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Description:	S2.5 Mark Kootstra, CEC
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Multi-Year Reliability: Scope, Inputs, and Assumptions

July 8, 2021

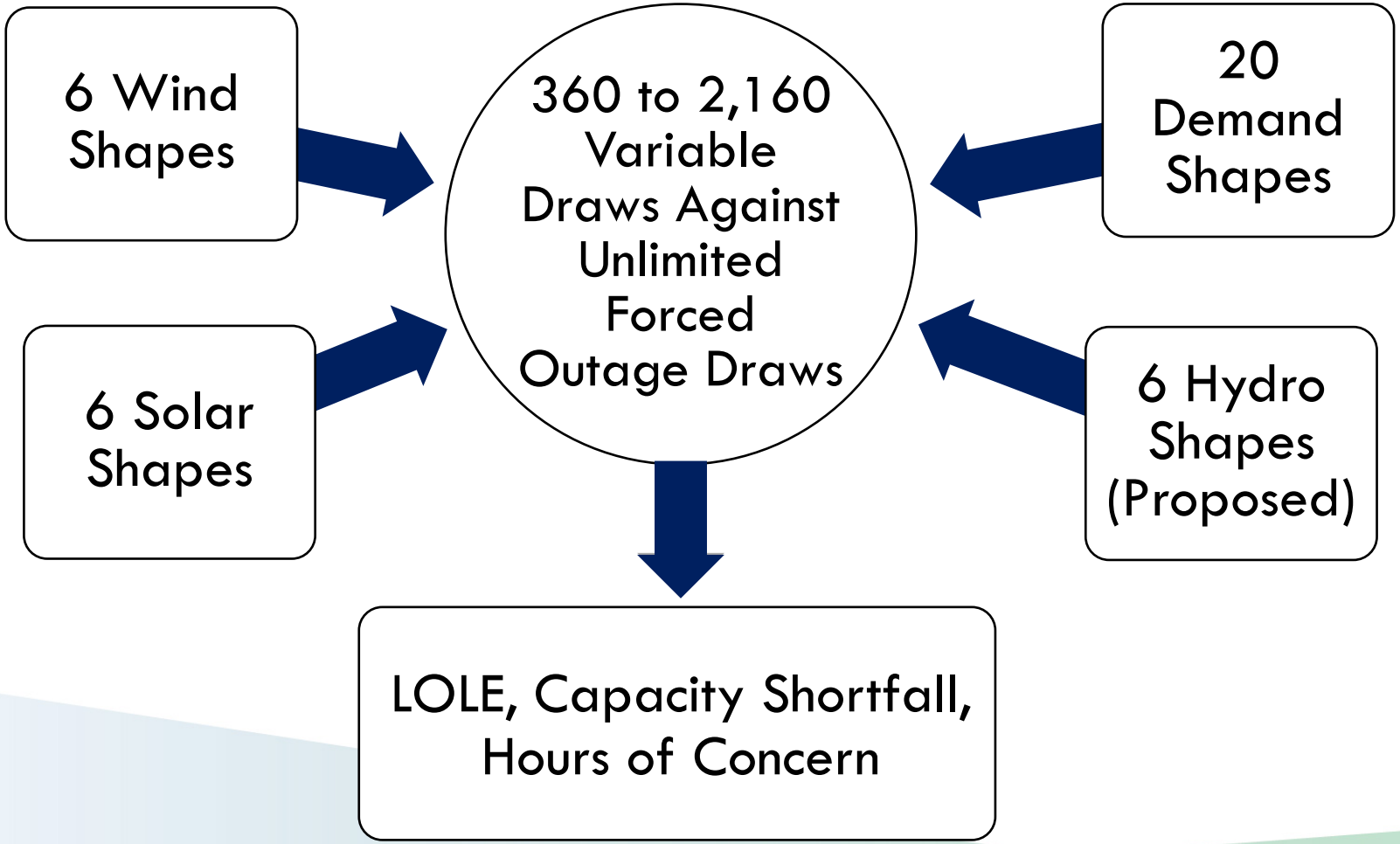
Mark Kootstra

Key Study Questions

- Is additional capacity beyond current procurement orders needed to meet the standard LOLE of 1 day with unserved energy every 10 years, or 0.1days/year?
  - If so, how much and when?

