California's blackout signals a need for enhanced reliability planning

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Another record-breaking heat wave in Southern California and the Southwestern United States has led to rolling blackouts—just when air conditioning is most needed for health and safety reasons, and when the COVID-19 pandemic makes public shelters especially risky.[1]

The blackouts have exposed the limitations of California's current reliability and resource adequacy (RA) planning, while an increasing amount of intermittent resources and the tightening of system supply due to retirements have eliminated the margin for error.

These limitations led to a failure to sufficiently plan for high stress conditions and left the overall system vulnerable due to:

- Limited visibility into resource availability, including thermal units and uncontracted imports.
- Insufficient consideration of stressful scenarios in resource adequacy planning, which led to a lack of operating reserves[2] relative to actual needs.
- A failure to secure sufficient resources for use in emergency situations (e.g., callable demand response resources).
- A reliance on planning standards and protocols which have not been fully updated for current realities.

[1] Rolling blackouts are a form of rationing power during supply shortages; this is different from targeted blackouts, which are frequently used for fire avoidance.

[2] Operating reserves are resources that can flexibly and quickly respond to system fluctuations and contingencies. Planning reserves are set to ensure that adequate operating reserves exist in all hour types, including peak demand hours.

To successfully implement California's ambitious goals for renewables and batteries, the state needs to augment its recent efforts to further align reliability planning with facts on the ground.

Planners predicted low risk of inadequate resources

A heatwave hit multiple states in the West in mid-August, bringing with it an enormous challenge to California's power grid. The California independent grid operator, CAISO, issued multiple flex alerts[3] calling for energy conservation to help relieve the pressure on the grid for the period beginning Friday, August 14, and continuing through Wednesday, August 19, between 3 p.m. and 10 p.m. each day.

On Friday, August 14, at 6:36 p.m., and Saturday, August 15, at 6:28 p.m., CAISO declared a Stage 3 Emergency[4] due to increased electricity demand and the unexpected loss of generating resources, and implemented rolling blackouts that affected thousands of customers in its control area.[5]

As recently as May 2020, CAISO announced low probability and risk for operational challenges this summer. In its 2020 Summer Loads and Resources Assessment, CAISO concluded there would be sufficient capacity to meet market demand this summer, despite expectations of relatively low hydro generation. Specifically, CAISO estimated the chance of rolling blackouts at 0.2%.

Multiple factors behind rolling blackouts

High demand driven by high temperatures is one of the driving factors leading to the rolling blackouts, but not the major one. Demand turned out to be higher on Friday, August 14, than what was forecasted year ahead by the California Energy Commission (CEC), but not significantly higher. The highest demand reported was 46,777 MW for Friday, August 14, compared with the 45,907 MW 1-2 load forecast. This means the demand during blackout hours on Friday, August 14, was only around 870 MW, or approximately 2% higher than the expected median demand forecast.

The accompanying supply shortages were more significant. These supply shortages took various forms:

- **Thermal.** Unexpected gas resource outages were reported for both days during the outage hours. Total gas generation was only around 25 GW from 6 p.m. to 9 p.m. for both days. In contrast, in their August 2019 filing to the California Public Utilities Commission (CPUC) (hereafter referred to as "CAISO August 2019 RA Assessment"), CAISO estimated 28.7 GW gas resources would be available during system peak hours.[6] Actual gas generation was roughly 13% lower than considered in the CAISO August 2019 RA assessment.

[3] A flex alert is a call by CAISO for consumers to voluntarily conserve electricity when there is a predicted shortage of energy, especially if the grid operator needs to dip into reserves to cover demand.

[4] A Stage 3 Emergency is declared when demand begins to outpace available supply and grid operators need to tap electricity reserves to balance the grid.

[5] http://www.caiso.com/Documents/ISORequestedPowerOutagesFollowingStage3EmergencyDeclarationSystemNowBeingRestored.pdf

[6] CAISO, Reply Comments of the California Independent System Operator. Rulemaking 16-02-007. August 12, 2019.

