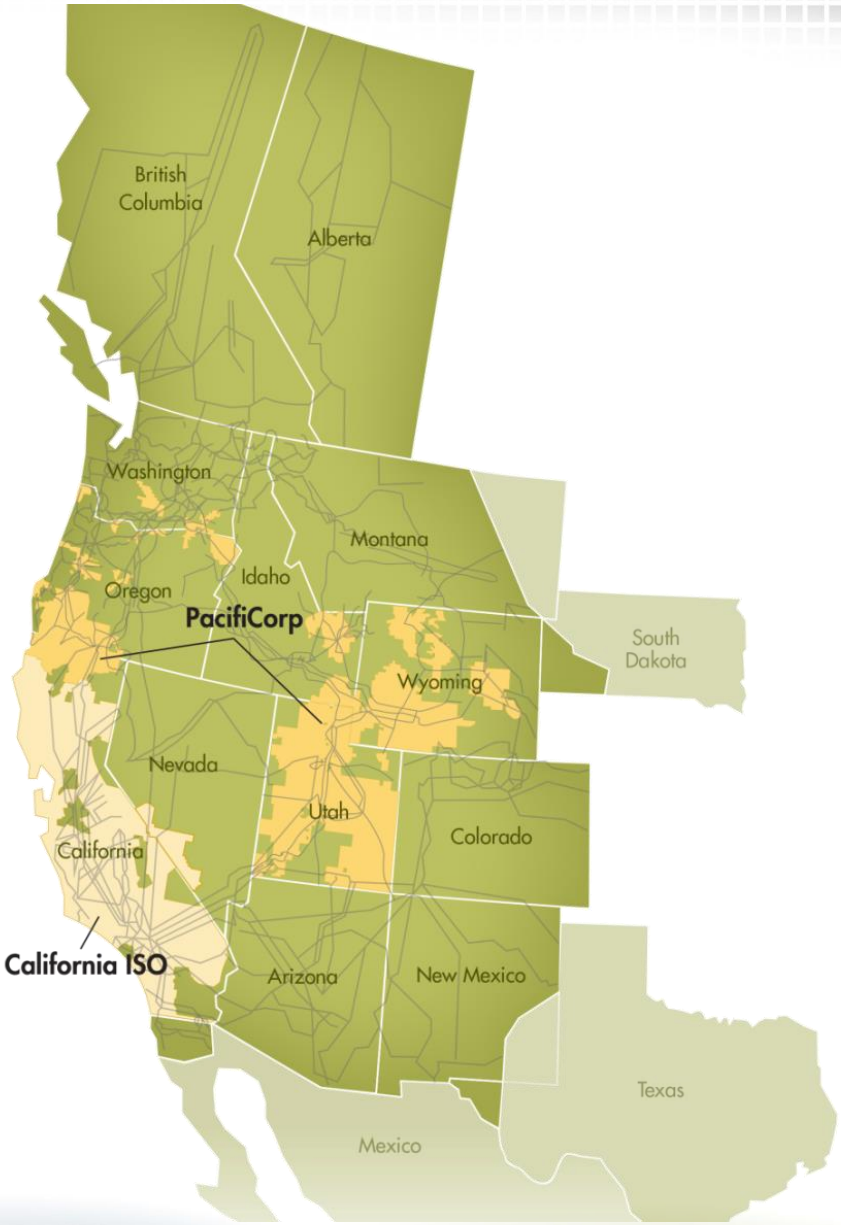
Keith E. Casey, Ph.D.
Vice President, Market and Infrastructure Development
California ISO

