**BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA**

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| Order Instituting Rulemaking to Develop an Electricity Integrated Resource Planning Framework and to Coordinate and Refine Long-Term Procurement Planning Requirements. | Rulemaking 16-02-007<br>(Filed February 11, 2016) |

# REPLY COMMENTS OF THE CALIFORNIA INDEPENDENT SYSTEM OPERATOR CORPORATION


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# REPLY COMMENTS OF THE CALIFORNIA INDEPENDENT SYSTEM OPERATOR CORPORATION

Pursuant to the *Assigned Commissioner and Administrative Law Judge's Ruling Initiating Procurement Track and Seeking Comment on Potential Reliability Issues* (Ruling) issued on June 20, 2019, the California Independent System Operator Corporation (CAISO) hereby provides reply comments in response parties' July 22,2019 opening comments filed regarding potential reliability issues.

## I. Introduction

Opening comments in response to the Ruling indicate that the vast majority of parties agree with Energy Division staff's assessment that there are significant impending system reliability concerns by 2021. Supplemental analyses conducted by the CAISO, Southern California Edison Company (SCE), and the California Public Advocates Office (Cal Advocates) corroborate Energy Division's analysis, though the system resource deficiencies differ based on input assumptions and study methodologies. Based on the broad agreement regarding near-term system needs and the consistency between the various analyses, the CAISO recommends that the Commission:

(1) Move forward with efforts to extend the once-through-cooling (OTC) regulation compliance dates for existing generation resources. At minimum, the Commission should work toward extending the OTC compliance date for the Alamitos Generating Station (Alamitos) as it provides both local and system reliability benefits. The Commission should identify any other OTC units that will be needed for system reliability, taking into account ongoing efforts to procure existing, under development, or new resources (including reliable imports). The Commission should make the case for

extending any additional OTC compliance dates to the State Water Resources Control Board as necessary to maintain system reliability, with the understanding that the requested compliance extension(s) may not ultimately be needed.

(2) Develop a procurement plan for 2020-2022 to meet reliability needs and facilitate the retirement of any generating unit that receives an OTC compliance date extension. At a minimum, this comprehensive plan should:

a. Direct resource adequacy procurement for uncontracted resources that are operational or mothballed;

b. Direct increased resource adequacy procurement for uncontracted import resources;

c. Ensure resources under construction are on-track for their online dates so that they do not exacerbate reliability concerns; and

d. Direct procurement for new resources.

To assist the Commission in making these determinations, the CAISO conducted a system resource adequacy analysis—similar to those conducted by Energy Division staff and SCE—that further demonstrates the short-term reliability needs. The CAISO's system resource adequacy analysis identifies a 500 MW system resource adequacy deficiency in 2020, which increases to 2,300 MW and 2,200 MW in 2021 and 2022, respectively. In addition, the CAISO refined its operational analysis presented in opening comments. These refinements indicate a greater operational deficiency reaching maximums of 2,300 MW, 4,400 MW, and 4,700 MW in 2020, 2021, and 2022, respectively. The CAISO recommends that the Commission take immediate action on the basis of these deficiencies to ensure short-term resource adequacy sufficiency.

## II. Discussion

### A. All Analyses Support Moving Forward with OTC Compliance Date Extensions.

The CAISO, SCE, and Cal Advocates conducted separate system resource adequacy analyses that complement Energy Division's system resource adequacy analysis. These analyses identify consistent near-term system resource adequacy needs, though the quantity of the need varies based on the different assumptions and methodologies used.

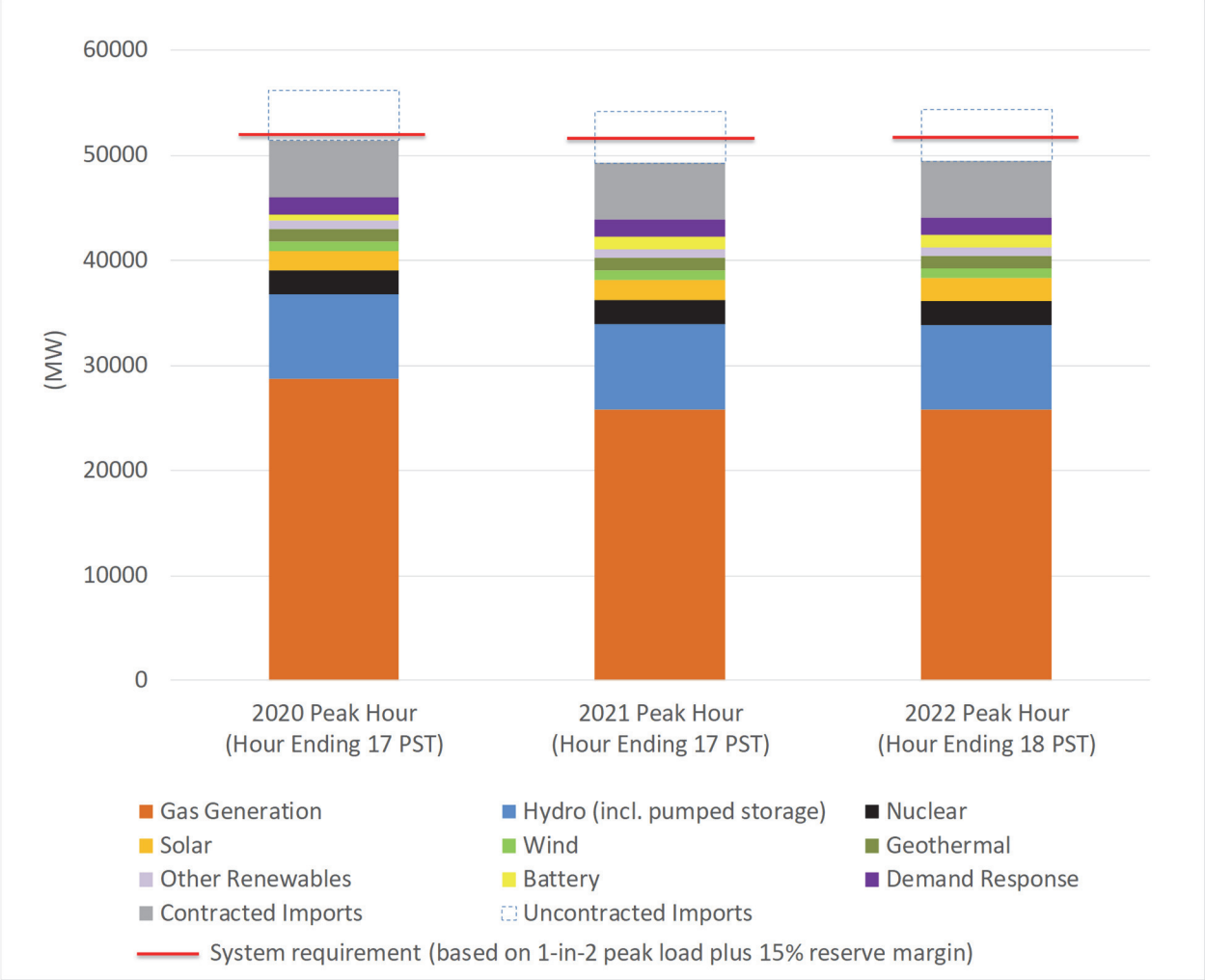
Since filing its opening comments, the CAISO further validated the near-term system resource adequacy need by (1) providing a new system resource adequacy analysis using net qualifying capacity (NQC) and effective load carrying capability (ELCC) counting principles and (2) refining the operational analysis provided in opening comments. The CAISO's system resource adequacy analysis provides an apples-to-apples comparison with the analysis submitted by SCE (Southern California Edison Company, *Opening Comments*, July 22, 2019, (SCE Opening Comments)).[1] The CAISO used a methodology similar to the one employed by SCE to identify a 500 MW system resource adequacy deficiency in 2020, which increases to 2,300 MW and 2,200 MW in 2021 and 2022, respectively. The CAISO's updated operational analysis again focuses on the hours after peak. The CAISO refined the operational analysis to more accurately reflect the expected available generation from solar, wind, and hydro resources during the post-system peak hours. The CAISO's operational analysis shows a reliability deficiency greater than previously projected—up to 2,300 MW, 4,400 MW, and 4,700 MW in 2020, 2021, and 2022, respectively. The CAISO describes both its resource adequacy analysis and its updated operational analysis below.