- If so, does new incremental gas capacity improve reliability compared to a portfolio of new preferred resources with equivalent NQC values?

Methodology: Uncertainty Considered



Methodology: Reliability Benefits of Gas

The reliability benefits of gas generation will be assessed by adding incremental NQC resources until the LOLE is at or below 0.1. Scenario studies are expected to look at additions of:

- Only incremental gas capacity
- Combinations of renewables and energy storage
- Combinations of renewables, energy storage, and incremental gas capacity

Demand Response

Total demand response proposed is based on CPUC IRP stack analysis assumptions: 2,195 MW

Stakeholder Questions:

- What is the best way to characterize demand response in the model?
- What dispatch restrictions should be placed on demand response?
  - No more than X hours in a year, month, day, or consecutively?
  - Energy limitations?
- Should the use of demand response by the model in peak hours result in increased load during other hours? If so, when and how much?
- Should uncertainty related to DR be incorporated into the model? If so, how?

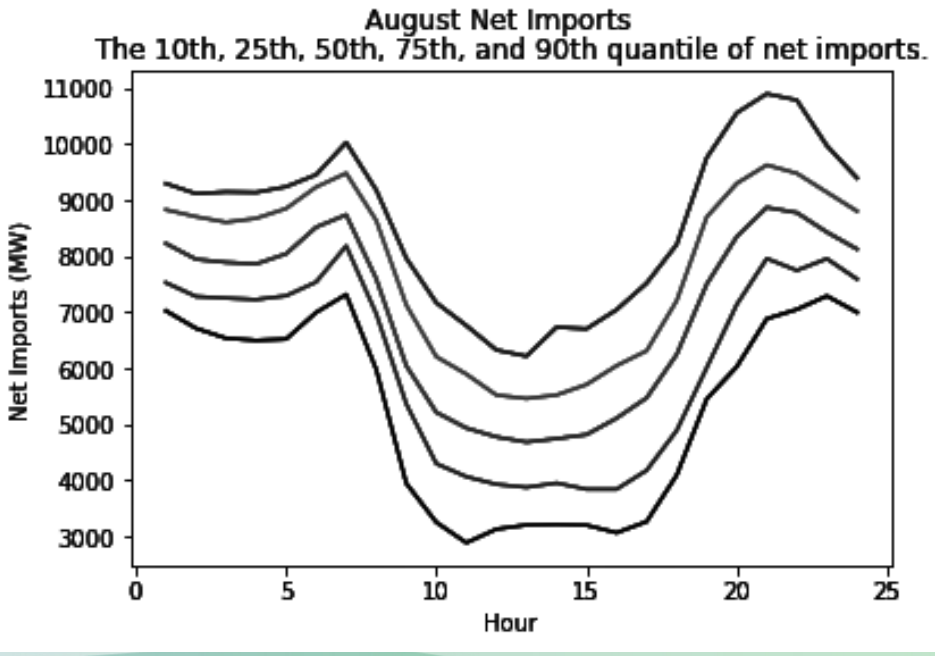
Import Assumptions

Options for import assumptions:

- Based on historic RA showings, a single monthly maximum import capacity

MW limits	July	August	September
Maximum RA Showing	6,197	6,480	8,498
Minimum RA Showings	3,840	5,624	4,486
Average RA Showings	5,340	6,095	5,921

- Single 24 h-month import shape based on historic net imports to the CAISO



Imports Assumptions

Stakeholder Questions:

- How should imports be included in the analysis? Options:
  - Historic RA showings
  - Historic economic imports
  - At what level (min, max, mean, median)
  - Something else
- Should availability of imports change through the study horizon? If so, how?
- Should uncertainty related to imports be incorporate into the model? If so, how?

Wind, Solar, and Hydroelectric Plants

Stakeholder Question:

- Should solar and wind weather years be linked to each other or demand?
- Should historic profiles or artificially generated solar and wind shapes be used?
- How should hydroelectric generation be modeled? Options:
  - Monthly NQC value, with no restrictions on generation up to that capacity.
  - Historic average fixed shape.
  - Distribution of historic profiles to account for uncertainty.
    - Should these profiles be linked to wind and solar weather years?