California ISO

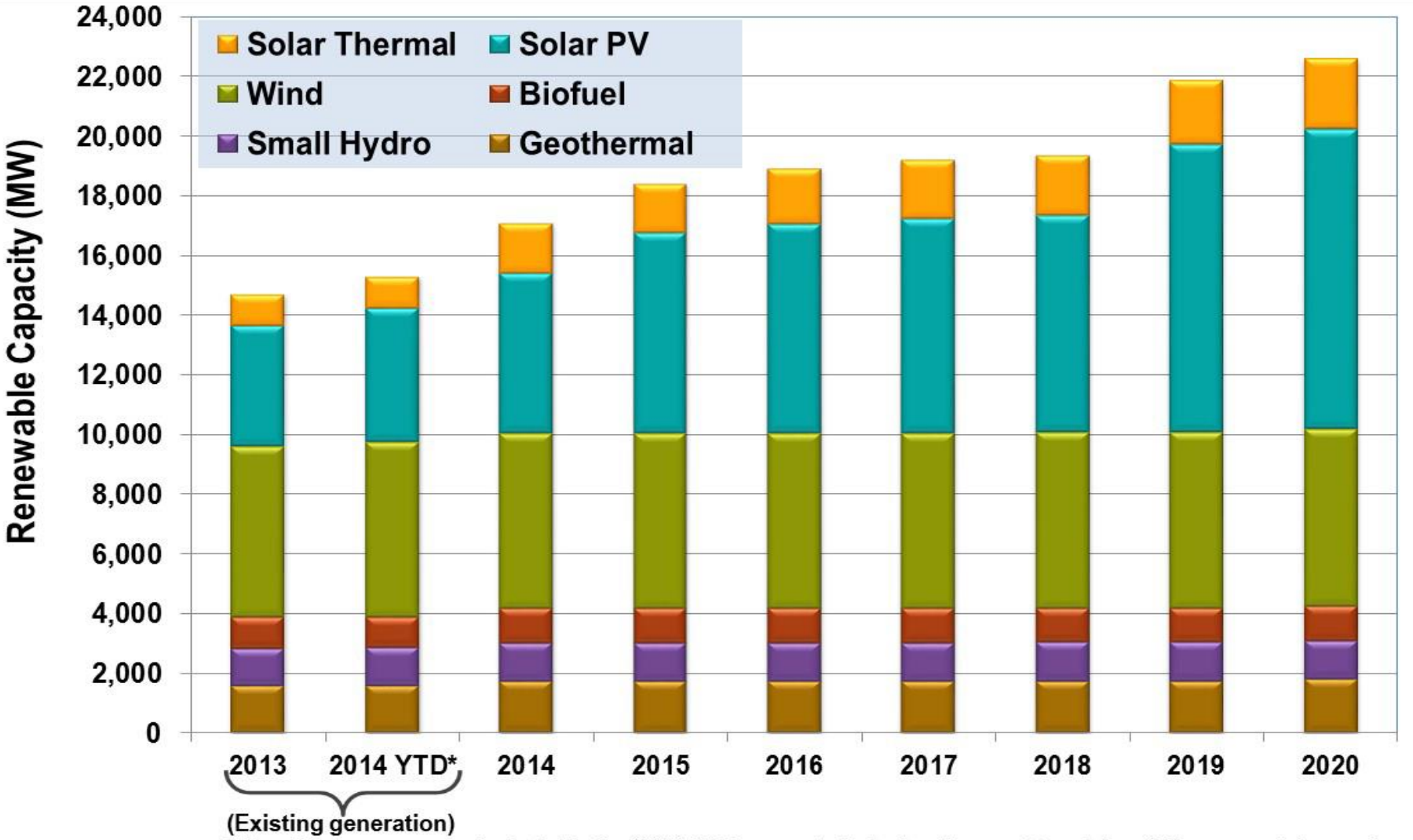
- **Nonprofit** public benefit corporation
- **Part of Western Electricity Coordinating Council**: 14 states, British Columbia, Alberta and parts of Mexico
- **65,225** MW of power plant capacity
- **50,270** MW record peak demand (July 24, 2006)
- **26,014** circuit-miles of transmission lines
- Energy Imbalance Market: Leverages the benefits of existing CAISO market. Facilitates integration of renewables by sharing diverse resources across a larger geographical area



California energy and environmental policies drive renewable integration and transmission needs

- Greenhouse gas reductions to 1990 levels by 2020
- 33% of load served by renewable generation by 2020
- 12,000 MW of distributed generation by 2020
- Ban on use of once-through cooling in coastal power plants
- Governor Brown's 2030 goals:
  - 50% renewables
  - 50% reduction petroleum use – cars & trucks
  - Double energy efficiency existing buildings
  - Make heating fuels cleaner