### 1. CAISO's System Resource Adequacy Analysis Is Directionally Consistent with SCE's Similar Methodological Analysis.

In opening comments, SCE provided a system resource adequacy (single peak hour) analysis using NQC and ELCC counting principles to estimate a system resource adequacy shortfall of 1,443 MW in 2020, 5,517 MW in 2021, and 4,458 MW in 2022.[2] In response, the CAISO conducted its own resource adequacy analysis to test SCE's results. The CAISO's resource adequacy analysis shows a 500 MW system resource adequacy deficiency in 2020, which increases to 2,300 MW and 2,200 MW in 2021 and 2022, respectively. These results are summarized in Figure 1 below.

[1] The CAISO developed a comparison with SCE's analysis because SCE provided detailed numerical data to allow for a more robust investigation.
[2] SCE Opening Comments, Table 8: Estimated System RA Shortfall (RA Capacity (MW)), p. 27.

**Figure 1: 2020, 2021, 2022 System Resource Adequacy**




The CAISO's resource adequacy analysis generally uses the same inputs and assumptions as SCE's analysis and adheres to the Commission's resource adequacy program counting rules using September NQC or ELCC values, as appropriate. To calculate the system resource requirements per the Commission's guidelines, the CAISO used the California Energy Commission (CEC) 2018 Integrated Energy Policy Report Update (2018 IEPR Update) 1-in-2 mid-mid peak load forecast for the coincident CAISO footprint and applied a 15 percent reserve margin.[3] The peak hour of the year occurs consistently in September. In 2020 and 2021, the

[3] California Energy Commission, *2018 Integrated Energy Policy Report Update*, March 21, 2019, (2018 IEPR Update), https://efiling.energy.ca.gov/GetDocument.aspx?tn=226461&DocumentContentId=57240 and California Public Utilities Commission, *2018 Resource Adequacy Report*, available at: https://www.cpuc.ca.gov/ra/.

projected peak falls within hour ending 17 (based on P.S.T. or 6:00 p.m. P.D.T.).[4] By 2022, the peak shifts to hour ending 18 (based on P.S.T. or 7:00 p.m. P.D.T.).

The CAISO used the September values from the 2019 NQC list for all natural gas-fired, hydro, nuclear, and renewable resources (excluding wind and solar).[5] The CAISO included the 1,020 MW Moss Landing Power Plant (Moss Landing), which is subject to OTC compliance. The CAISO's included Moss Landing in its analysis because as recently as March 2019, the Statewide Advisory Committee on Cooling Water Intake Structures (SACCWIS) stated that is expected to comply with OTC regulation by making the necessary capital investment upgrades to reduce impingement and entrainment.[6] In a change from the CAISO's July 22 analysis, the 500 MW Sutter Energy Center was removed from the available internal generation because it is not currenlty in the CAISO balancing authority area and therefore should fall into the category of potential "Uncontracted Imports."[7]

The CAISO's existing wind and solar installations are based on the 2019 NQC list, while resources with online dates from 2020 through 2022 are based on full capacity deliverability status resources from the 2017 IRP RESOLVE dataset.[8] All resource adequacy values for wind and solar are based on September ELCC values adopted in Decision 19-06-026.[9] Battery storage resources include existing batteries, incremental investor-owned utility procured batteries based on the most recent *Unified Resource Adequacy and Integrated Resource Plan Inputs and Assumptions*[10] document, and 558 MW of transmission- and distribution-connected batteries from PG&E's recent procurement authorized in Resolution E-4949. Demand response quantities are based on data provided by the investor-owned utilities to the CAISO in its 2019-2020

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[4] The CAISO's analysis is conducted in Pacific Standard Time (P.S.T.) and does not account for daylight savings. In September of each year, hours ending 15 through 20 correspond to 4:00 p.m. through 9:00 p.m. Pacific Daylight Time (P.D.T.).

[5] http://www.caiso.com/Documents/NetQualifyingCapacityList-2019.xlsx

[6] *2019 Report of the Statewide Advisory Committee on Cooling Water Intake Structures*, (March 8, 2019), pp. 19-21. Available at: https://www.waterboards.ca.gov/water_issues/programs/ocean/cwa316/saccwis/docs/sac2019fnl.pdf

[7] The CAISO notes that Sutter can effectively meet system capacity requirements if the proper contracting and import arrangements are in place.

[8] The RESOLVE model with updated 2017 IEPR assumptions file "RESOLVE_2017IEPRupdate_2018-04-17.zip," available at: ftp://ftp.cpuc.ca.gov/resources/electric/irp2017/resolvemodel.

[9] *See* D.19-06-026, *Order Instituting Rulemaking to Oversee Resource Adequacy*, July 5, 2019, Appendix A, Ordering Paragraph 19, p. 64.

[10] California Public Utilities Commission, Energy Resource Modeling Section, Energy Division, Unified Resource Adequacy and Integrated Resource Plan Inputs and *Assumptions – Guidance for Production Cost Modeling and Network Reliability Studies*, March 29, 2019, p. 80, see footnote 96: http://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/UtilitiesIndustries/Energy/EnergyPrograms/ElectPowerProcurementGeneration/irp/2018/Combined_IOU_Storage_2017update_public.xlsx

Transmission Planning Process and were held constant from 2020 through 2022. The CAISO also used a fixed quantity of contracted imports for its analyses based on the simple average of September imports from 2015 through 2018. Detailed input assumptions for the resource adequacy-based analysis are described in Attachment A to these comments.

The CAISO's resource adequacy analysis generally agrees with the direction of SCE's findings and notes that differences between the analyses are largely explained by different assumptions for hydro, natural gas-fired resources, and batteries. There is an approximately 3,200 MW difference between SCE's (5,517 MW) and the CAISO's (2,300 MW) shortfall in 2021 as shown in Table 1.

