Energy+Environmental Economics

Contextualizing Need in Step 2 of the CAISO's LTPP Analysis

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Agenda

1. Context for “Need” Resulting from CAISO Analysis
2. Drill down into need result from All-Gas Case
3. Lessons learned from “Deep Dive” analysis

Context for Need Results of Step 2 Analysis

Framework of Integration Analysis

- **The "Vintage" (2009) cases from the CAISO Integration Analysis were built to the 15-17% planning reserve margin before being simulated in PLEXOS to determine integration need**
  - All need for new capacity above PRM was described as "integration need"—need above a threshold that has served as an adequate margin in traditional capacity planning
- **The adaptation of the CAISO Integration Analysis for use in the CPUC LTPP process relaxed the assumption that the simulated system was built to meet PRM exactly**
  - Instead, the CPUC cases modeled the large capacity surplus expected with the achievement of the 33% RPS
- **In order to rationalize the seemingly counterintuitive results of the All Gas case (1,400 MW need) and the renewable cases (no need), the results need to be reframed:**
  - What are the main drivers of need in the CPUC cases?
  - What does "need" actually mean in the All-Gas case?

Methodology

+ **This analysis uses a "constrained hour" approach to focus on system operations during the hours when the system is pushing its limits**

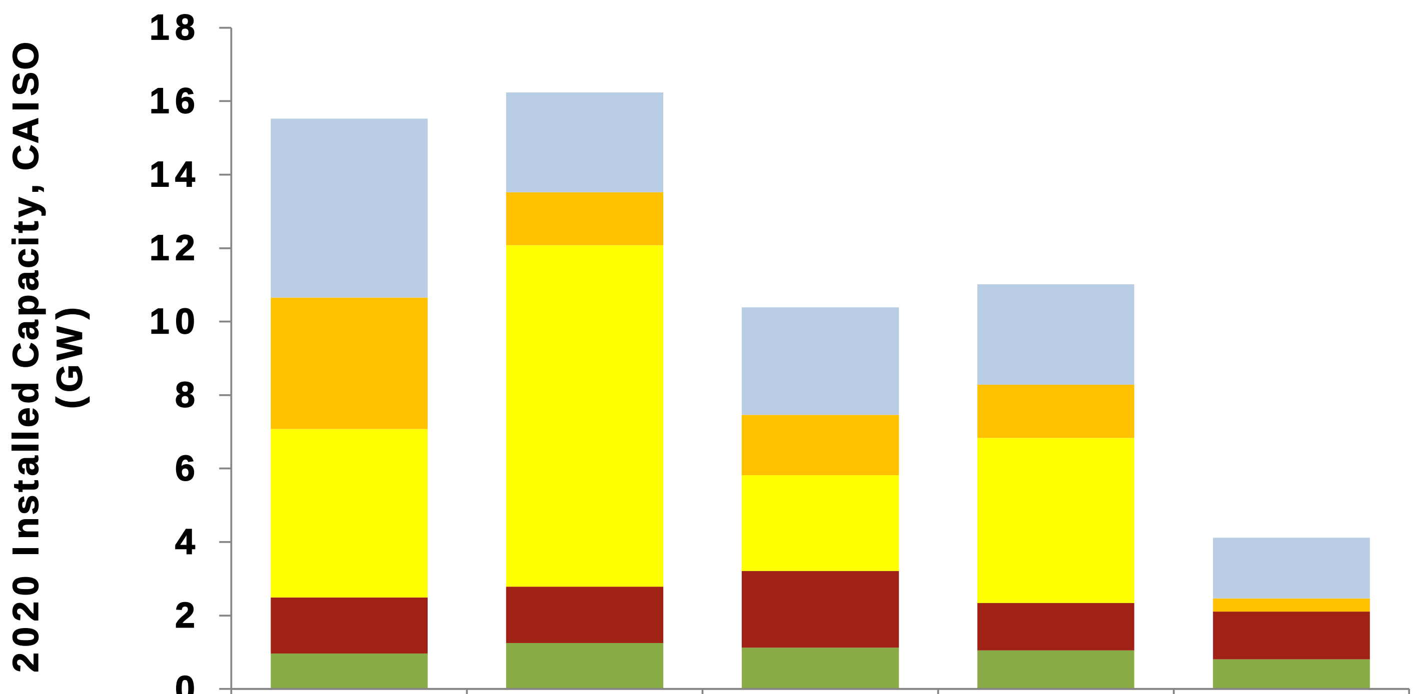
+ **Constrained hours are identified as the 50 hours in the year in which the system's use of flexible resources is the highest**
  - These are meant to capture the hours most likely to drive need

	Net Load Approach to Flexibility Requirement			Flexibility Requirement Based on Supply Side Resources
	Load			Generation by flexible resources
-	Baseload & RPS generation		+	Imports
+	Upward A/S requirements	=	+	Upward A/S provision
+	Load following up requirement		+	Load following up provision
=	**System Flexibility Requirement**		=	**System Flexibility Requirement**

