California's blackouts signal further enhancement is needed in its reliability planning

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Another record-breaking heat wave in Southern California and the U.S. Southwest has led to rolling blackouts just when air conditioning is most needed for health and safety reasons and public sheltering is especially risky given COVID-19.[1]

The blackouts exposed the limitations of California's current reliability and resource adequacy planning processes. An increasing amount of intermittent resources and the tightening of system supply due to retirements have eliminated the margin for error in California planning.

These limitations resulted in failure to sufficiently plan for high stress conditions, resulting in the power rationing through rolling blackouts last week, leaving the overall system vulnerable due to:

- Limited visibility into resource availability:
  - Expectations for availability of thermal units are set too high in contradiction to historical performance.
  - Lowered availability of uncontracted imports as thermal retirements occur, both in and outside the state, and historical trends are no longer predictive; this is a long-standing issue in California and was the root of the shortages in 2000 and 2001.
- Insufficient consideration of stressful scenarios in Resource Adequacy (RA) planning which led to lack of operating reserves[2] relative to actual needs.
- Failure to secure sufficient resources for use in emergency situations (e.g., callable demand response resources) has contributed to the limited flexibility in responding to emergencies.
- Reliance on planning standards and protocols which have not been fully updated for current realities.

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

[1] Rolling blackouts are a form of rationing power during supply shortages; this is different from targeted blackouts 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.

Planners predicted low risk of inadequate resources

A heat wave hit multiple states in the West in recent days, bringing enormous challenge to the power grid in California. The California 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 pm and 10 pm each day. On Friday, August 14 at 6:36 pm and Saturday, August 15 at 6:28 pm, the CAISO declared Stage 3 emergencies[4] due to increased electricity demand and unexpected loss of generating resources, and implemented rolling blackouts affecting 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 that 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%.

A combination of factors contributed to the 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 Friday 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, compared with the 45,907 MW 1-2 load forecast – i.e., the demand during blackout hours on Friday was only ~870 MW or approximately 2 percent higher than the expected median demand forecast.

The accompanying supply shortages were more significant. 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 to 9 pm for both days. In contrast, in their August 2019 filing to the CPUC (hereafter referred to as "CAISO August 2019 RA Assessment"), it estimated 28.7 GW gas resources would be available during system peak hours.[6] Actual gas generation was roughly 13 percent lower than considered in the CAISO August 2019 RA assessment.
- **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. In fact, the actual wind generation was around 1.3 GW lower during 6 to 9 pm 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 and 7 pm for both days, while in the CAISO 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.[7] CAISO took a slightly more conservative approach in the May 2020 Summer Loads and

[3] A flex alert is a call by the CAISO for consumers to voluntarily conserve electricity when there is a predicted shortage of energy supply, 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.

[7] Ibid.

Resources Assessment by assuming that imports would be capped at 9.5 GW when demand approached 50 GW in its base case modeling. This considered that import resources might be limited when demand is high in neighboring states as well. 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 pm hour amounted to 9.9 GW on Friday and 10.7 GW on Saturday, roughly 25% below the RA assessment levels.

Exhibit 1 provides a comparison of the supply and demand conditions during the blackout hours and the numbers assumed in CAISO's August 2019 RA Assessment.

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[8]

Implications for California reliability planning

The California 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 resulted in tightened system supply, leaving very little room for planning and operational errors and grid uncertainties and fluctuations. At the same time, the state regulator and grid operator have taken multiple actions to improve the state's resource adequacy planning to adjust for the changing dynamics, including:

- An introduction of hour by hour assessment of system supply and demand conditions in 2019, which identified a significant amount of capacity shortfall for the upcoming 2 to 3 years and led to the CPUC's decision of ordering procurement of an incremental 3.3 GW of generating capacity before the summer of 2023;

[8] 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.

- Updates of reliability standards used in CAISO's local capacity need assessment;
- Sharp decrease of solar reliability contribution; and
- Requiring RA imports to commit for firm energy delivery.

Unfortunately, the blackouts illustrate that California's reliability and resource adequacy planning continues to need improvements – many of which have been identified for some time (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 imports-related issues in its RA procurements, room for improvement remains. Import resources account for around 10-12% of the total RA procurement in California,[9] and the significant implications of this to resource adequacy has been clearly recognized in a July 2020 California Public Utilities Commission ("CPUC") decision requiring that non-resource specific imports counting towards RA requirements be backed up by energy contracts and required to self-schedule into CAISO's Day Ahead and Real Time markets during the Availability Assessment Hours (AAH).[10]

However, another important import-related problem exists: the state continues to include import resources that are not backed up by RA contracts (in addition to RA contracted imports) to meet its peak demand in its resource adequacy planning assessments. According to statistics released by CPUC, jurisdictional LSEs only have around 5.8 GW of contracted import RA capacity.[11] However, as mentioned above, CAISO's 2020 summer assessment assumes availability of imports up to 9.5 GW during constrained hours.

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 brings challenges to system operation under extreme events. Only around 5 GW of imports were delivered to CAISO during the 6 pm hour on Saturday, 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, and overall, estimating available imports is difficult. Imports that are not backed up by contracts with deliverability requirements may deviate from estimation significantly, as shown in recent events. Further, lack of imports is not a new California problem – 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 available for the future considering retirements and increasing reliance on intermittent resources in neighboring states. In this case, if 5.8 GW instead of 9.5 GW had been used in CAISO's

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

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

[11] Ibid.

summer assessment, the grid operator might have anticipated a higher chance of capacity shortage this summer and have made better preparations for extreme events.

Areas for improvement: Preparation for system fluctuations

The blackout last week shows 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 outside WECC 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 procurement process 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 tends to have higher than estimated outage rates during critical hours. In the Fifth Revised Straw Proposal for CAISO's RA enhancement stakeholder process, CAISO is considering adopting a UCAP based resource adequacy requirement, or to increase its planning reserve margin from 15% to 20% or above. The proposal, if implemented, will be helpful in pushing the LSEs to secure additional resources to prepare for emergency conditions.

Another proposal, which has not been laid out in detail yet, might bring more structural changes in California's RA program. In the Fifth Revised Straw Proposal, the 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,[12] will help the state better understand if there is enough firm capacity under various potential scenarios, especially stressful scenarios. The high level of uncertainty and intermittency observed in California in recent years show that it is not enough to rely on fixed assumptions in assessing resource adequacy anymore.

Demand fluctuates more nowadays than 10 year before due to increasing climate risks; solar and wind generation are heavily dependent on weather conditions and may change significantly each hour, imports might be restricted with transmission outages, etc. It becomes more and more important for California to simulate grid operations considering these uncertainties and prepare for stressful conditions. The introduction of stochastic simulation model in RA assessment might result in further derates in the reserve margin contribution of use- and availability-limited resources, or requirement of further increase of system planning reserve margin.

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 a battery storage duration to be at least 4 hours to receive full RA credits. As observed in recent days, system need for capacity support still falls into a short-duration (i.e., <4 hours) period at this point, i.e. 6 to 9 pm.

However, it needs to be highlighted that this might be extended to longer durations as evidenced by requests for conservation over a 7-hour period. On the other hand, the performance of battery fleet

[12] 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.

heavily relies on availability of charging resources. Given the low margin for error, the ability of batteries to deliver during critical hours may deserve greater scrutiny. The stochastic simulation model discussed above, could be a useful tool to assess battery deliverability under stressful scenarios, and help the state plan accordingly.

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