**Table 1:**

**Sample 2021 CAISO and SCE System Resource Adequacy Analysis Reconciliation (MW)**

| | **CAISO analysis** | **SCE analysis** | **Difference** |
|---|---|---|---|
| | [A] | [B] | [C] |
| *Calculations* | | | *[A] minus [B]* |
| Hydro | 8,074 | 6,358 | 1,716 |
| Natural gas | 25,833 | 24,864 | 969 |
| Battery (existing and future) | 1,223 | 673 | 550 |
| Total | | | 3,235 |

Hydro resources accounted for a net difference of approximately 1,700 MW, because the CAISO included all hydro resources as listed on the 2019 NQC list published July 2019 whereas SCE used the 2019 NQC list as of February 12, 2019.[11] In addition, the CAISO notes that it accounted for Hoover as an import, whereas SCE included Hoover generation as a hydro resource.

The CAISO's analysis includes approximately 1,000 MW more natural gas resources than SCE's analysis, largely because the CAISO includes Moss Landing (1,020 MW) as an available unit. On the other hand, the CAISO removed the Sutter Energy Center (500 MW) as an available resource, which is included in the SCE analysis.[12] The Sutter Energy Center's

[11] SCE Opening Comments, p. 15.

[12] As noted above, the CAISO removed the Sutter Energy Center from the available thermal generation list because it is not in the CAISO balancing authority area and therefore should fall into the category of potential "Uncontracted

exclusion, however, is offset by the CAISO including approximately 450 MW in thermal resources that are not included SCE's analysis.[13]

The CAISO's analysis includes approximately 550 MW more in battery capacity than SCE's analysis.[14] The CAISO analysis includes existing batteries, incremental investor-owned utility procured batteries,[15] and 558 MW of transmission- and distribution-connected batteries from PG&E's recent procurement authorized in Resolution E-4949. The CAISO assumes all battery resources procured and under construction will be operational according to publicly available schedules, whereas the CAISO understands SCE made some conservative adjustments to the battery amounts to reflect expectations of in-service dates.

There are minor differences between the CAISO and SCE analyses for contracted imports, demand response, wind, solar, and other renewable (RPS eligible) resources, the differences effectively net out. Collectively, these capacity counting differences help explain the variance between SCE's and CAISO's resource adequacy-based analyses.

### 2. Commission Should Use CAISO's System Resource Adequacy Analysis to Authorize Additional Resource Procurement and Seek OTC Compliance Date Extensions.

The CAISO's resource adequacy-backed analysis represents a detailed and accurate representation of the near-term reliability challenges to the electric system. The Commission sets system resource adequacy requirements based on a 1-in-2 peak load forecast using NQC values to quantify capacity availability. The CAISO's resource adequacy analysis shows that there will be a capacity deficiency in excess of 2,000 MW in 2021 based on current Commission adopted NQC counting methodologies and planning reserve margin criteria. The CAISO's analysis provides the most detailed and accurate assessment of the deficiency and it

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Imports." The CAISO notes that Sutter can effectively meet system capacity requirements if the proper contracting and import arrangements are in place.

[13] This 450 MW difference includes 100 MW of mothballed units that the CAISO analysis assumes can be contracted for, 165 MW assumed retired by SCE, and 185 MW of NQC list discrepancies or missing units.

[14] For CAISO's battery numbers, see Attachment A for a detailed discussion on how Commission Energy Division staff for IRP included all domains of battery storage (customer, distribution, and transmission) towards the resource adequacy system requirement. The CAISO is concerned by this practice as behind-the-meter customer sited resources do not have the same must offer obligations or be required to respond to CAISO dispatch.

[15] California Public Utilities Commission, Energy Resource Modeling Section, Energy Division, *Unified Resource Adequacy and Integrated Resource Plan Inputs and Assumptions – Guidance for Production Cost Modeling and Network Reliability Studies*, March 29, 2019, p. 80, see footnote 96: http://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/UtilitiesIndustries/Energy/EnergyPrograms/ElectPowerProcurementGeneration/irp/2018/Combined_IOU_Storage_2017update_public.xlsx

comports with the current methodology for setting and meeting resource adequacy obligations. As a result, the Commission should use this analysis to establish a minimum procurement requirement from new resources or resources that receive an extension to their OTC regulation compliance date. The Commission should also use the CAISO's analysis to justify extending the OTC regulation compliance date for Alamitos at the least. The Commission should identify any other OTC units that will be needed for system reliability, taking into account ongoing efforts to procure existing, under development, or new resources (including reliable imports). The Commission should make the case for extending any additional OTC compliance dates to the State Water Resources Control Board as necessary, with the understanding that the requested compliance extension(s) may not ultimately be needed.

The Commission should also consider whether additional procurement is necessary to address potential delays in the in-service dates for any new resources assumed in the CAISO system resource adequacy analysis. For example, the Commission should seek confirmation from PG&E on whether battery resources authorized under Resolution E-4949 included in the CAISO's analysis are proceeding in light of PG&E's bankruptcy.[16] Similarly, the Commission should ensure other projects under construction meet their in-service dates.

### 3. The Commission Should Use the CAISO's Operational Analysis to Guide Procurement Directives.

As described in opening comments, CAISO's operational analysis complements the system resource adequacy analysis by showing the capability of the projected resource adequacy fleet to serve load after the gross peak hour based on historical operational performance rather than static NQC and ELCC capacity values. The CAISO updated some of its assumptions as described below and as provided in detail in Attachment B.

As in its prior analysis, the CAISO assumed all resources would produce energy up to their NQC value except wind, solar, and hydro (including pumped storage) resources.[17] The CAISO modeled wind, solar, and hydro resources based on the actual generation profiles for those resources. In contrast to the analysis submitted in its opening comments, the CAISO used historical data from September 2015 through 2018 to calculate median generation per hour for

[16] *See* Attachment A for detailed discussion on battery storage treatment.
[17] *See* Attachment B for detailed assumptions and inputs. Wind and solar are based on a generalized generation profile for each resource. Hydro (including pumped storage) resources are assumed to produce approximately 70 percent of the total NQC value to reflect historical generation plus provision of ancillary services.

wind and solar generation profiles. In the previously submitted operational analysis CAISO used a projected September 2030 generic resource profile. The change was necessary because the generic 2030 solar generation profile assumed a larger penetration of solar resources with tracking capability than currently exists. For consistency, the CAISO updated the wind and hydro generation profiles to reflect the historical September 2015 through 2018 median generation as well.

The CAISO's analysis includes energy from "contracted imports" based on the average resource adequacy-backed import levels from September from 2015 through 2018. The average reflects recent contracting experience during both drought and non-drought years. In addition to the projected resource adequacy capacity, the analysis includes a provision for "uncontracted imports." These uncontracted imports reflect uncontracted energy up to the maximum import capability (MIC), which the CAISO assumed to be static (at 10,193 MW) for the analysis.