- **Wind.** A loss of around 1 GW wind generation was reported by CAISO to be one of the driving factors for the blackout on Saturday, August 15. In fact, the actual wind generation was around 1.3 GW lower during 6 p.m. to 9 p.m. that Friday and Saturday—about 50% below expectations from the CAISO August 2019 RA assessment—due to the unique weather pattern.
- **Imports.** Most importantly, less than 7 GW of imports were available between 6 p.m. and 7 p.m. for both days, while in the August 2019 RA assessment, CAISO assumed that around 10.2 GW of import resources would be available to help the system meet annual peak demand in 2020.[7] CAISO took a slightly more conservative approach in the May 2020 Summer Loads and Resources Assessment by assuming that imports would be capped at 9.5 GW when demand approached 50 GW in its base case modeling.[8] This assumption considered that import resources might be limited when demand is high in neighboring states. However, this amount is still significantly higher than the imports that actually materialized in the emergency condition.

Combined, the supply shortages in these three areas against expectations in the 6 p.m. hour amounted to 9.9 GW on Friday, August 14, and 10.7 GW on Saturday, August 15, roughly 25% below the RA assessment levels.

Exhibit 1: Market fundamentals during blackout hours

Time		Market performance (MW)			CAISO RA Assessment for 2020 (MW)			Delta (MW)				Delta (%)			
Date	Hour	Natural gas	Wind	Imports	Natural gas	Wind	Imports	Natural gas	Wind	Imports	Total	Natural gas	Wind	Imports	Total
8/14/20	18	24,962	810	5,855	28,689	2,694	10,193	(3,727)	(1,884)	(4,338)	(9,949)	-13%	-70%	-43%	-24%
8/14/20	19	25,278	1,045	6,887	28,689	2,876	10,193	(3,411)	(1,831)	(3,306)	(8,548)	-12%	-64%	-32%	-20%
8/14/20	20	25,220	1,025	7,217	28,689	2,828	10,193	(3,469)	(1,803)	(2,976)	(8,248)	-12%	-64%	-29%	-20%
8/15/20	18	24,320	2,033	4,521	28,689	2,694	10,193	(4,369)	(661)	(5,672)	(10,701)	-15%	-25%	-56%	-26%
8/15/20	19	25,781	1,436	5,480	28,689	2,876	10,193	(2,908)	(1,440)	(4,714)	(9,062)	-10%	-50%	-46%	-22%
8/15/20	20	25,880	2,114	5,751	28,689	2,828	10,193	(2,809)	(714)	(4,442)	(7,964)	-10%	-25%	-44%	-19%

Source: CAISO[9]

[7] Ibid.

[8] This is in spite of the maximum imports in 2019 during high load hours being 8.8 GW and a downward trend of import availability between 2017 and 2019. There is no reference to WECC supply and demand studies.

[9] Market performance data were retrieved from CAISO OASIS. CAISO RA Assessment data were retrieved from CAISO Reply Comments of the California Independent System Operator. Rulemaking 16-02-007. August 12, 2019.

Implications for reliability planning

California's grid has experienced rapid changes, including the increasing penetration of intermittent renewable resources and the large-scale retirement of thermal generation resulting in large part from Once-Through-Cooling (OTC) regulation. These changes have led to a tightened system supply that leaves very little room for planning and operational errors, as well as grid uncertainties and fluctuations. The state regulator and grid operator have taken multiple actions to improve California's resource adequacy planning to adjust for the changing dynamics, including:

- The introduction of an hour-by-hour assessment of system supply and demand conditions.
- Updated reliability standards used in CAISO's local capacity need assessment.
- A sharp decrease in solar reliability contribution.
- Requirements for RA imports to commit for firm energy delivery.

Unfortunately, the blackouts illustrate that California's reliability and resource adequacy planning continues to need improvements— some of which have been identified by analysts before (see previous whitepapers published by ICF, CAISO reliability is feeling the heat; California, the coming retirement wave and the return of capacity pricing).

