Slice of Day Approach to RA Markets

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Together, Building a Better California

Decarbonization Goals Impact Reliability Programs

Traditionally, resources had complementarity in cost trade offs.

- Complementarity was based on capital/running cost trade-offs:
  - Base load (high capital /low running cost)
  - Cycling plants: (medium capital costs/medium running cost)
  - Peaking plants: (low capital costs / high running costs)

In world of climate change, complementarity of resources is in fuel availability.

- Complementarity between resources changes with changing resource portfolio.
  - Fossil resources can be available anytime, but there is expressed desire for reduced emissions.
  - Renewables (wind and solar) are only available when fuel is available.
  - Storage consumes energy and is only available when sufficiently charged.

Decentralized Approach: Planning and Compliance in California

California's Decentralized (market) Approach:

- Individual LSEs are responsible for planning and procuring to meet their own load.
- CPUC is responsible for setting the requirements (both long-term and near term) that each LSE must meet.
- Competition provides incentive to meet requirements at least cost.

CPUC problem:

How to set requirements so that reliability is maintained?

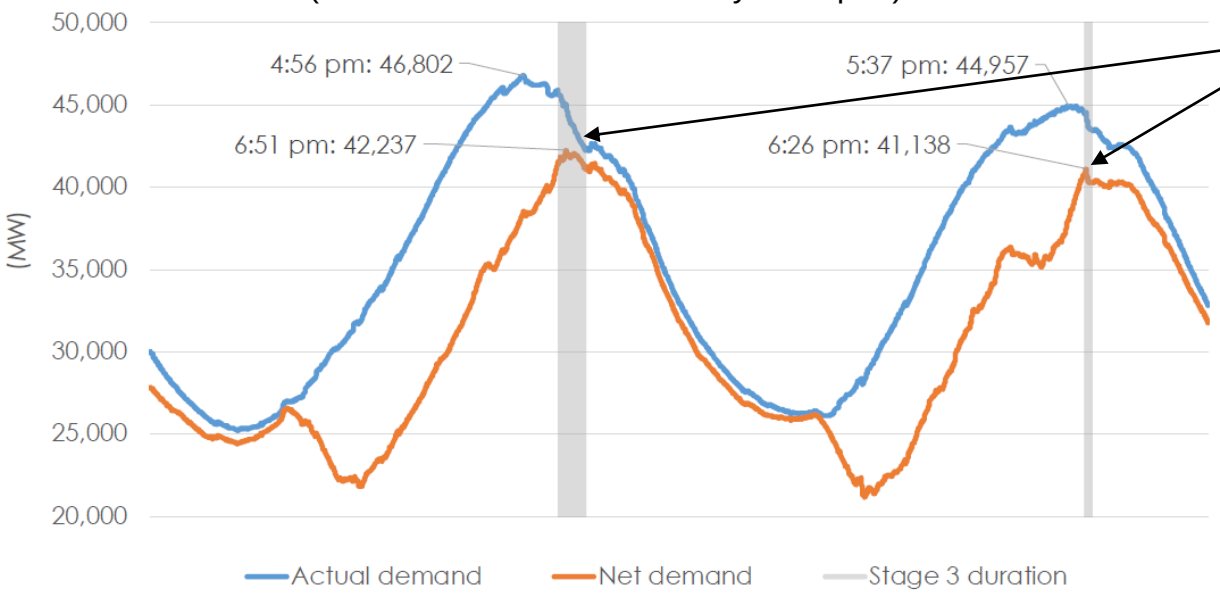
RA program in California is not a planning mechanism, but a compliance mechanism.