The CAISO continued to use the CEC's 2018 IEPR Update in its operational analysis to establish the projected load per hour and to calculate an hourly capacity need based on the maximum load in each hour plus a planning reserve margin (PRM) equal to 15 percent of the hourly demand. This hourly capacity need shows that although loads remain high after the peak hour, the reduction in solar generation greatly reduces the total resource adequacy-backed available energy output.

Figures 2, 3, and 4 below show the energy production from the projected resource adequacy fleet from hours ending 15 through 20 in 2020, 2021, and 2022, respectively.[18]

[18] The CAISO's analysis is conducted in Pacific Standard Time (P.S.T.) and does not account for daylight savings. In September of each year, hours ending 15 through 20 correspond to 4:00 p.m. through 9:00 p.m. Pacific Daylight Time (P.D.T.).

**Figure 2: 2020 Projected Energy Production from Resource Adequacy Fleet**

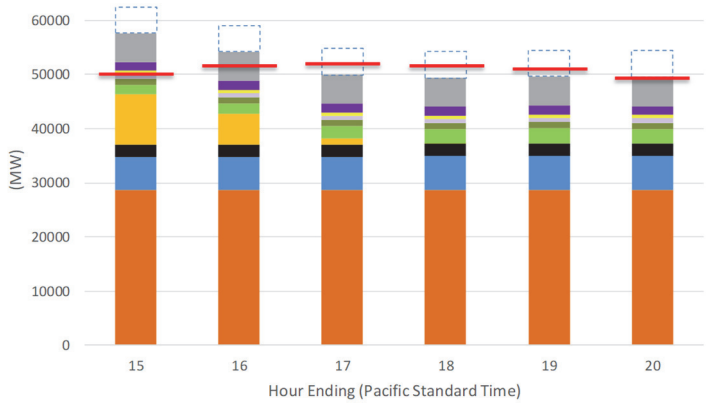



**Figure 3: 2021 Projected Energy Production from Resource Adequacy Fleet**

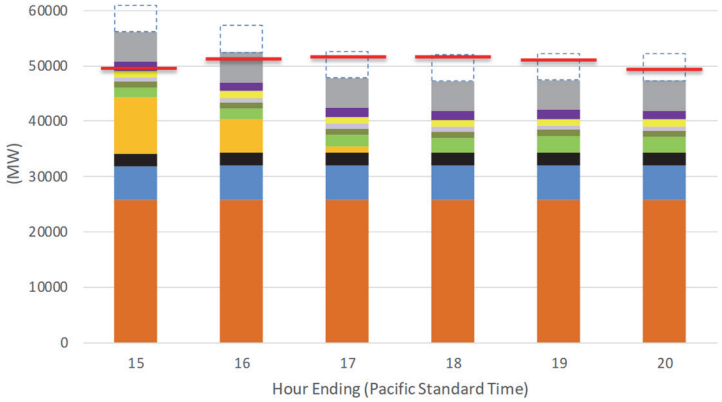
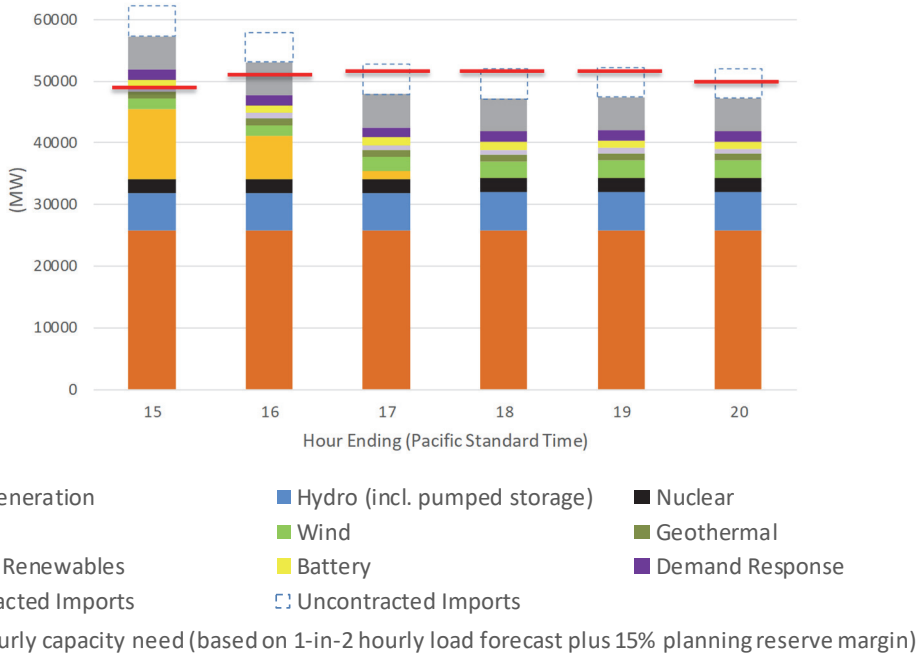



**Figure 4: 2022 Projected Energy Production from Resource Adequacy Fleet**



In Figure 2, the 2020 analysis shows a reliability concern at peak (hour ending 17) and in the two hours immediately after. Specifically, resource adequacy-backed energy exceeds the hourly capacity need only through hour ending 16. In hours ending 17 through 19, the resource adequacy-backed energy is 2,200 MW, 2,300 MW, and 1,500 MW less than the hourly capacity need, respectively. In hour ending 20 the energy need is at the margin of what resource-adequacy backed capacity can supply. The disparity between resource adequacy-backed energy and the hourly capacity need reflects the reliability gap the Commission should address to ensure the CAISO has the resources to serve load reliably. This analysis also shows that the system is implicitly relying on uncontracted (non-resource adequacy) imports to balance demand.

Figure 3 shows that the 2021 reliability gap expands to cover four hours—from hours ending 17 through 20. The reliability gap is 4,000 MW, 4,400 MW, 3,800 MW, and 2,200 MW during hours ending 17, 18, 19, and 20, respectively.

Figure 4 shows that the 2022 reliability gap continues to cover hours ending 17 through 20, though the peak hour shifts from hour ending 17 to 18. The reliability gap is 3,900 MW, 4,700 MW, 4,200 MW, and 2,600 MW during hours ending 17, 18, 19, and 20, respectively.

These results almost double the reliability gap described in CAISO's opening comments yet may still be considered conservative. In addition to the concerns noted in CAISO's opening comments,[19] this updated operational analysis still does not account for the significant range of wind generation actually observed during hours ending 17, 18, 19 and 20. As noted above, the analysis relies on new resources assumed to be online to support reliability, including the 558 MW of transmission-connected battery resources authorized under Resolution E-4949. The Commission should seek confirmation from PG&E on whether these battery projects are proceeding on schedule. Similarly, the Commission should ensure other projects under construction meet their in-service dates.

## III. Responses to specific opening comments

The CAISO provides responses to specific opening comments below.

[19] *See* California Independent System Operator Corporation, *Opening Comments*, July 22, 2019, p. 6.