Methodology

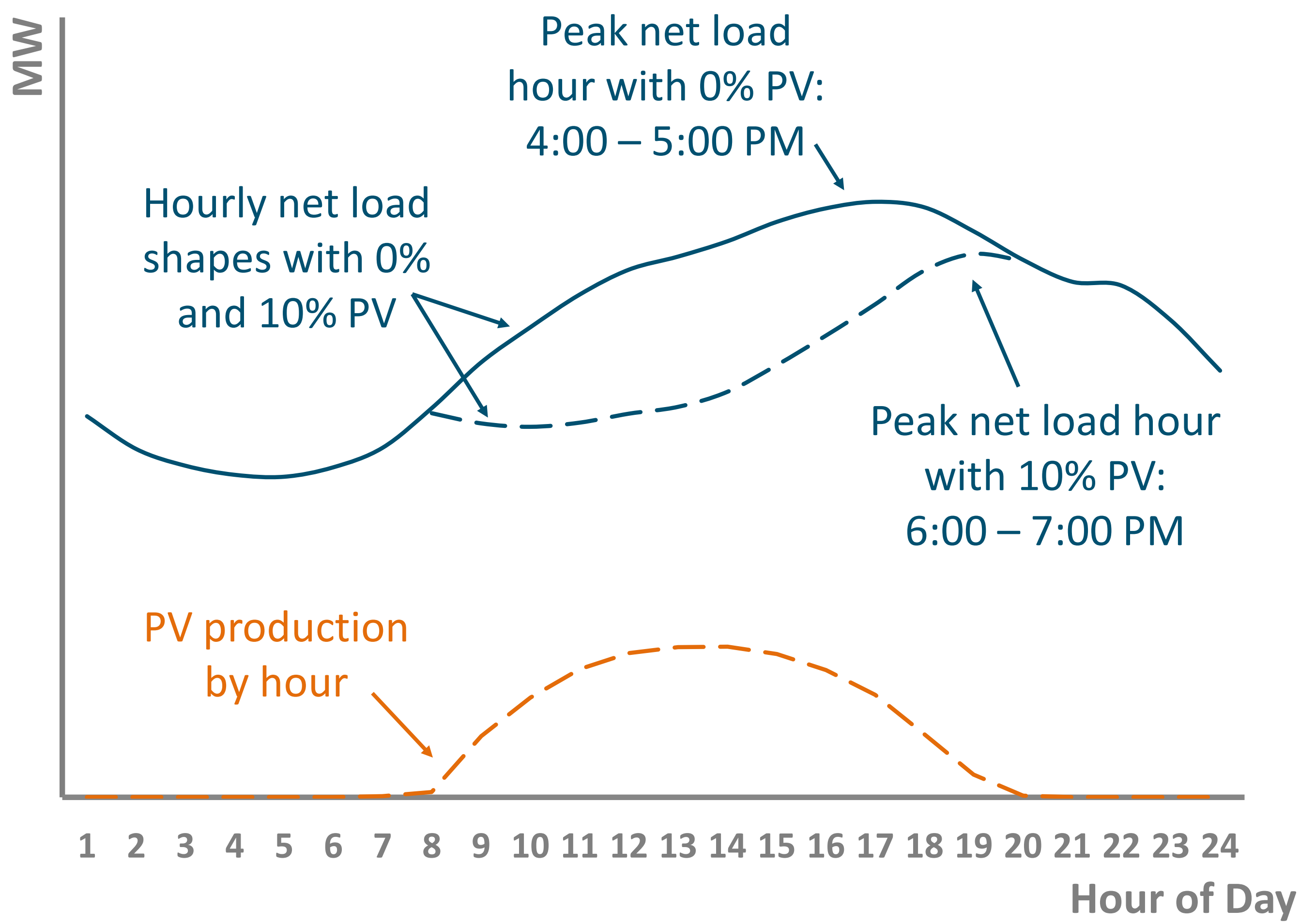
- One important caveat: this analysis are based on the results from the production cost runs—data already available from the LTPP analysis
- Two important differences between the “need” and “cost” runs of PLEXOS under current methodology
  - Need run uses monthly max LF and Reg requirements for each hour; cost run uses daily requirements
  - Cost run includes the generic gas CTs that are needed to resolve violations in the need run
- Additionally, this approach classifies resources as they are used—not as available—to meet peak period requirements
- Because of these differences, we cannot pinpoint the exact causes of need in the hours in which they occur, but the constrained hour approach is still useful to reconcile PLEXOS results with the PRM calculation and to understand drivers of need