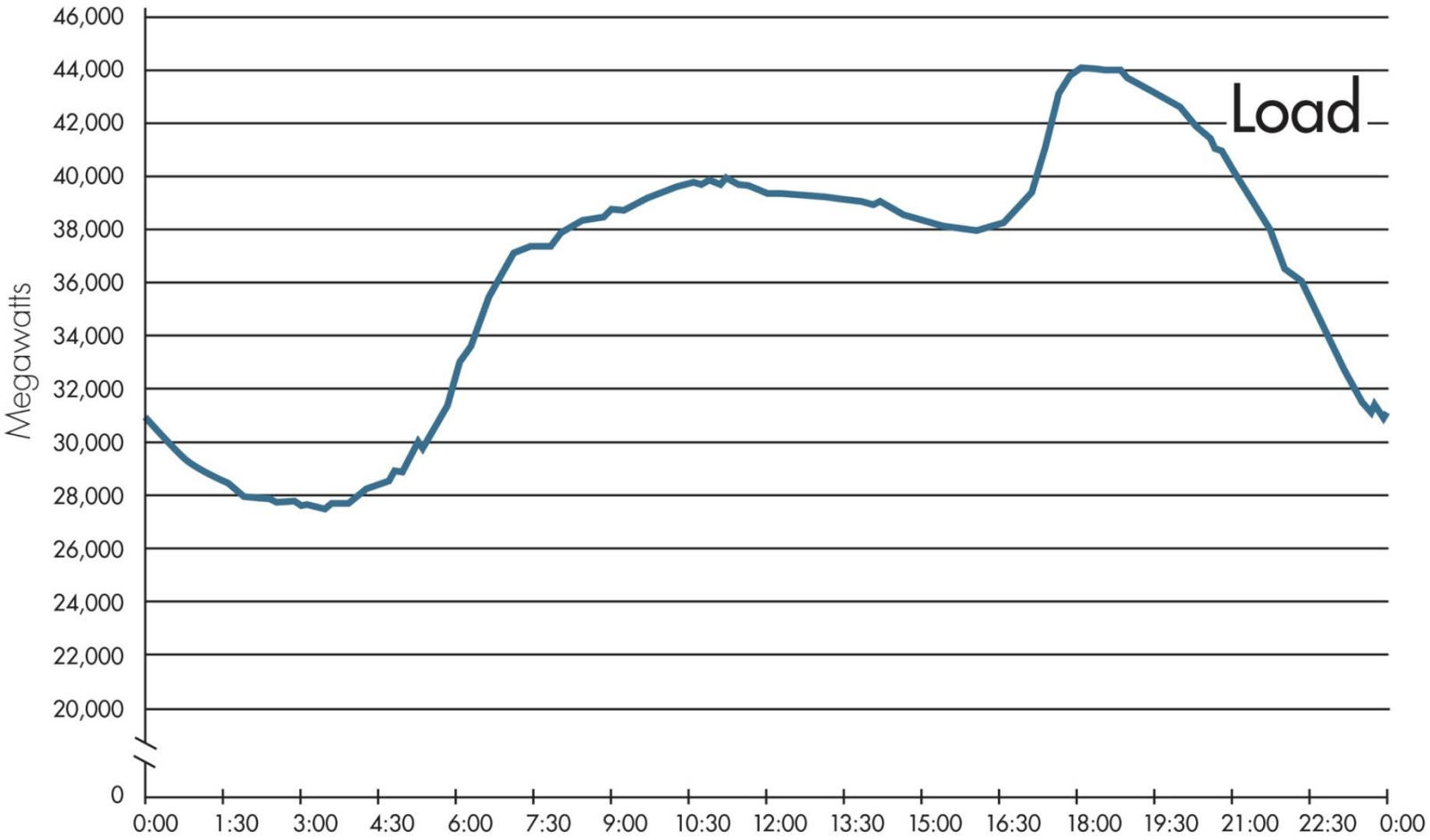
Solar generation doubles between now and 2020



*All online resources are included in the 2014 YTD amounts, including those yet to achieve full commercial operation.