### A. The Resource Adequacy Program is the Most Appropriate Mechanism to Retain OTC Resources.

PG&E and SCE both recommend that the CAISO use the reliability must run (RMR) mechanism to procure OTC resources.[20] Although the CAISO retains the right to exercise the RMR mechanism, the resource adequacy program is the "frontstop" and as such, any needed OTC resources should be pursued in the first instance through LSE bilateral procurement.

### B. The Commission Should Diversify the Resource Adequacy Fleet to Address Reliability After the Peak Hour.

Some parties have either requested additional solar resource procurement or intend to make additional solar resource procurement to counts towards system resource adequacy.[21] For example, California Community Choice Association (CalCCA) noted in opening comments that 1,047 MW of the 1,597 MW in nameplate capacity contracted to come online before August 2021 is solar.[22] Though the September ELCC value is currently 14 percent, the later peak hour in 2022 (hour ending 18 or 7 p.m.) reduces average solar generation to only 0.04 percent of maximum generation.[23] In other words, the 1,047 MW of new contracted for solar capacity will effectively be providing on average, under non-cloudy conditions 42 MW of energy during peak system demand. As the CAISO analysis shows, the reliability gap in the hours after peak is almost twice as much as during the peak hour. The Commission should ensure diversity in the resource adequacy fleet so that it can provide sufficient energy both during the peak and in the hours immediately after the peak.

### C. The Commission Should Strengthen Resource Adequacy Import Rules to Take Advantage of Additional Contracting as Soon as Possible.

The CAISO agrees with parties that there is no reason to discount the resource adequacy

[20] Pacific Gas & Electric Company, *Opening Comments*, July 22, 2019, pp. 5-6 and SCE Opening Comments, p. 33.
[21] California Community Choice Association, *Opening Comments*, July 22, 2019 p. 11 (CalCCA Opening Comments), p. 11; Solar Energy Industries Association opening comments, p. 7.
[22] CalCCA Opening Comments, p. 11.
[23] *See* Attachment B for CAISO assumptions on solar generation profile.

qualifying capacity for incremental imports.[24] While the MIC itself is not a limiting factor,[25] it is critical that the Commission ensure that needed imports are contracted for earlier because supplies are becoming increasingly scarce in light of prevailing changes throughout the west.[26] For example, the Northwest Power and Conservation Council, which releases periodic regional power plans covering Idaho, Montana, Oregon, and Washington, noted several significant changes since its last plan in 2016.[27] Specifically, the changes include major coal plant retirements, a tightening of resource adequacy in the northwest, policy direction to reduce carbon emissions and increase renewable procurement. Similarly, there have been observations that merchant generation in the southwest capable of importing energy into California are being procured by utilities in Arizona.[28] Given these trends, the Commission should strengthen its resource adequacy import rules as proposed by the CAISO[29] so that incremental imports can be procured as soon as possible to address the near-term reliability gap. The most appropriate entities to conduct market analysis on import trends or feasibility are the load serving entities who can then provide such information to the Commission.[30]

## IV. Conclusion

The CAISO's resource adequacy analysis shows that there will be a capacity deficiency in excess of 2,000 MW based on current NQC counting methodologies. The CAISO's analysis provides the most detailed and accurate assessment of the deficiency and it comports with the current methodology for setting and meeting resource adequacy obligations. As a result, the Commission should use this analysis to establish a minimum procurement requirement from new resources or resources that receive an extension to their OTC regulation compliance date. The

[24] Bonneville Power Administration, *Opening Comments*, July 22, 2019, p. 4; Department of Market Monitoring of the California Independent System Operator Corporation, *Opening Comments*, July 22, 2019, p. 5; Powerex Corp., *Opening Comments*, July 22, 2019, p. 4 (Powerex Opening Comments); Public Generating Pool, *Opening Comments*, July 22, 2019, pp. 6-7.
[25] CalCCA Opening Comments, p. 14; City and County of San Francisco *Opening Comments*, July 22, 2019 p.7, (CCSF Opening Comments); Powerex Opening Comments, p. 5.
[26] Calpine Corporation *Opening Comments*, July 22, 2019, p. 4; Center for Energy Efficiency and Renewable Technologies, *Opening Comments*, July 22, 2019, pp. 2-3; Powerex Opening Comments, p.4.
[27] *See* https://www.nwcouncil.org/sites/default/files/2019_0716_p1.pdf
[28] *See* Comments of Calpine Corporation: http://www.caiso.com/Documents/CalpineComments-ResourceAdequacyEnhancements-StrawProposalPart1.pdf
[29] CAISO opening and reply comments to Assigned Commissioner's Ruling Seeking Comment on Clarification to Resource Adequacy Import Rules, July 3, 2019, R. 17-09-020.
[30] CalCCA Opening Comments, p. 15.

Commission should also use the CAISO's analysis to justify extending the OTC regulation compliance date for at least Alamitos.

Several parties[31] have requested more rigorous or complex analysis to better under the reliability gap. For system resource adequacy, a spreadsheet-based analyses, such as the one provided by the CAISO, is sufficient for meeting the Commission's established standard. While the CAISO encourages the Commission to develop more sophisticated reliability-based analysis in the future, the near-term needs are clear, well supported, and extremely urgent. The CAISO urges the Commission to take decisive action now to address these near-term needs. The CAISO appreciates the opportunity to provide these reply comments and looks forward to working with the Commission to address these reliability issues.

Respectfully submitted,

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[31] For example: Alliance for Retail Energy Markets, *Opening Comments*, July 22, 2019, p. 4; CalCCA Opening Comments, p. 9; CCSF Opening Comments, p. 2; First Solar,Inc., *Opening Comments*, July 22, 2019 p. 2; Vote Solar, *Opening Comments*, July 22, 2019, p. 3; Western Power Trading Forum, *Opening Comments*, July 22, 2019, pp. 3-4.

**Attachment A**
**CAISO Input Assumptions and Tabular Data for Resource Adequacy Analysis**

Table A-1 below summarizes the input assumptions for Figure 1 and Table 1.