CAISO Renewable Resource Capacity by Scenario



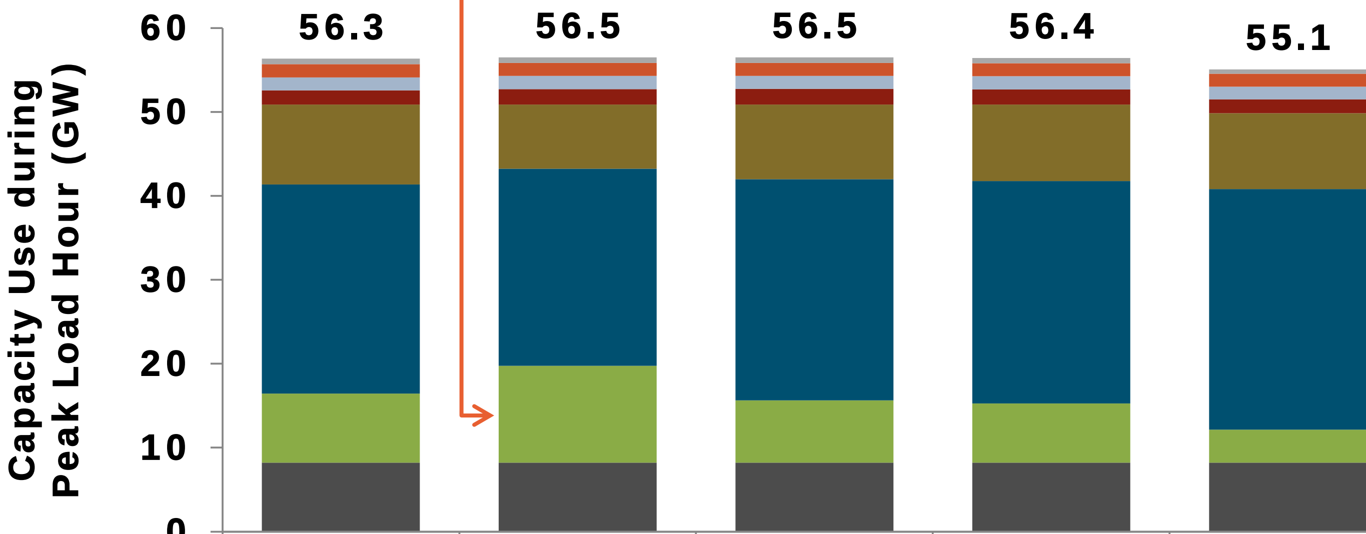
	Trajectory	Environmental	Cost	Time	All Gas
Wind	4,864	2,717	2,924	2,729	1,645
Solar Thermal	3,583	1,436	1,643	1,448	364
Solar PV	4,579	9,300	2,601	4,490	-
Geothermal	1,523	1,533	2,091	1,294	1,294
Biomass	972	1,249	1,127	1,051	812

Effect of Solar on Daily Load Shape



CAISO Resource Utilization in Peak Load Hour

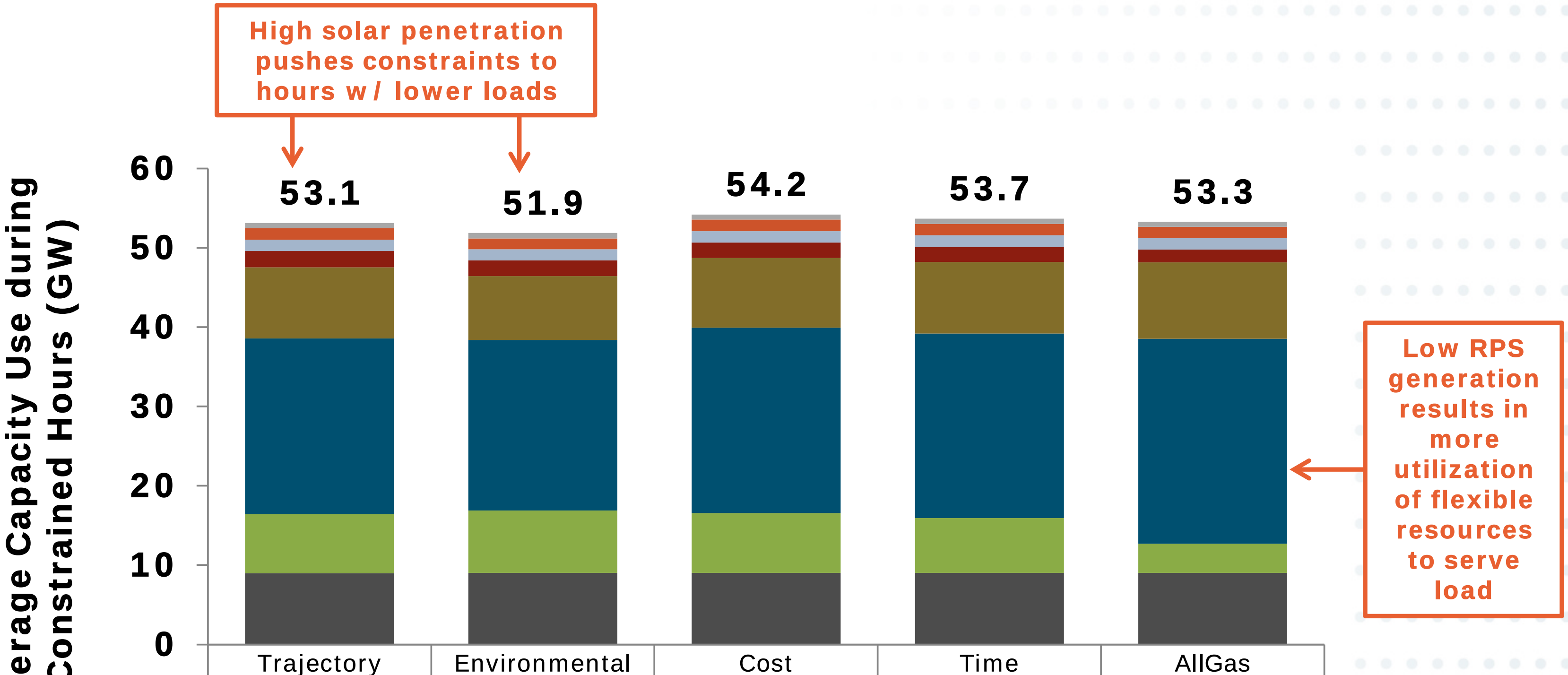
High RPS generation during peak load hour due to high solar penetration