Areas for improvement: Reliance on uncontracted imports

While California has taken steps to address import-related issues in its RA procurements, room for improvement remains. Import resources account for around 10% to 12% of California's total RA procurement.[10] The significant implications of this percentage to resource adequacy was clearly recognized in a July 2020 CPUC decision requiring non-resource specific imports counting toward RA requirements to be backed up by energy contracts and to self-schedule into CAISO's Day Ahead and Real Time markets during the availability assessment hours (AAH).[11]

However, another important import-related problem exists: California continues to include import resources that are not backed up by RA contracts (in addition to RA contracted imports) to meet peak demand for its resource adequacy assessment and planning. According to statistics released by CPUC, jurisdictional Load Serving Entities (LSEs) only have around 5.8 GW of contracted import RA capacity.[12] However, as mentioned above, CAISO's 2020 Summer Assessment assumes the availability of imports up to 9.5 GW during constrained hours.

[10] Historically, California has been the state most reliant on the import of power and with the largest interties with other states. Of course, transmission is a necessary but not sufficient condition for imports; generation is also required.

[11] CPUC. Decision Adopting Resource Adequacy Import Requirements. July 6, 2020.

[12] Ibid.

In the August 2019 RA Assessment, CAISO assumed availability of 4.9 GW uncontracted imports during peak hours. The reliance on uncommitted import resources brings additional uncertainties to a grid with a large amount of intermittent internal resources and challenges to system operation under extreme events. Only around 5 GW of imports were delivered to CAISO during the 6 p.m. hour on Saturday, August 15, when the rolling blackouts were implemented.

It is important to emphasize that the 4.9 GW of "unidentified and uncontracted imports" is primarily based on historical analysis; overall, estimating available imports is difficult. Imports not backed up by contracts with deliverability requirements may deviate from estimation significantly, as shown in recent events. Further, the lack of imports is not a new problem in California; the sudden and unexpected loss of imports and high import prices played a critical role in the California crisis of 2000 and 2001.

California needs a more holistic treatment of imports in its resource adequacy planning. Uncontracted imports do not equate to firm capacity resources, and this must be recognized in resource adequacy calculations. Furthermore, a more structural supply and demand analysis is needed to assess import resource availability for the future, given retirements and increasing reliance on intermittent resources in neighboring states. In this case, if CPUC or CAISO have conducted a more thorough analysis of the 2020 resource adequacy considering contracted imports only (which is 5.8 GW compared with 9.5 GW or 10.3 GW), the regulators and grid operator might have been able to identify a higher chance of capacity shortfall for the summer of 2020 and have made better preparations for highly stressful events.

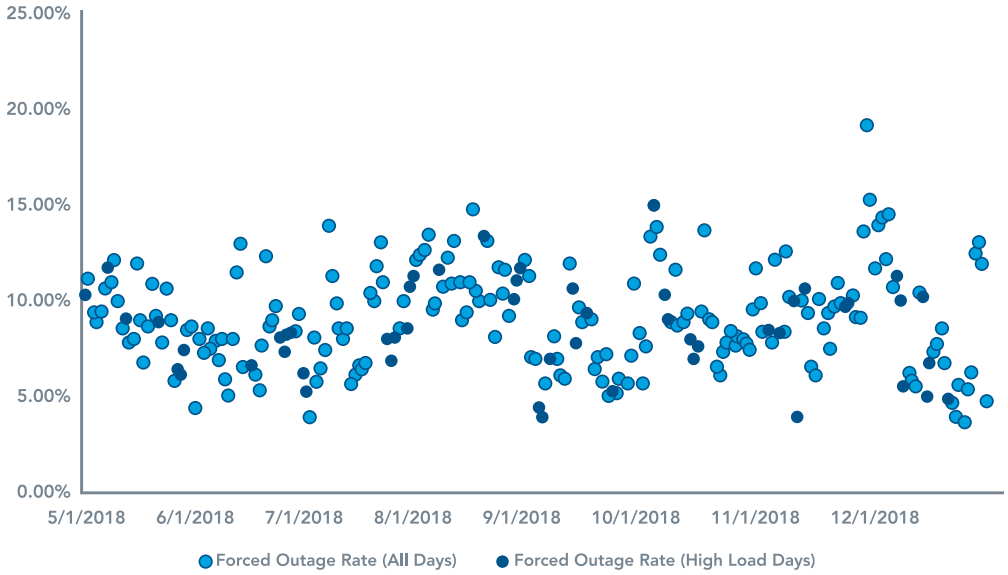
Areas for improvement: Preparation for system fluctuations