**Table A-1: CAISO Load and Resource Assumptions for Resource Adequacy Analysis**

| | |
|---|---|
| **System Requirement** | |
| System Requirement | California Public Utilities Commission: "System requirements are determined based on the each LSEs CEC adjusted forecast plus a 15% planning reserve margin."<br><br>https://www.cpuc.ca.gov/ra/ |
| Load | California Energy Commission 2018 Integrated Energy Policy Report Update (2018 IEPR Update) 1-in-2 system peak Mid/Mid Load (2020 and 2021 peak hour = hour ending 17 PST; 2022 peak hour = hour ending 18 PST).<br><br>https://efiling.energy.ca.gov/GetDocument.aspx?tn=226461&DocumentContentId=57240 |
| Planning Reserve Margin | 15%<br><br>https://www.cpuc.ca.gov/ra/ |
| **Generation** | |
| Net Qualifying Capacity | 2019 Net Qualifying Capacity (NQC) list: http://www.caiso.com/Documents/NetQualifyingCapacityList-2019.xlsx (Version dated July 10, 2019.)<br><br>Resource IDs from the NQC list were cross-referenced with CAISO MasterFile for resource category verification. |
| Mothballed Units | CAISO's list is http://www.caiso.com/Documents/AnnouncedRetirementAndMothballList.xlsx#search=mothball |
| **Gas Generation** | |
| Existing Gas Generation | Existing generators from 2019 NQC list based on September values. Does not include once-through cooling (OTC), Mothballed, Announced Retired and New Units. Dynamic scheduled generators included in Imports. |
| Once-through Cooling compliance | Once-through Cooling (OTC) retirements based upon compliance dates. Moss Landing is assumed to continue operation.<br><br>https://efiling.energy.ca.gov/GetDocument.aspx?tn=228353&DocumentContentId=59542 |

| | |
|---|---|
| Mothballed | Based on CAISO's published list (see above). Mothballed units are assumed available, except for Inland Empire.<br><br>Inland Empire is assumed retired by end of 2019. *See* Inland Empire Energy Center Decommissioning and Demolition Plan, Docket Number: 01-AFC-17C, TN Number: 228806, June 20, 2019, p.1. |
| New Units | Announced new gas generation (includes repowering for Huntington Beach and Alamitos). |
| Sutter Energy Center | Not included in analysis because not in CAISO balancing authority area and currently uncontracted (considered Uncontracted Imports) |
| **Hydro (including Pumped Storage)** | |
| Large Hydro | >30 MW hydro resources within the CAISO footprint. Qualifying capacity based on 2019 NQC list based on September values.<br><br>Hoover accounted for under Contracted Imports. |
| Small Hydro | ≤30MW, RPS eligible resources within the CAISO footprint. Qualifying capacity based on 2019 NQC list based on September values. |
| Pumps with net qualifying capacity | Pumps designated to provide ancillary services with an NQC value. Qualifying capacity based on 2019 NQC list based on September values. |
| Pumped Storage | Includes Helms, San Luis and Eastwood. |
| **Nuclear** | |
| Nuclear | Diablo Canyon only. Qualifying capacity based on 2019 NQC list based on September values.<br><br>Palo Verde accounted for under Contracted Imports. |
| **Solar** | |
| Existing Solar | Total installed values from 2019 NQC list based on September values. Qualifying capacity based on effective load carrying capability for September from D.19-06-026 (*i.e.,* 14%). |
| Future Solar | Total installed values from the Commission's RESOLVE model with updated 2017 IEPR assumptions file "RESOLVE_2017IEPRupdate_2018-04-17.zip" is available at: ftp://ftp.cpuc.ca.gov/resources/electric/irp2017/resolvemodel. Resource Build = FCDS.<br><br>Since RESOLVE only produces outputs for 2018 and 2022, buildout for 2020 through 2022 were cross referenced against the CAISO interconnection queue. Qualifying capacity based on effective load carrying capability for September from D.19-06-026 (*i.e.,* 14%). |
| **Wind** | |
| Existing Wind | Total installed values from 2019 NQC list based on September values. Qualifying capacity based on effective load carrying capability for September from D.19-06-026 (*i.e.,* 15%). |

| | |
|---|---|
| Future Wind | Total installed values from the Commission's RESOLVE model with updated 2017 IEPR assumptions file "RESOLVE_2017IEPRupdate_2018-04-17.zip" is available at: ftp://ftp.cpuc.ca.gov/resources/electric/irp2017/resolvemodel. Resource Build = FCDS.<br><br>Since RESOLVE only produces outputs for 2018 and 2022, buildout for 2020 through 2022 were cross referenced against the CAISO interconnection queue. Qualifying capacity based on effective load carrying capability for September from D.19-06-026 (*i.e.,* 15%). |
| **Geothermal** | |
| Geothermal | Qualifying capacity based on 2019 NQC list based on September values. |
| **Other Renewables** | |
| Other Renewables | Includes Biomass, Biogas, Heat recovery, Waste and Other. Qualifying capacity based on 2019 NQC list based on September values. |
| **Battery** | |
| Existing and Procured | Assumes all capacity is 4 hour duration. Existing storage qualifying capacity based on 2019 NQC list based on September values. Incremental procurement based on most recently available investor-owned utility storage procurement compiled by Commissioner Energy Division staff (IOU procurement) available at: http://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/UtilitiesIndustries/Energy/EnergyPrograms/ElectPowerProcurementGeneration/irp/2018/Combined_IOU_Storage_2017update_public.xlsx<br><br>Note that the IOU procurement spreadsheet also includes existing resources. Based on Commission guidance, all domains (customer, distribution and transmission-connected) listed in the IOU procurement spreadsheet were assumed to count towards resource adequacy obligations. See discussion below.<br><br>Annual distributions for 2020 through 2022 based on Commission Energy Division staff guidance for the CAISO's Transmission Planning Process. |
| Resolution E-4949 | Based on authorized storage procurement by PG&E. 10 MW of customer behind-the-meter storage was removed.<br><br>http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M240/K050/240050937.PDF |
| **Demand Response** | |
| Demand Response | Based on investor owned-utility submitted data into CAISO's 2019-2020 Transmission Planning Process Study Plan (pages 25-27).<br><br>http://www.caiso.com/Documents/Final2019-2020StudyPlan.pdf |

| **Imports** (based on total maximum import capability of 10,193 MW) | |
|---|---|
| Contracted Imports | 5,340 MW was used for 2020 through 2022. Based on average of historical contracted imports from 2015 through 2018 for September, which includes both drought and non-drought years. (Values are: 4,486 MW in 2015; 5,178 MW in 2016; 5,885 MW in 2017; and 5,813 MW in 2018.)<br><br>Includes Palo Verde and Hoover. |
| Uncontracted Imports | Calculated as the difference between the maximum import capability and Contracted Imports. |

***Battery discussion***

The *2019 Unified Resource Adequacy and Integrated Resource Plan Inputs and Assumptions* (2019 Unified I&A) provided the following guidance on how to treat batteries:

> *CPUC staff assumed that the full 1,325 MW is online by 2024 and has an average duration of 4 hours, meaning the full 1,325 MW counts towards RA obligations, is dispatchable, and can be used to provide ancillary services, regardless of interconnection domain (transmission-connected, distribution-connected, BTM). This was consistent with the assumptions used in the RESOLVE model and the IRP Reference System Plan*.[32]

The CAISO is concerned by Commission Energy Division staff guidance to count all domains toward resource adequacy. Customer sited (behind-the-meter) storage should not count towards resource adequacy as these resources will likely not have a must-offer obligation or be required to respond to CAISO dispatch. Nonetheless, for this analysis, the CAISO stayed consistent with Commission Energy Division staff guidance and assumed all domains count towards the system resource adequacy requirement, including approximately 200 MW of customer domain batteries. Recent filings made by PG&E noting an over-procurement in transmission-connected storage resources beyond their allocated procurement amount directed by Commission Decision (D.) 13-

[32] California Public Utilities Commission, Energy Resource Modeling Section, Energy Division, *Unified Resource Adequacy and Integrated Resource Plan Inputs and Assumptions – Guidance for Production Cost Modeling and Network Reliability Studies*, March 29, 2019, p. 55.