Forced Outages

Options:

- Apply outages to models of individual power plants.
- Apply outages to an estimated standard unit size (approximate).

Plant Type	Forced Outage Rate (%)	Mean Time to Repair (h)	Standard Unit Size (MW)
Thermal - not Cogen	7.2	23	100
Thermal - Cogen	8	38	100
Nuclear	3.1	298	1,140
Geothermal	7.2	24	25
Biomass	8	38	10
Imports - Specified	7.2	23	100

Forced outage rates are adapted from NERC GADs data included in the CAISO Resource Adequacy Enhancements Draft Final Proposal- Phase 1 and Sixth Revised Straw Proposal from December 17, 2020. Mean time to Repair is adapted from the CEC IEPR PLEXOS dataset.

Forced Outages

Stakeholder Questions:

- Should forced outages be applied to other technology types?
  - Forced outages are incorporate into profile shapes for wind and solar.
- Should more specific technology types be used?
- What forced outage rates should be used for each technology?
- What average outage duration should be used?
- If an estimated standard unit size is used, what should it be for each technology type?

Planned Resource Build

Straw Proposal for a Resource Build

- Assumes all new wind and solar is paired with energy storage on a 1:1 power capacity basis.
- Uses Currently published marginal ELCC values for wind, solar and energy storage.
  - Average ELCC values for Geothermal.
- CEC plans to do additional analysis to generate a final resource build for the study.

	Net Qualifying Capacity					Installed Capacity				
Resource	**2023**	**2024**	**2025**	**2026**	**Total**	**2023**	**2024**	**2025**	**2026**	**Total**
Hybrid (Solar + 4h Storage)	850	3,150	1,500	-	5,500					
Hybrid Solar						850	4,646	2,568	-	8,065
Hybrid Energy Storage						850	4,646	2,568	-	8,065
Hybrid (Wind + 4h Storage)	150	350	-	-	500					
Hybrid Wind						150	516	-	-	666
Hybrid Energy Storage						150	516	-	-	666
Geothermal	-	-	-	1,000	1,000	-	-	-	1,124	1,124
8h Storage	-	-	-	1,000	1,000	-	-	-	1,000	1,000
4h Storage	1,000	2,500	-	-	3,500	1,000	3,687	-	-	4,687
Total	**2,000**	**6,000**	**1,500**	**2,000**	**11,500**	**3,000**	**14,012**	**5,137**	**2,124**	**24,272**

Planned Resource Build

Stakeholder Questions:

- What resource mix should be used when adding capacity to meet the ordered procurement from all outstanding procurement orders?
- For hybrid resources, what should be the ratio of energy storage and generation capacity?
  - Should this be different for wind, solar, etc.?
- Is it reasonable to expect significant capacity will come online prior to the required dates?

Next Steps

- Staff is requesting comments and responses to questions be submitted to the docket: 21-IEPR-04 by July 23, 2021
  - Please include sources, rational, and numbers in your response to the stakeholder questions.
  - Are there things we need to consider as we develop this analysis?
- Staff is expecting to publish their final analysis in September 2021.

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Appendix A: Stakeholder Questions

Stakeholder Questions

CEC staff requests that responses and suggestions include:

- Sources or rational for any recommendations.
  - Sources should be publicly available information.
- Specific numbers, ratios, or ranges, when possible, rather than just general suggestions.

Stakeholder Questions: Demand Response

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- How should imports be included in the analysis? Options:
  - Historic RA showings
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- Should availability of imports change through the study horizon? If so, how?
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Stakeholder Questions: Wind, Solar, Hydro

- Should solar and wind weather years be linked to each other or demand?
- Should historic profiles or artificially generated solar and wind shapes be used?
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Stakeholder Questions: Resource Build

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Appendix B: Technical Slides

Methodology: Loss of Load Expectation

Loss of load expectation (LOLE) is an industry standard used to measure resource adequacy.