Load is identical in each of the cases, but the utilization of flexible resources used to serve load varies dramatically as a result of RPS generation

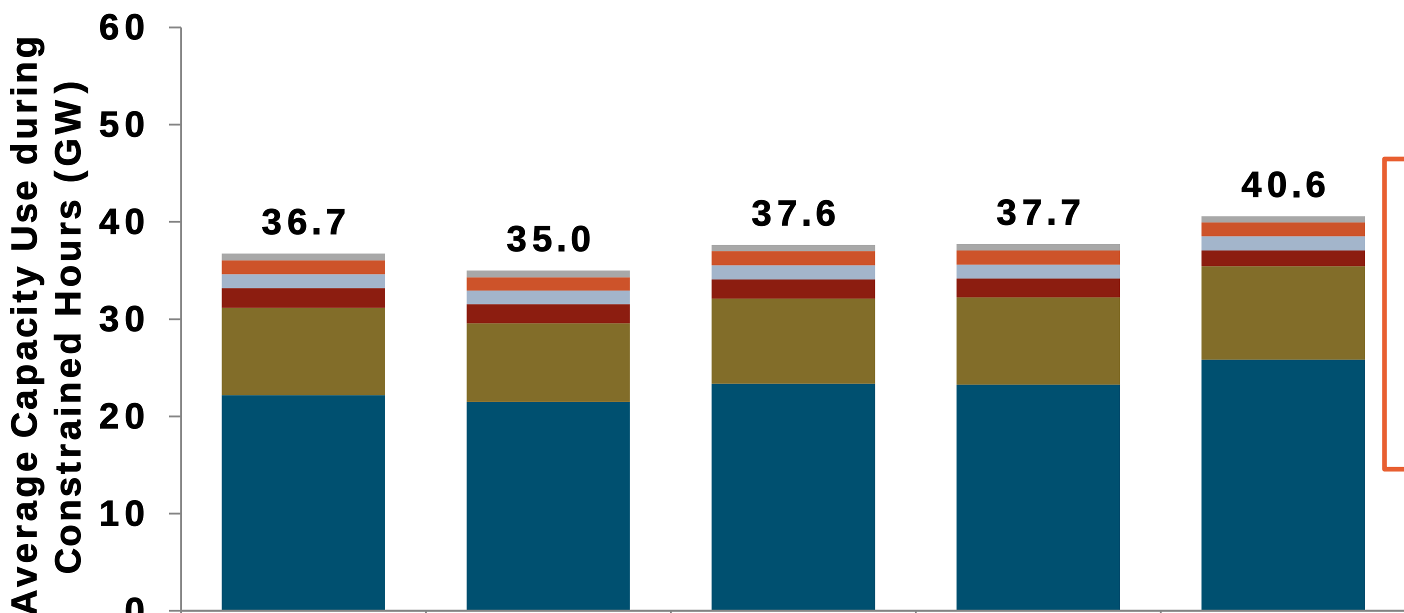
	Trajectory	Environmental	Cost	Time	AllGas
Total	56,328	56,479	56,489	56,432	55,077
RegUp	655	646	644	634	545
NonSpin	1,555	1,555	1,555	1,555	1,525
Spin	1,555	1,555	1,555	1,555	1,525
LFU	1,700	1,859	1,871	1,825	1,635
Imports	9,499	7,630	8,885	9,118	9,048
Flex Gen	24,934	23,468	26,357	26,470	28,646
RPS Gen	8,212	11,549	7,405	7,058	3,937
Baseload Gen	8,217	8,217	8,217	8,217	8,217

CAISO Resource Utilization in Constrained Hours



	Trajectory	Environmental	Cost	Time	AllGas
Total	53,130	51,855	54,193	53,655	53,265
RegUp	690	672	637	653	619
NonSpin	1,426	1,393	1,461	1,445	1,444
Spin	1,426	1,393	1,461	1,445	1,444
LFU	2,042	1,967	1,948	1,931	1,616
Imports	8,979	8,065	8,759	8,978	9,626
Flex Gen	22,168	21,494	23,356	23,255	25,816
RPS Gen	7,394	7,853	7,563	6,928	3,687
Baseload Gen	9,004	9,018	9,008	9,018	9,012

CAISO Flexible Resource Utilization in Constrained Hours



	Trajectory	Environmental	Cost	Time	AllGas
Total	36,731	34,984	37,622	37,708	40,565
RegUp	690	672	637	653	619
NonSpin	1,426	1,393	1,461	1,445	1,444
Spin	1,426	1,393	1,461	1,445	1,444
LFU	2,042	1,967	1,948	1,931	1,616
Imports	8,979	8,065	8,759	8,978	9,626
Flex Gen	22,168	21,494	23,356	23,255	25,816