10-040 may counterbalance the inappropriate inclusion of customer domain storage.[33] The CAISO did not attempt to reconcile PG&E's subsequent advice letter filing. The Commission should seek confirmation from PG&E on whether these battery projects are proceeding in light of PG&E's bankruptcy.

The 2019 Unified I&A also provided a link to a spreadsheet detailing the progress of investor-owned utility (IOU) battery procurement across all three domains.[34] Annual distributions for 2020 through 2022 based on Commission Energy Division staff guidance for the CAISO's Transmission Planning Process.

Procurement from Resolution E-4949 is incremental to the existing and procured amounts described above. Of the total 567.5 MW authorized, the CAISO removed 10 MW in the customer domain which will be behind the retail meter.[35]

The total procurement by 2022 (existing and procured plus Resolution E-4949) is equal to 1,128 MW of capacity. This was cross-checked with the total 2022 installed battery value from the Commission's RESOLVE model with updated 2017 IEPR assumptions of 1,113 MW.[36]

Table A-2 below is the tabular data used to create Figure 1 and Table 1.

[33] *See* Table 1, p. 2 at: https://www.pge.com/tariffs/assets/pdf/adviceletter/ELEC_5427-E.pdf.
[34] California Public Utilities Commission, Energy Resource Modeling Section, Energy Division, *Unified Resource Adequacy and Integrated Resource Plan Inputs and Assumptions – Guidance for Production Cost Modeling and Network Reliability Studies*, March 29, 2019, p. 80 and available at: http://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/UtilitiesIndustries/Energy/EnergyPrograms/ElectPowerProcurementGeneration/irp/2018/Combined_IOU_Storage_2017update_public.xlsx.
[35] *See* Table 5, p. 26: http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M240/K050/240050937.PDF.
[36] *See* "RESOLVE_2017IEPRupdate_2018-04-17.zip" available at: ftp://ftp.cpuc.ca.gov/resources/electric/irp2017/resolvemodel.

**Table A-2: CAISO Load and Resource Calculations for Resource Adequacy Analysis**

| | | 2020 | 2021 | 2022 |
|---|---|---|---|---|
| [1] | **Gas Generation** | **28,689** | **25,833** | **25,779** |
| [2] | Existing Gas Generation | 24,349 | 24,349 | 24,295 |
| [3] | Once Through Cooling Units | 4,239 | 0 | 0 |
| [4] | Mothballed | 101 | 101 | 101 |
| [5] | New Units | 0 | 1,382 | 1,382 |
| [6] | **Hydro (incl. pumped storage)** | **8,074** | **8,074** | **8,074** |
| [7] | Large Hydro | 5,423 | 5,423 | 5,423 |
| [8] | Small Hydro | 635 | 635 | 635 |
| [9] | Pumps with net qualifying capacity | 559 | 559 | 559 |
| [10] | Pumped Storage | 1,457 | 1,457 | 1,457 |
| [11] | **Nuclear** | **2,280** | **2,280** | **2,280** |
| [12] | **Solar** | **1,797** | **1,937** | **2,168** |
| [13] | Existing Solar | 1,657 | 1,657 | 1,657 |
| [14] | Future Solar | 140 | 280 | 511 |
| [15] | **Wind** | **968** | **968** | **968** |
| [16] | Existing Wind | 917 | 917 | 917 |
| [17] | Future Wind | 51 | 51 | 51 |
| [18] | **Geothermal** | **1,140** | **1,140** | **1,140** |
| [19] | **Other Renewables** | **814** | **814** | **814** |
| [20] | **Battery** | **566** | **1,223** | **1,233** |
| [21] | Existing and Procured | 566 | 666 | 676 |
| [22] | Resolution E-4949 | 0 | 558 | 558 |
| [23] | **Demand Response** | **1,660** | **1,660** | **1,660** |
| [24] | **Imports** | **10,193** | **10,193** | **10,193** |
| [25] | Contracted Imports | 5,430 | 5,340 | 5,340 |
| [26] | Uncontracted Imports | 4,763 | 4,853 | 4,853 |
| [27] | **Total Resources (excl. Uncontracted Imports)** | **51,418** | **49,269** | **49,455** |
| [28] | **System Requirement** | **51,882** | **51,549** | **51,678** |
| [29] | Load | 45,115 | 44,825 | 44,937 |
| [30] | Planning Reserve Margin (15%) | 6,767 | 6,724 | 6,741 |
| [31] | **System Resource Adequacy (Shortfall)** | **(464)** | **(2,280)** | **(2,222)** |

**Attachment B**
**CAISO Input Assumptions and Tabular Data for Operational Analysis**

Table B-1 below summarizes the input assumptions for Figures 2, 3, and 4.

**Table B-1: CAISO Load and Resource Assumptions for Operational Analysis**

| | |
|---|---|
| **Hourly Capacity Need** | |
| Hourly Capacity Need | Based on the same concept as the system requirement for resource adequacy per California Public Utilities Commission rules, except the hourly capacity need varies from hour to hour. System requirement needs are: "System requirements are determined based on the each LSEs CEC adjusted forecast plus a 15% planning reserve margin."<br><br>https://www.cpuc.ca.gov/ra/ |
| Load | California Energy Commission 2018 Integrated Energy Policy Report Update (2018 IEPR Update) 1-in-2 system peak Mid/Mid Load (2020 and 2021 peak hour = hour ending 17 PST; 2022 peak hour = hour ending 18 PST). For the operational analysis, used hourly data.<br><br>https://efiling.energy.ca.gov/GetDocument.aspx?tn=226142&DocumentContentId=56881 |
| Planning Reserve Margin | 15%<br><br>https://www.cpuc.ca.gov/ra/ |
| **Generation** | |
| Net Qualifying Capacity | 2019 Net Qualifying Capacity (NQC) list: http://www.caiso.com/Documents/NetQualifyingCapacityList-2019.xlsx (Version dated July 10, 2019.)<br><br>Resource IDs from the NQC list were cross-referenced with CAISO MasterFile for resource category verification. Resources based on NQC values are assumed to generate up to its full NQC value per hour unless otherwise noted. |
| Mothballed Units | CAISO's list is http://www.caiso.com/Documents/AnnouncedRetirementAndMothballList.xlsx#search=mothball |
| **Gas Generation** | |
| Existing Gas Generation | Existing generators from 2019 NQC list based on September values. Does not include once-through cooling (OTC), Mothballed, Announced Retired and New Units. Dynamic scheduled generators included in Imports. |