Calculated using a probabilistic model with thousands of samples drawing from multiple load profiles, variable renewable energy profiles and random outage draws:

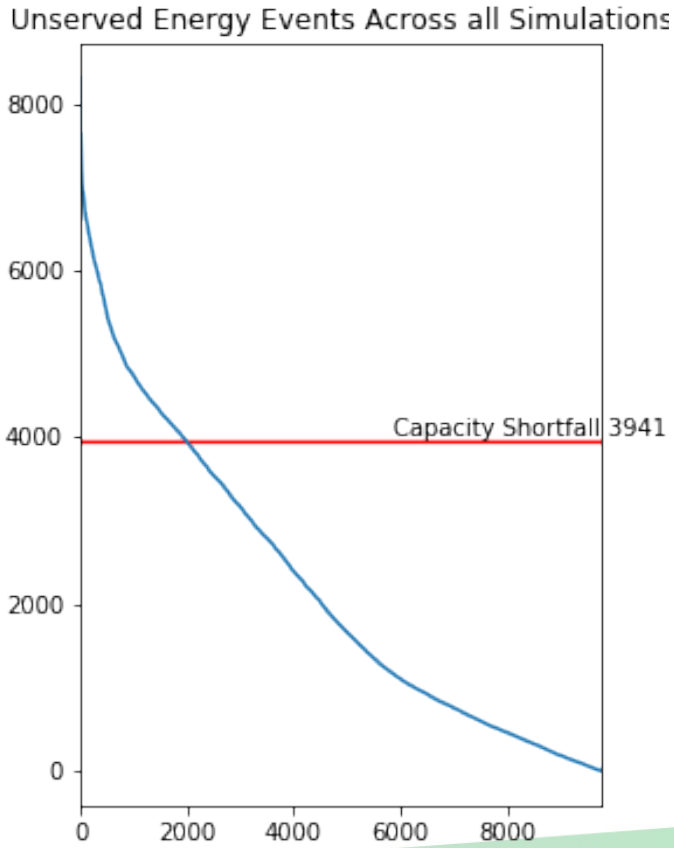
$$LOLE = \frac{total\ number\ of\ days\ with\ unserved\ energy}{number\ of\ samples}$$

An LOLE > 0.1 days with unserved energy/year means the resource stack does not meet the reliability metrics and additional capacity is needed.

Methodology: Determining Capacity Shortfall

The capacity shortfall for a 100 sample simulation is the 11th highest unserved energy event when ordered from highest to lowest unserved energy event. For a 20,000 sample simulation, it would be the 2,001th highest unserved energy event when ordered from highest unserved energy to lowest unserved energy. See the sample figure to the right.

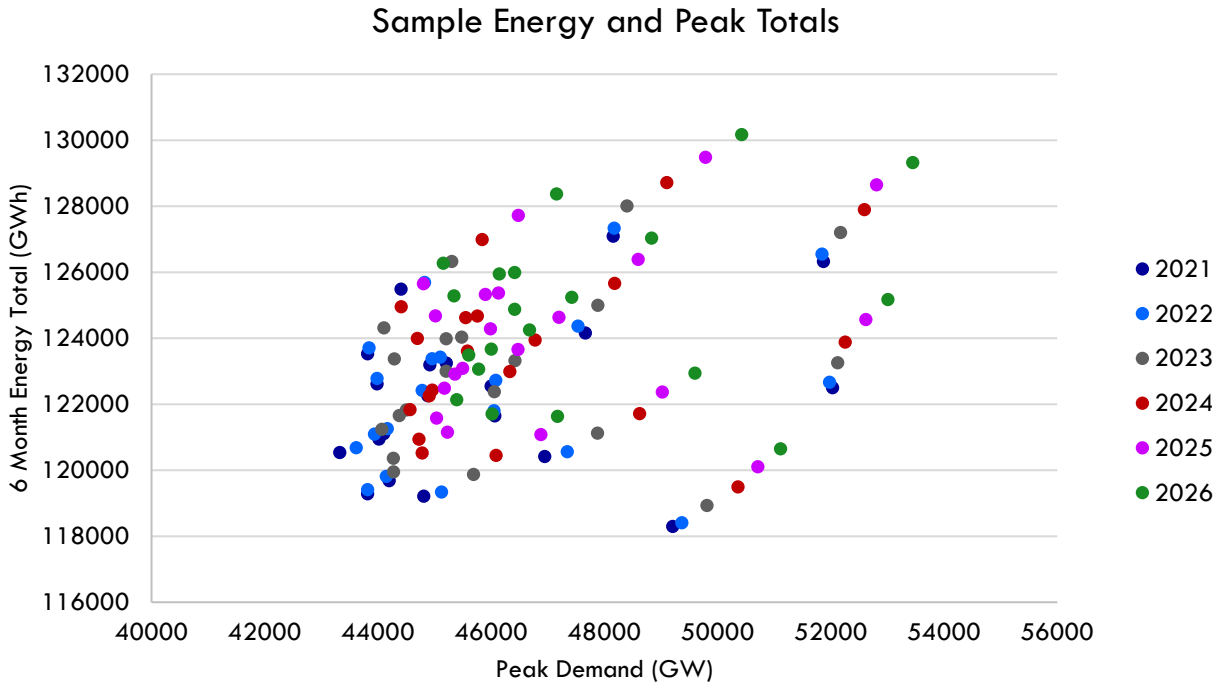
This is approximately the net qualifying capacity (less unexpected outages) needed to meet reliability requirements. However, the exact NQC needed will depend on the time of the outages and the resources selected to meet the shortfall.