Largest difference between cases is the amount of flexible capacity use to serve load—not the change in A/S requirements

Breakdown of Differences – Environmental vs. All-Gas

	Component	Environmental Case	All-Gas Case	Difference
	Load	46,430	48,141	1,711
-	Baseload Generation	(9,018)	(9,012)	6
-	RPS/CSI Generation	(7,853)	(3,687)	4,166
+	Contingency Reserves	2,786	2,888	103
+	Regulation Up	672	619	(53)
+	Load Following Up	1,967	1,616	(351)
=	**Flexibility Requirement**	**34,984**	**40,565**	**5,581**

High solar penetration pushes constrained hours off the peak period in the environmental case

Low RPS penetration in the All-Gas case results in much less RPS generation during constraints

Regulation and load following requirements are slightly higher in the Environmental case, driven by the higher penetration of intermittent resources

Table shows average requirements and resource performance over the top 50 constrained hours

System Need for New Resources

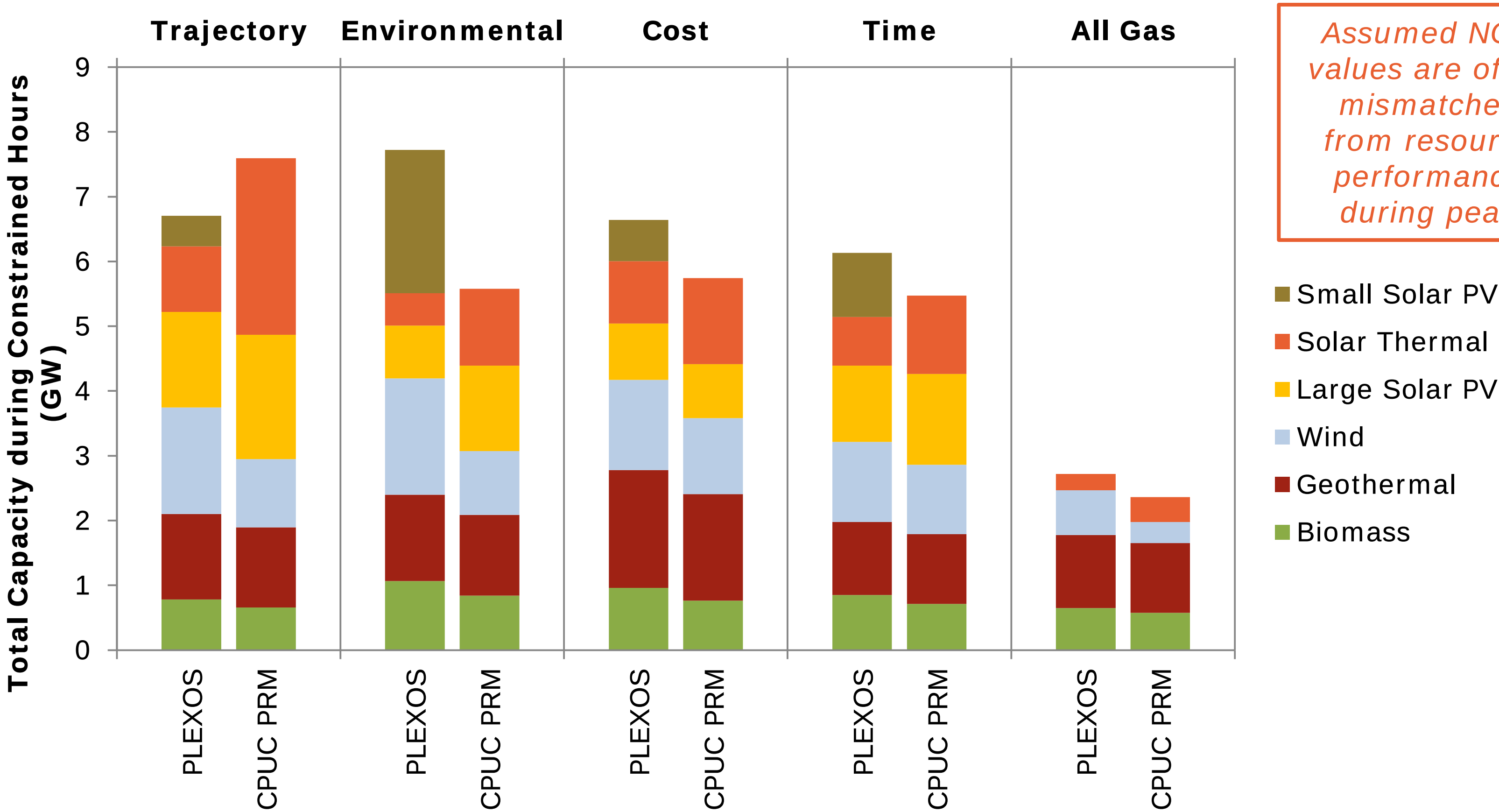
+ **The resulting need in the All-Gas case is better described as "system need"**
  - The primary distinction between the All-Gas case and the other four is its net load—**not** its ancillary services requirements
+ **The variations in net load are substantially larger than the variations in ancillary services requirements—which suggests that two questions are key to forward-looking capacity planning:**
  1. How high are loads expected to be?
  2. How much renewable generation can be counted on to offset peak loads?
+ **Both of these questions lend themselves to more robust analysis through a probabilistic, LOLP-type analysis**