The recent blackouts show another key risk in California's reliability planning. As the grid increasingly relies on intermittent resources, and retires thermal units, the margin for error is gone. This is occurring in other WECC (Western Electricity Coordinating Council) states as well. These circumstances call for more careful consideration of potential system fluctuations in supply as well as demand, and, importantly, in the convergence of the two. California's RA planning and procurement should consider potential hourly variations in resource deliverability and prepare for stressful scenarios.

The CAISO has recently been re-examining its planning standards and protocols. Statistics show that the thermal resource fleet in CAISO has higher than estimated outage rates. In a figure that was recently released by CAISO, which shows operational conditions from May to December in 2018, the thermal forced outage rates regularly exceeded 10%, and sometimes passed 15%, while the CAISO assumed only 4% to 6% planning reserve margin to cover forced outages. (See Exhibit 2). In the Fifth Revised Straw Proposal for CAISO's RA enhancement stakeholder process, CAISO is considering adopting a UCAP (unforced capacity) based resource adequacy requirement, or to increase its planning reserve margin from 15% to 20% or above. The proposal, if

implemented, will help push LSEs to secure additional resources to prepare for emergency conditions.

Exhibit 2 Forced outages relative to monthly high load days (2018)



Source: CAISO. Resource Adequacy Enhancement – Fifth Revised Straw Proposal. July 7, 2020.

Another proposal, which has not been laid out in detail yet, might bring more structural changes to California's RA program. In the Fifth Revised Straw Proposal, CAISO mentioned that it is considering the possibility of using a stochastic simulation model in the RA assessment process. The CAISO has been using stochastic models in its summer assessment. However, taking this one step further and doing simulation analysis with resources backed up by RA contracts only[13] will help California better understand if there is enough firm capacity under various potential scenarios, especially stressful ones. The high level of uncertainty and intermittency observed in California in recent years show it is no longer enough to rely on fixed assumptions when assessing resource adequacy.

Due to increasing climate risks, demand fluctuates more now than it did 10 years ago. On the supply side, solar and wind generation is heavily dependent on weather conditions and may change significantly each hour; imports might be restricted due to high demand in neighboring states or with transmission outages. It becomes increasingly important, considering these uncertainties, for California to simulate grid operations and prepare for stressful conditions. The introduction of the stochastic simulation model in RA assessment might result in further derates in the reserve margin contribution of use- and availability-limited resources, or further increase of system planning reserve margins.

[13] CAISO's current summer assessments analyze system supply and demand conditions by looking at all potential resources available based on historical operational data, which might underestimate risks when the actual deviates from historical.

Areas for continued observation: Battery operation

The recent situation also raises questions about battery storage operation in California and its implication on RA planning. The state is counting on storage to play an important role in providing reliability support to CAISO's grid in the future as renewable penetration increases. Current RA provisions require battery storage duration to be at least four hours to receive full RA credits. As observed in recent events, the system need for capacity support still falls into a short-duration period at this point, i.e., 6 to 9 pm.

However, this might be extended to longer durations, as evidenced by requests for conservation over a seven-hour period. In addition, the performance of battery fleet heavily relies on the availability of charging resources. Given the low margin for error, the ability of batteries to deliver during critical hours, and the duration requirement overtime may deserve greater scrutiny. The stochastic simulation model discussed above will be a useful tool to assess battery deliverability under stressful scenarios as well and to help the state plan accordingly.

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