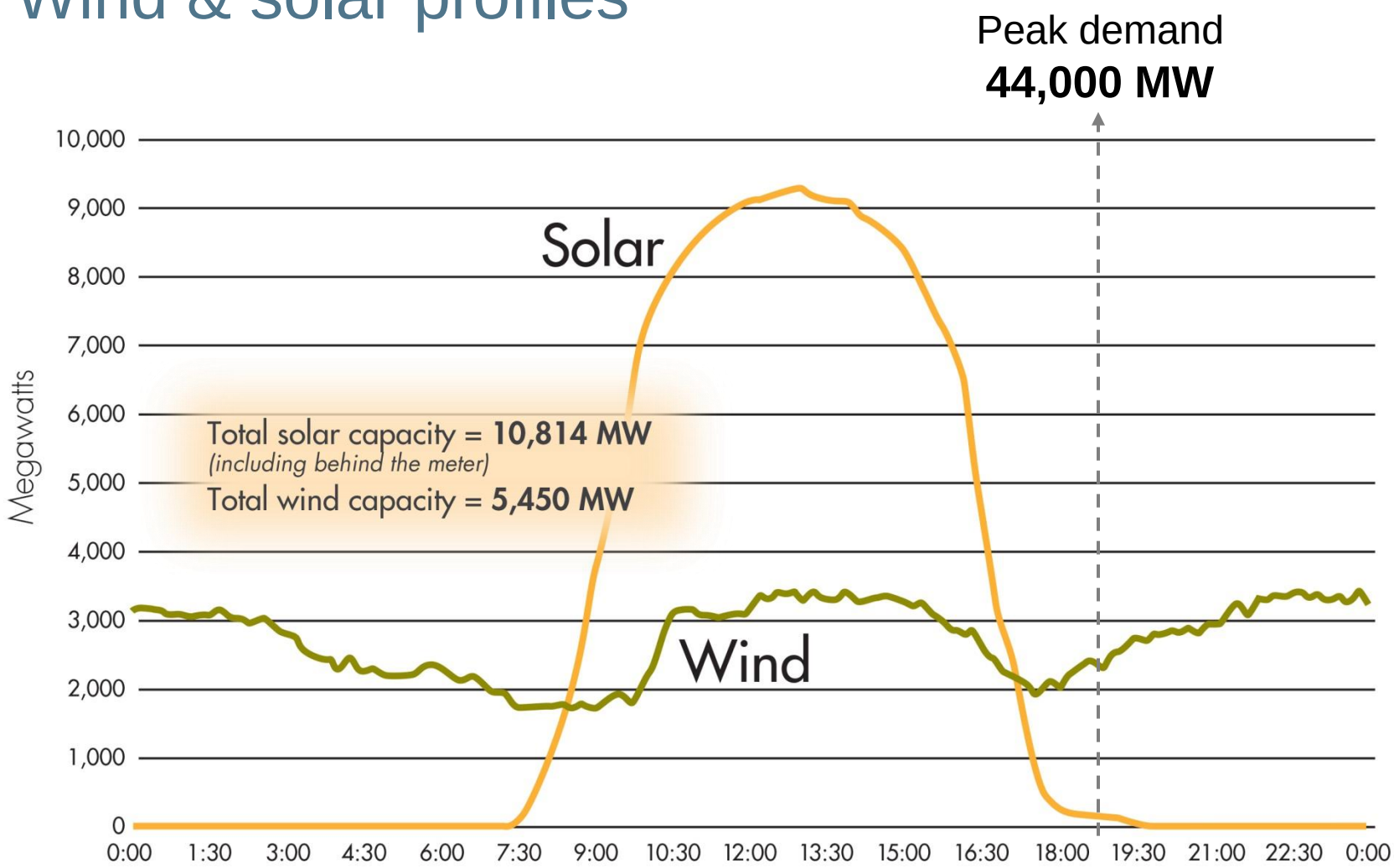
(IOU data through 2017 and RPS Calculator data 2018 – 2020)