Demand Assumptions

Demand Distribution Characteristics:

- Consumption levels for 20 weather years, 2000-2019
- Include May – October for years 2021-2026
- Hold all load modifiers (BTM solar, AAEE, climate change, etc.) and VEA load (~150 MW peak load)



The final demand distribution for this study will be posted to the docket.

Raw demand data is scaled up by 6% to account for operating reserves.

Import Assumptions

Options for import assumptions:

- Based on historic RA showings, a single monthly maximum import capacity
- Single 24-month import shape based on historic net imports to the CAISO

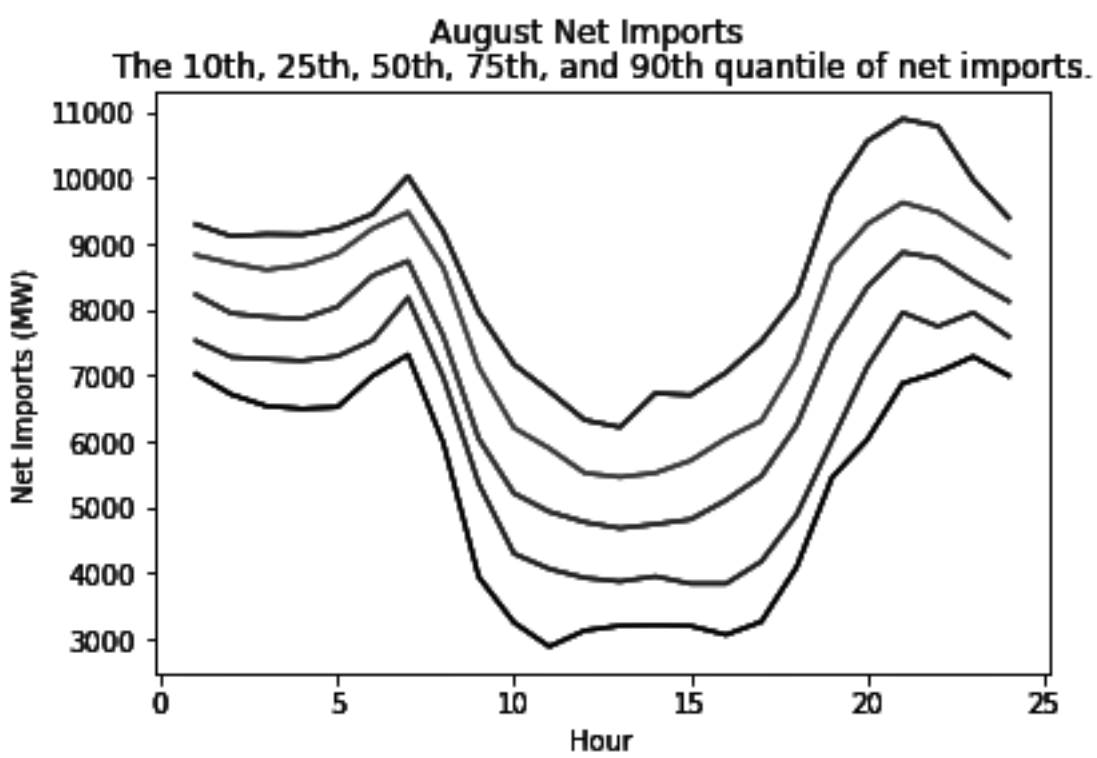
Historic RA Showing for Imports

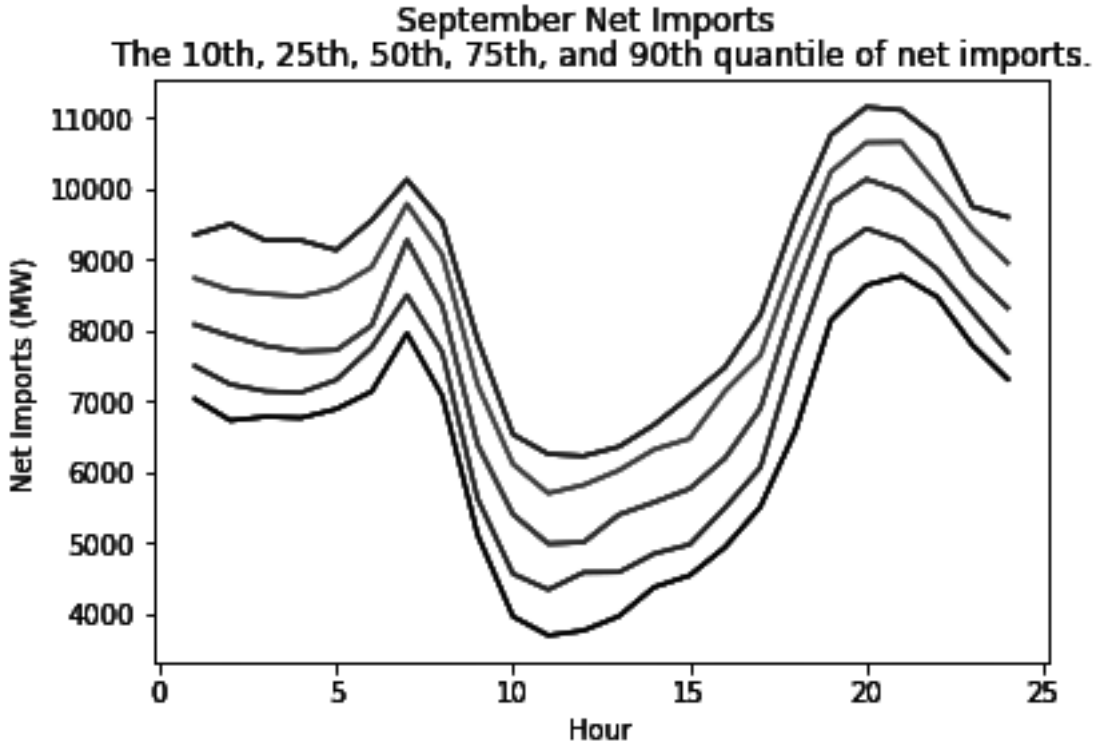
Based on the 2015-2020 RA Showings

Source: November 2020 CAISO Supply Stack

MW limits	May	June	July	August	September	October
Maximum Import Capacity	10,805	10,805	10,805	10,805	10,805	10,805
Maximum RA Showing	3,909	4,692	6,197	6,480	8,498	5,036
Minimum RA Showings	3,181	3,311	3,840	5,624	4,486	3,167
Average RA Showings	3,484	3,922	5,340	6,095	5,921	4,171

Historic Economic Imports





Notes:

1. Data is from publicly posted CAISO data on imports for December 2019 through November 2020.
2. Data is in hour ending and observes daylight savings.

Wind and Solar Assumptions

- From 6 years of CAISO data, 2015-2020
- Wind and solar are aggregated (one wind plant, one solar plant, or one Joint plant)
- Forced outages are incorporated within the profile.
- **Stakeholder Question:**
  - Should solar and wind weather years be linked?