Background: Slice-of-Day Proposal

The RA program must evolve to address demand in all hours of the day

- California's RA program was designed to meet **gross peak demand**
  - But the resource mix is increasing its reliance on **energy-limited** resources
- The summer 2020 events highlighted the **challenges with the current approach**
  - Meeting **net peak demand** has become a growing concern
  - **Challenges in other hours** are likely in the future as large levels of energy storage are added

Actual Demand and Net Demand for August 14 and 15
(from Prelim Root-Cause Analysis Report)



Outages coincide with net peak demand

Prelim Root-Cause Analysis Report:
"Today, **the single critical period of peak demand is giving way to multiple critical periods during the day** including the net demand peak, which is the peak of load net of solar and wind generation resources." (p. 47)

Comparison: Slice-of-Day Proposal

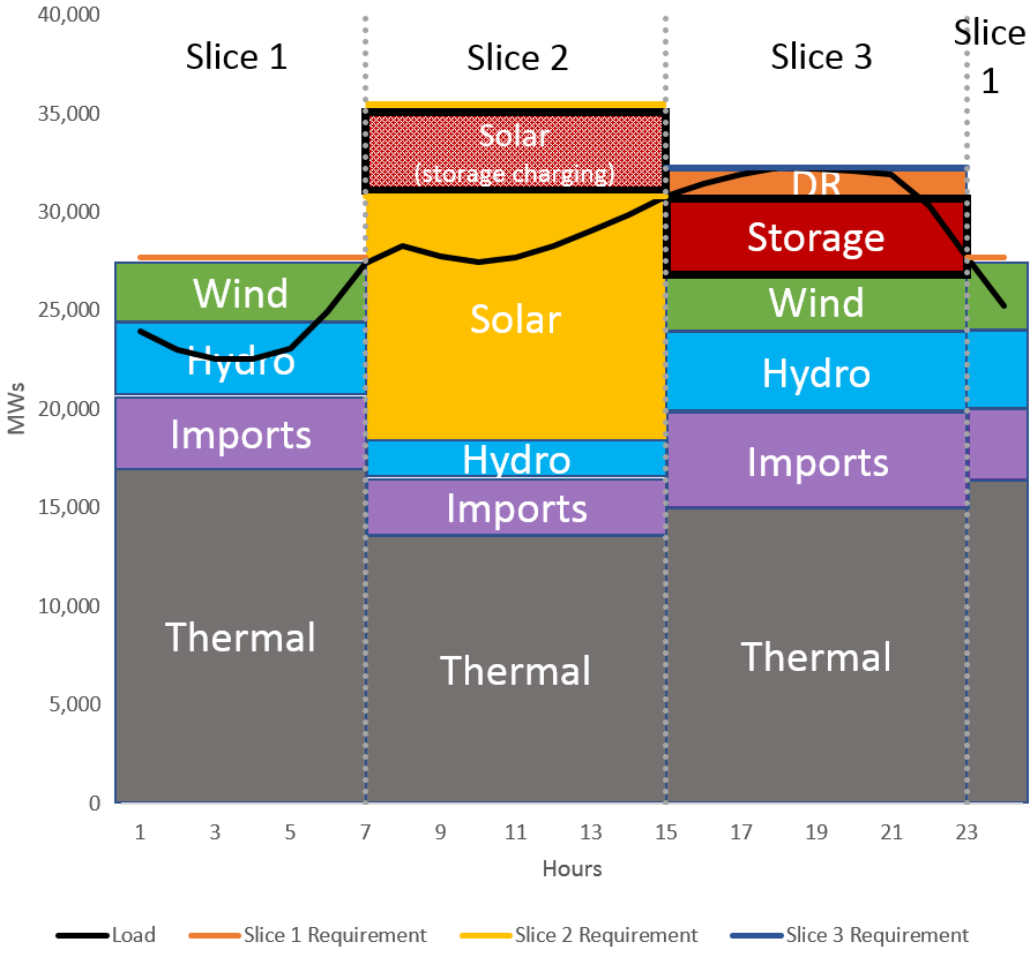
To address the changing resource mix, the proposal changes the RA requirement from a single peak period to multiple peak periods or "slices" across a 24-hour period

Summary of "Slice-of-Day" Changes Relative to Status Quo

#	Description	Today	"Slice-of-Day"
1	RA Showing Requirements	Gross peak hour; annual and monthly	Peak hour in each slice-of-day; seasonal
2	Establishment and Allocation of Requirements	Top-down based on forecasted peak load	Bottoms-up based on forecasted peak load in each slice-of-day
3	Resource Counting	Resource/technology dependent (PMax, exceedance, ELCC)	Exceedance (determined for each slice-of-day)
4	Energy Market Obligation	24/7	All hours during slice-of-day for which the resource is shown
5	RA Requirements Related to Energy Storage Charging	None	LSE is obligated to show capacity to meet charging needs