Load profile – Sample Winter Day 2020



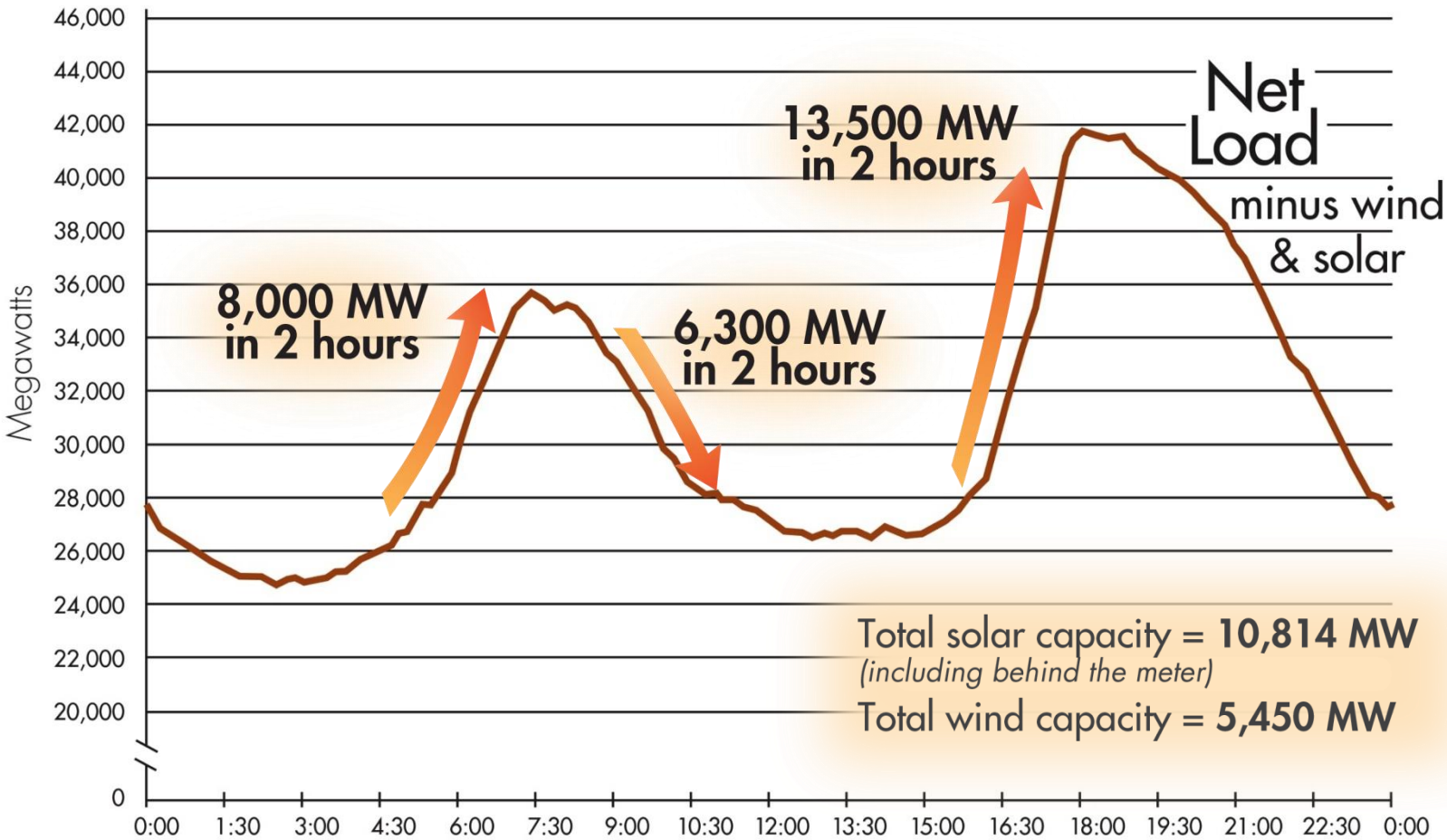
Sample winter day in 2020

Wind & solar profiles



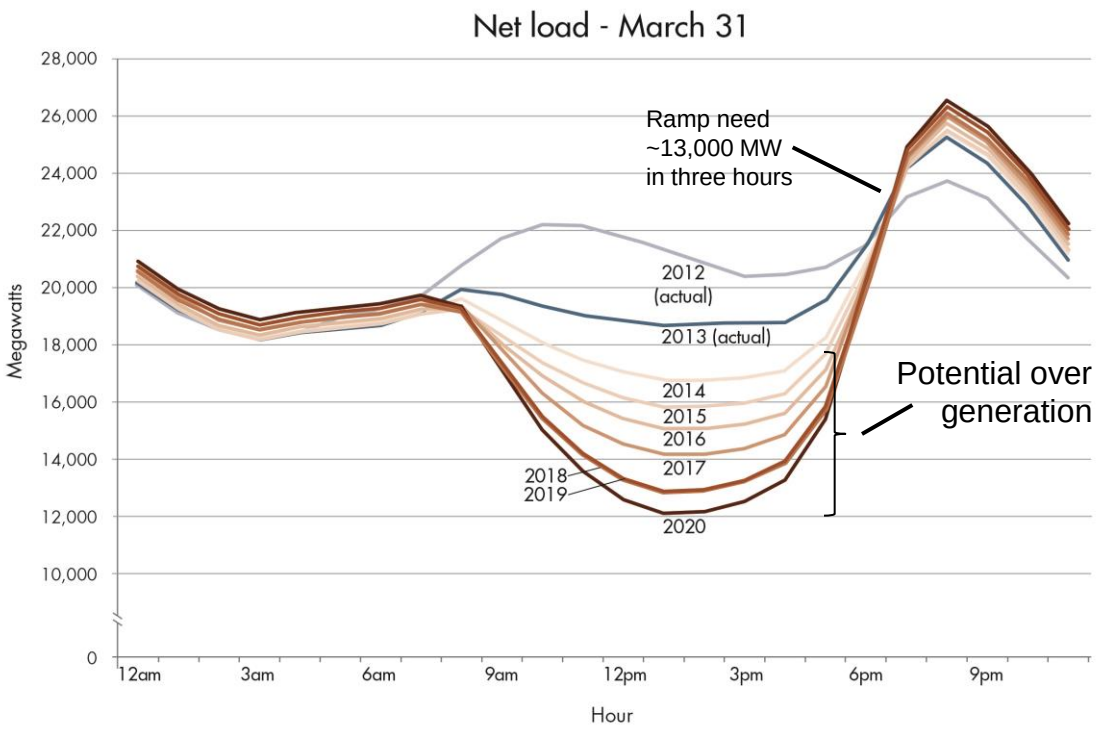
Sample winter day in 2020

Flexible resources will be essential to meeting the net load demand curve



Sample winter day in 2020