Summary of Flexible Resource Use during Constrained Hours

Scenario	Net Load[1] [MW]	Total A/S Requirement[2] [MW]
Trajectory	31,146	5,585
Environmental	29,559	5,425
Cost	32,115	5,506
Time	32,233	5,475
All Gas	35,442	5,123

[1] Sum of CAISO flexible generation and imports
[2] Sum of load following up, regulation up, and spinning & non-spinning reserves

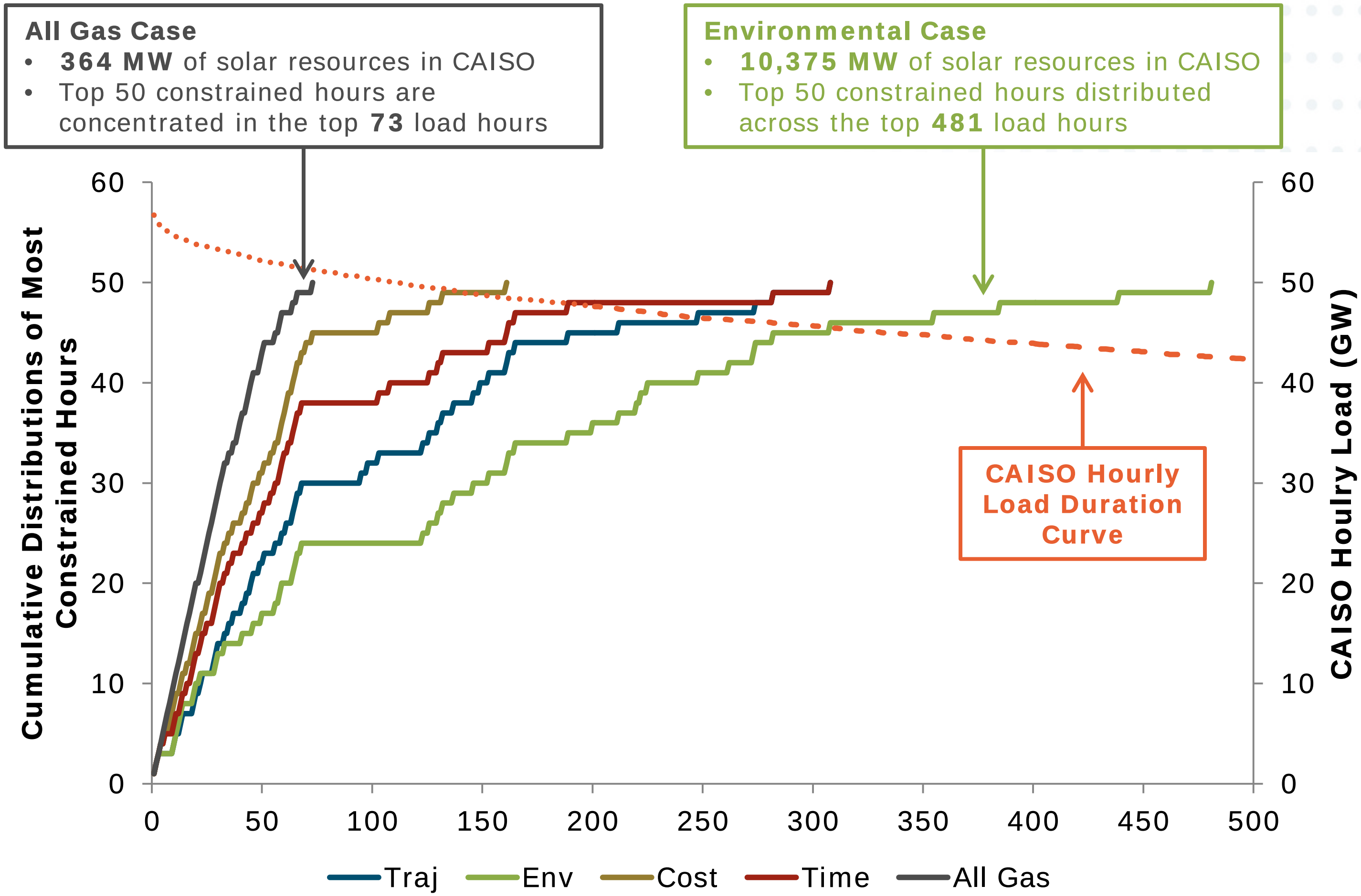
RPS Resources: Assumptions vs. Performance



Assumed NQC values are often mismatched from resource performance during peak

PLEXOS: actual average resource performance during 50 constrained hours of simulation
CPUC PRM: deemed (or assumed) NQC value of resources used in PRM calculation