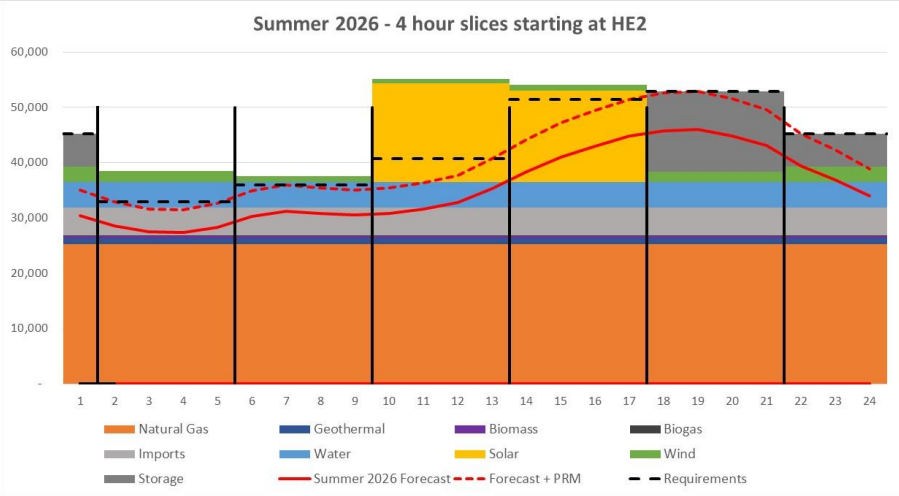
Example: Slice-of-Day Proposal

Illustrative RA Requirements and Resource Stack



- Resources would count for each slice-of-day based on the ability of the resource to produce during that period.
- Energy storage presents a unique operational characteristic in that it needs to charge to discharge.
  - In addition to a positive NQC, it would also have a 'negative NQC' that would increase the LSE's requirement in one of the other slices.

Alternative Slice/Season Options

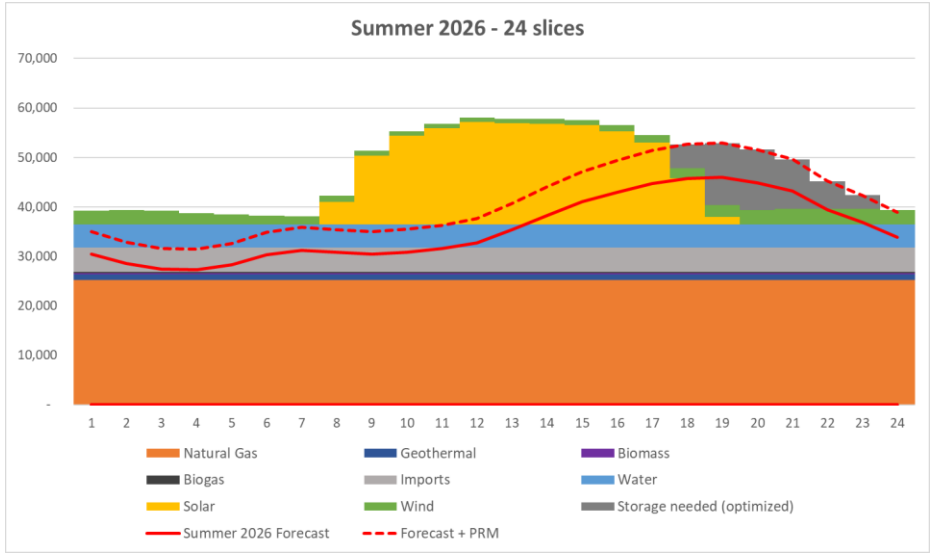


Options 1:

- 6 4-hour slices calculated on a seasonal basis with unbundling of capacity across slices

Option 2:

- 24 1-hour slices calculated on a monthly basis with required bundling of capacity across slices