Non-Flexible resources create over-generation conditions and potential for RPS curtailment



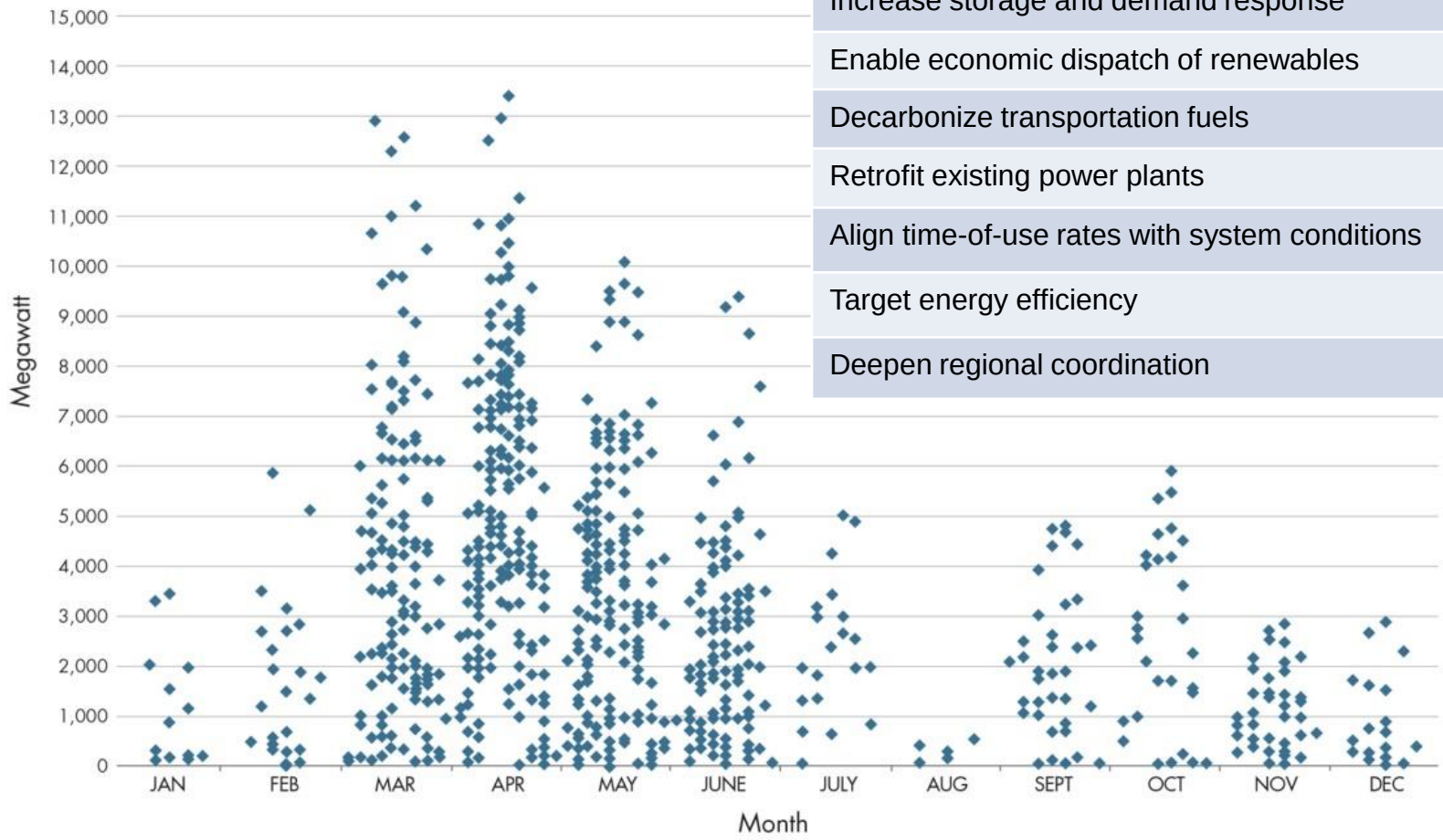
- ISO has already seen the need to curtail generation in 2014.
- Overgen may lead to curtailment because of dispatch limitations on some resources, such as:

  - Geothermal
  - Nuclear
  - Small hydro
  - Combined heat and power

- Operational requirements include:

  - Minimum gas necessary to provide ramping
  - Necessary ancillary services
  - Load following

Renewable Curtailment in 2024 at 40% RPS



Solutions
Increase storage and demand response
Enable economic dispatch of renewables
Decarbonize transportation fuels
Retrofit existing power plants
Align time-of-use rates with system conditions
Target energy efficiency
Deepen regional coordination

California's energy storage procurement targets resulted in approximately 2,000 MW of storage projects in the ISO interconnection queue.

Storage Procurement Targets

Energy Storage Procurement Targets (in MW)[22]

Storage Grid Domain Point of Interconnection	2014	2016	2018	2020	Total
Southern California Edison					
Transmission	50	65	85	110	310
Distribution	30	40	50	65	185
Customer	10	15	25	35	85
Subtotal SCE	**90**	**120**	**160**	**210**	**580**
Pacific Gas and Electric					
Transmission	50	65	85	110	310
Distribution	30	40	50	65	185
Customer	10	15	25	35	85
Subtotal PG&E	**90**	**120**	**160**	**210**	**580**
San Diego Gas & Electric					
Transmission	10	15	22	33	80
Distribution	7	10	15	23	55
Customer	3	5	8	14	30
Subtotal SDG&E	**20**	**30**	**45**	**70**	**165**
Total - all 3 utilities	**200**	**270**	**365**	**490**	**1,325**

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The initial target for transmission interconnected storage is 700 MW.

Energy Storage Roadmap – High priority actions for the ISO

- Rate treatment – Clarify wholesale rate treatment.
- Market participation –
  - Clarify existing ISO requirements, rules and market products for energy storage.
  - Identify gaps and potential changes or additions to existing ISO requirements, rules, market products and models.
  - Where appropriate, expand options to current ISO requirements and rules for aggregations of distributed storage resources.

Energy Storage Roadmap – High priority actions for the CPUC

- Planning – Describe distribution grid operational needs, clarify constraints that may limit interconnection on distribution system, and examine opportunities for storage to defer/displace distribution upgrades.
- Procurement – Clarify RA counting rules for storage and consider “unbundling” flexible capacity RA counting.
- Rate treatment – Clarify/modify net energy metering tariffs where storage is paired with renewables.
- Interconnection -- Clarify/improve distribution level interconnection processes.

Multiple-use Applications – Overview

- In a “multiple-use” scenario, the resource:
  - provides service to multiple entities, and
  - is compensated through multiple revenue streams.

- Stakeholders identified 3 main dual-use scenarios in the 2014 energy storage roadmap process:
  1) Transmission asset + market participant
  2) Service provider to both transmission and distribution systems
  3) Load-management for end-use customer + market participant

The ISO has created opportunities for the full participation of energy storage resources in the wholesale market.