Timing of Constraints

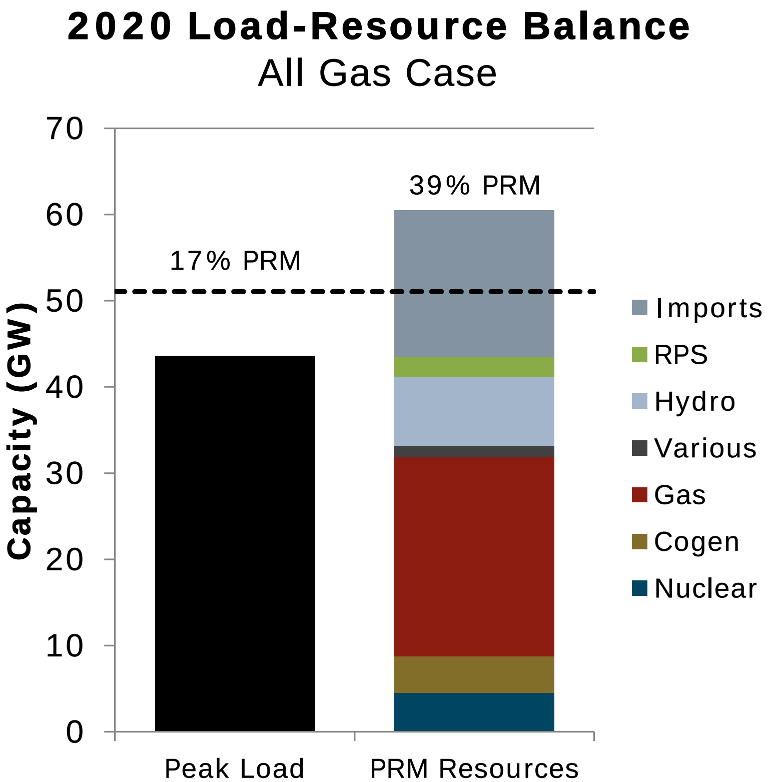


Adding solar resources to the system ***expands*** the range of hours over which the system is constrained

Drill-Down into All Gas Case Need Results

Conflicting Results from the All-Gas Case

- Using assumptions specified by the CPUC, the All-Gas case showed a reserve margin of **39%** before the PLEXOS need analysis
- When modeled in PLEXOS, the All-Gas case required **1,400MW** of additional capacity to resolve operational violations, bringing its reserve margin to **41%**
- With a low penetration of RPS resources, there should not be such a large gap between the two methodologies for resource adequacy



Based on LTPP assumptions

Constrained Hours in the All Gas Case

+ **Because of the low penetration of renewables in the All Gas case, constraints within the CAISO are almost entirely load-driven**
  - The 50 most constrained hours all occur within the 75 hours of highest load
  - The upward load following violations occur as a result of the commitment of the system’s flexible units to meet high loads in these hours
+ **Focusing on the most constrained hour—the hour most likely driving need and in this case also the peak load hour—can help provide insight into the drivers of need**

Approximate PRM Based on Simulation Results

- **The PRM is a measure of the amount of capacity available at the time of system peak (without accounting for maintenance and outages)**
- **Within this formulation, there are effectively two classes of resources:**
  1. Resources whose capacity during peak is a known, fixed quantity (e.g. nuclear, natural gas)
  2. Resources whose capacity during peak is uncertain and varies based on external conditions (e.g. wind, solar, hydro, cogeneration)
- **The CPUC's methodology for the second category involves the calculation of a Net Qualifying Capacity by evaluating historical resource performance during a set window of hours**
- **In order to approximate the PRM as modeled in these cases, the capacity of these resources to meet peak is calculated based on the performance of these resources during the most constrained hour of the year**