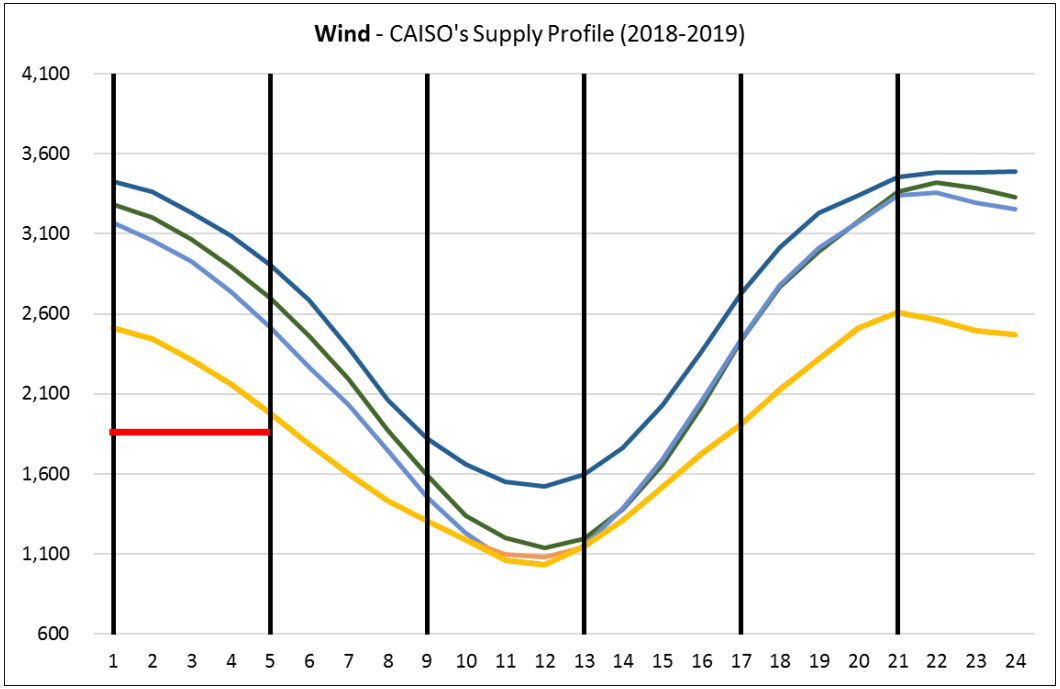
Resource Value for Wind / Solar

Draw upon approach used for hydroelectric exceedance

- "Dry" water year receives greater weight
- Similarly, lower monthly data receives higher weight for wind / solar

Example:

- Includes wind profiles for four summer months with six 4-hour slices
- Exceedance value set based on the observed production in each season and slice
  - In this case, four summer months, in each 4-hour slice
- In the example, the lowest profile would receive higher weight to account for the variability
  - See red bar, which is intended to demonstrate a value below the average



Resource Value: Standalone Energy Storage

PG&E Proposal

Standalone energy storage resources should be counted by measuring the **full output capability of the storage resource, accounting for energy capacity**.

- The full output will be measured over the determined slice duration subject to the interconnection limit
  - **Example:** A 100MW (400MWh) storage resource could count for:
    - 100MW for 4 hours or
    - 40MW for 10 hours.
- LSEs need to show sufficient capacity to charge the storage, namely capacity that can produce the energy (plus losses) needed to charge the resource.
- No limitations to showing in multiple slices throughout the day if the resource is operationally capable and/or willing to charge and discharge multiple times

Wrap Up

- Addition of climate concerns impacts the complementarity of resources and their trade-offs.
  - Single attribute product thinking must yield to multi-attribute product thinking.
- Industry structure makes a difference in achieving goals.
  - Centralized planning and build structures can assess trade-offs more effectively.
  - Decentralized competitive structures are less effective in getting the best portfolio of resources.
- Slice-of-day focuses on:
  - Ample resource available in all hours of the day as the resource mix changes.
  - Making sure LSEs bring resources that could be used to meet their load.

Slice of Day is one approach to implementing compliance in a decentralized market structure.