Market Products

- Energy
- *Flexible ramping**
- Regulation up
- Regulation down
- Spinning Reserve
- Non-spinning reserve

Non-generator resource (NGR) model

** Planned or under development*

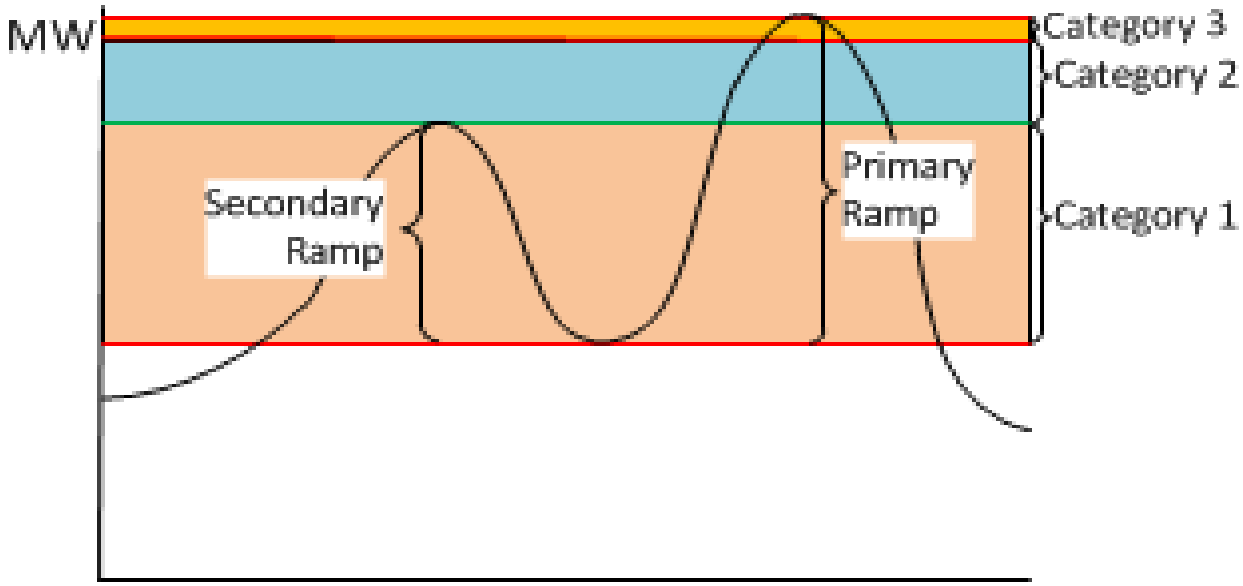
Non-Generator Resource Model Characteristics

- Modeled as a generator with positive and negative energy
- Can be dispatched seamlessly within their entire capacity range
- Constrained by an energy (MWh) limit to inject or withdraw energy on a continuous basis
- Amount of energy available for ISO participation is monitored as the “State of Charge”.
- Any resource that can operate continuously from negative to positive can use this functionality

Flexibility capacity market product and procurement rules provide opportunities for storage development.

- CPUC Long-Term Procurement Plan (LTPP)
  - All system load (peak and off-peak)
  - Flexibility needs (ramping and over-generation)
- Resource Adequacy (RA) Program
  - Flexible Capacity Requirements
  - Must-Offer Obligations in ISO Market
- ISO day-ahead and real-time markets
  - Flexible Ramping Product (under development)

RA flexible capacity categories enable a portion of flexible capacity needs to be provided by preferred resources that have limited availability



Category 1 (Base Flexibility): Set at level of the largest secondary 3-hour net-load ramp (Secondary Ramp)

Category 2 (Peak Flexibility): Set at difference between largest secondary 3-hour net-load ramp and 95% of maximum 3-hour net-load ramp ((0.95*Primary Ramp)-Secondary Ramp)

Category 3 (Super-Peak Flexibility): Set at 5% of maximum 3-hour net-load ramp (0.05*Primary Ramp)

Proposed offer obligations associated with each category

Parameter	Category 1 (Base Ramping)	Category 2 (Peak Ramping)	Category 3 (Super-Peak Ramping)
Economic Bid Must-Offer Obligation	5:00 a.m. – 10:00 p.m.	5 hour block (determined seasonally)	5 hour block (determined seasonally)
Energy Requirement	Minimum 6 hours at EFC	Minimum 3 hours at EFC	Minimum 3 hours at EFC
Daily Availability	7 days/week	7 days/week	Non-holiday weekdays
Daily Start-Up Capability	The minimum of two starts per day or the number of starts allowed by minimum up and down time	At least one start per day	At least one start per day
Examples of resource Types that Could Qualify for Category	Conventional gas fired resources, wind resources hydro resources, and storage resources with long discharge capabilities	Use-limited conventional gas fired resources, solar resources and conventional gas fired peaking resources	Short discharge battery resources providing regulation and demand response resources