PRM Summary – Resource Availability in the All-Gas Case

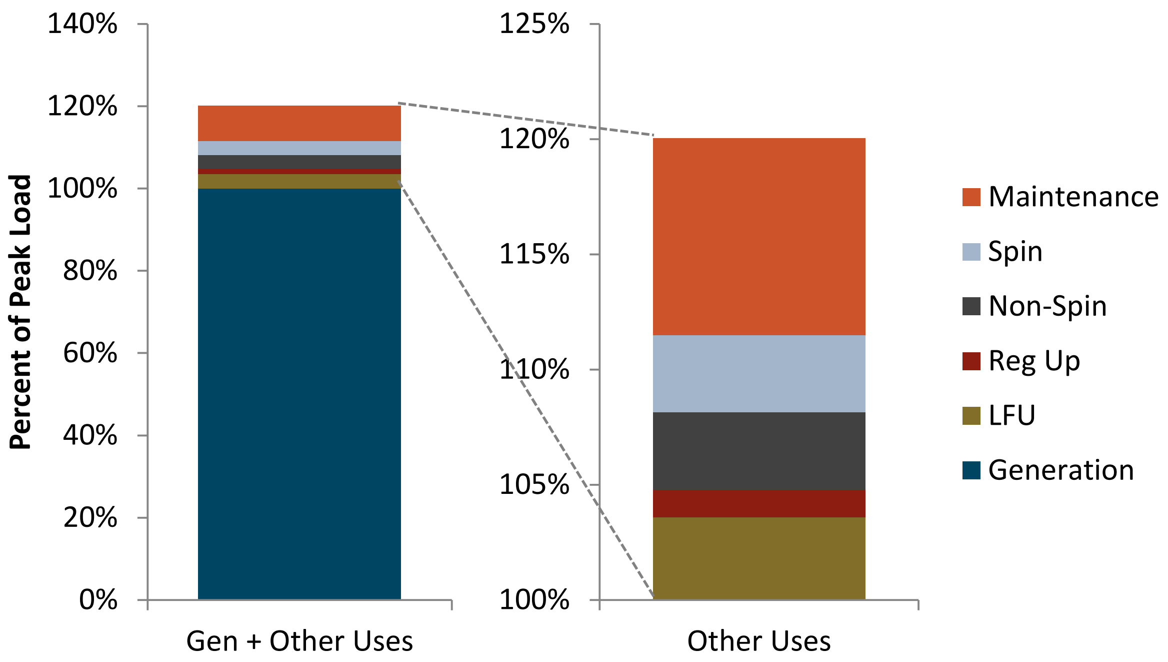
- Accounting for all discrepancies between loads an resources as modeled in the All-Gas case in PLEXOS, the reserve margin of this case is slightly higher than 17%—though the surplus is not as large as calculated in the CPUC LTPP analysis
- Load and imports represent the largest contributors to the disconnect between the two methodologies

	CAISO / PLEXOS	CPUC Assumed NQC	Difference
Generation			
Nuclear[1]	4,486	4,486	-
Cogeneration[1]	4,282	4,274	(8)
Natural Gas[1,2]	24,541	24,552	11
Hydro/Pumped Storage[3]	9,244	8,421	(823)
RPS[3]	2,864	2,363	(357)
Other[3]	123	822	699
Imports[3]	9,610	16,955	6,806
Total Capacity	**55,150**	**61,872**	**6,587**
Load			
Peak Load	49,749	48,464	(1,285)
Demand Response[3]	(4,287)	(4,818)	(531)
Net Peak	**45,463**	**43,647**	**(1,815)**
Reserve Margin			
Implied Reserve Margin	**21.3%**	**41.8%**	

[1] Based on rated capacity in PLEXOS
[2] Includes 1,400 MW of generic CTs added to resolve violations
[3] Based on performance during the top constrained hour
* Numbers may not add due to rounding

Utilization of Resources during Peak Hour

+ **During the peak load hour, maintenance & outages total nearly 3,900 MW**
  - 9% of peak load
  - 12% of CAISO thermal generating capacity



Reframing Need in the All Gas Case

- **As modeled in PLEXOS, the All-Gas case has a reserve margin much closer to the 17% requirement than suggested by the PRM calculation using CPUC assumptions**
- **Given the input assumptions and methodology, a reserve margin requirement of 121% is not a surprising result**
  - The load-following requirement adds approximately 4% to the traditional reserves requirement during the All-Gas peak period
  - Maintenance & outages account for nine percentage points of the traditional 17% PRM requirement and are likely overstated during the peak in this study

Lessons Learned

Load

	Trajectory	High Load Case	Difference
Load during most constrained hour	51,619	55,697	**4,088**
Flexibility resources used	33,137	35,203	**2,066**

- **Conclusion: Need to consider the effect of alternative load growth assumptions and weather uncertainty**

Imports

	Environment	All-Gas	Difference
Imports during most constrained hour	9,610	9,555	(55)
Assumed value in LTPP Case	16,955	16,955	-
Difference	**7,345**	**7,400**	

- **Conclusion: Need to consider the effect of imports on in-state need**

Hydro Performance on Peak

	Environment	All-Gas	Difference
Hydro MW during most constrained hours	7,459	7,459	-
NQC MW	6,524	6,524	-
Difference	**(935)**	**(935)**	

+ **Conclusion: Need to consider the effect of hydro availability on need for new resources**

Renewable Performance on Peak

	Environment	All-Gas	Difference
RPS MW during peak load hour	10,476	2,864	**(7,612)**
NQC MW	5,578	2,363	**(3,215)**
Difference	**(4,898)**	**(501)**	

+ **Conclusion: Need a robust estimate of the dependable production of renewable resources during peak load hours**

Timing of Renewable Production

	Environment	All-Gas	Difference
Peak load	51,838	50,823	**(1,015)**
Load during most constrained hour	51,619	50,823	**(796)**
Difference	**(219)**	-	

+ **Conclusion: Need to consider the timing effect of renewable production on need for new resources**

Shifting the Focus to Stochastic Analysis

+ **Need in CAISO’s methodology is sensitive to many factors besides variable energy resource (VER) integration requirements**
  - Load
  - Imports
  - Hydro production levels
  - Renewable resource production during critical hours

All of these factors are bigger drivers of need than flexibility requirements

+ **These factors are traditionally addressed through a different type of analysis**
  - Reliability analysis focused on the potential for loss of load
+ **Need to calibrate California’s fleet based on these other factors before evaluating whether it has enough flexibility to accommodate VER**

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Thank You!

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