| | |
|---|---|
| Once-through Cooling compliance | Once-through Cooling (OTC) retirements based upon compliance dates. Moss Landing is assumed to continue operation.<br><br>https://efiling.energy.ca.gov/GetDocument.aspx?tn=228353&DocumentContentId=59542 |
| Mothballed | Based on CAISO's published list (see above). Mothballed units are assumed available, except for Inland Empire.<br><br>Inland Empire is assumed retired by end of 2019. *See* Inland Empire Energy Center Decommissioning and Demolition Plan, Docket Number: 01-AFC-17C, TN Number: 228806, June 20, 2019, p.1. |
| New Units | Announced new gas generation (includes repowering for Huntington Beach and Alamitos). |
| Sutter Energy Center | Not included in analysis because not in CAISO balancing authority area and currently uncontracted (considered Uncontracted Imports) |
| **Hydro (including Pumped Storage)** | |
| Large Hydro | Includes >30 MW hydro resources within the CAISO footprint. Generation profile calculated as 70% of qualifying capacity based on 2019 NQC list for September values. 70% generation was derived by taking the median generation value during the single peak hour for all days in September from 2015 through 2018. The selected near-term historical years include both drought and non-drought years. The generation profile was held constant over the analysis hours.<br><br>Hoover accounted for under Contracted Imports. |
| Small Hydro | Includes ≤30MW, RPS eligible resources within the CAISO footprint. Generation profile calculated as 70% of qualifying capacity based on 2019 NQC list for September values. 70% generation was derived by taking the median generation value during the single peak hour for all days in September from 2015 through 2018. The selected near-term historical years include both drought and non-drought years. The generation profile was held constant over the analysis hours. |

<table>
<tr><td>Hydro and Pump Provision of Ancillary Services</td><td>Approximately 800 MW to 1,000 MW per hour. The same profile was used for 2020 through 2022. Based on observed provision of ancillary services (regulation up, regulation down, spinning reserves and non-spinning reserves) from all hydro resources and pumps from 2018 during the time of peak loading periods during summer. Only 2018 observations for ancillary services were used due to the change in BAL-002-2 standards effective January 1, 2018. See BAL-002-2 and operating reserve requirement changes implemented by the ISO is available here: http://www.caiso.com/Documents/Presentation-BAL-002-2DisturbanceControlStandardkContingencyReserveforRecoveryfromaBalancingContingencyEvent.pdf or in the NERC BAL-002-2 reliability standard here: http://www.nerc.com/pa/Stand/Reliability%20Standards/BAL-002-2.pdf.</td></tr>
<tr><td>Pumped Storage</td><td>Includes Helms, San Luis and Eastwood. Generation profile calculated as 70% of qualifying capacity based on 2019 NQC list for September values. 70% generation was derived by taking the median generation value during the single peak hour for all days in September from 2015 through 2018. The selected near-term historical years include both drought and non-drought years. The generation profile was held constant over the analysis hours.</td></tr>
<tr><td colspan="2">Nuclear</td></tr>
<tr><td>Nuclear</td><td>Diablo Canyon only. Qualifying capacity based on 2019 NQC list based on September values.<br><br>Palo Verde accounted for under Contracted Imports.</td></tr>
<tr><td colspan="2">Solar</td></tr>
<tr><td>Existing Solar</td><td>Based on the following generation profile as applied to total installed values from 2019 NQC list based on September values:<br><br>
<table>
<tr><td>Hour ending 15 P.S.T.</td><td>4 p.m.</td><td>72.61%</td></tr>
<tr><td>Hour ending 16 P.S.T.</td><td>5 p.m.</td><td>44.19%</td></tr>
<tr><td>Hour ending 17 P.S.T.</td><td>6 p.m.</td><td>8.47%</td></tr>
<tr><td>Hour ending 18 P.S.T.</td><td>7 p.m.</td><td>0.04%</td></tr>
<tr><td>Hour ending 19 P.S.T.</td><td>8 p.m.</td><td>0.00%</td></tr>
<tr><td>Hour ending 20 P.S.T.</td><td>9 p.m.</td><td>0.00%</td></tr>
</table>
<br>Generation profile calculated as the median generation value per hour in all days in September from 2015 through 2018 divided by the maximum generation during the same time period.</td></tr>
<tr><td>Future Solar</td><td>See Table A-1 for explanation on total installed values. Used same generation profile as Existing Solar.</td></tr>
<tr><td colspan="2">Wind</td></tr>
</table>

<table>
<tr><td>Existing Wind</td><td>Based on the following generation profile as applied to total installed values from 2019 NQC list based on September values:<br><br><table><tr><td>Hour ending 15 P.S.T.</td><td>4 p.m.</td><td>26.61%</td></tr><tr><td>Hour ending 16 P.S.T.</td><td>5 p.m.</td><td>29.17%</td></tr><tr><td>Hour ending 17 P.S.T.</td><td>6 p.m.</td><td>33.53%</td></tr><tr><td>Hour ending 18 P.S.T.</td><td>7 p.m.</td><td>41.73%</td></tr><tr><td>Hour ending 19 P.S.T.</td><td>8 p.m.</td><td>44.54%</td></tr><tr><td>Hour ending 20 P.S.T.</td><td>9 p.m.</td><td>43.81%</td></tr></table><br>Generation profile calculated as the median generation value per hour in all days in September from 2015 through 2018 divided by the maximum generation during the same time period. Note that wind generation is highly variable.</td></tr>
<tr><td>Future Wind</td><td>See Table A-1 for explanation on total installed values. Used same generation profile as Existing Wind.</td></tr>
<tr><td colspan="2">Geothermal</td></tr>
<tr><td>Geothermal</td><td>Qualifying capacity based on 2019 NQC list based on September values.</td></tr>
<tr><td colspan="2">Other Renewables</td></tr>
<tr><td>Other Renewables</td><td>Includes Biomass, Biogas, Heat recovery, Waste and Other. Qualifying capacity based on 2019 NQC list based on September values.</td></tr>
<tr><td colspan="2">Battery</td></tr>
<tr><td>Existing and Procured</td><td>Assumes all capacity is 4 hour duration. Existing storage qualifying capacity based on 2019 NQC list based on September values. Incremental procurement based on most recently available investor-owned utility storage procurement compiled by Commissioner Energy Division staff (IOU procurement) available at: http://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/UtilitiesIndustries/Energy/EnergyPrograms/ElectPowerProcurementGeneration/irp/2018/Combined_IOU_Storage_2017update_public.xlsx<br><br>Note that the IOU procurement spreadsheet also includes existing resources. Based on Commission guidance, all domains (customer, distribution and transmission-connected) listed in the IOU procurement spreadsheet were assumed to count towards resource adequacy obligations. See discussion in Attachment A.<br><br>Annual distributions for 2020 through 2022 based on Commission Energy Division staff guidance for the CAISO’s Transmission Planning Process.</td></tr>
<tr><td>Resolution E-4949</td><td>Based on authorized storage procurement by PG&E. 10 MW of customer behind-the-meter storage was removed.</td></tr>
<tr><td colspan="2">Demand Response</td></tr>
</table>

| | |
|---|---|
| Demand Response | Based on investor owned-utility submitted data into CAISO's 2019-2020 Transmission Planning Process Study Plan (pages 25-27).<br><br>http://www.caiso.com/Documents/Final2019-2020StudyPlan.pdf |
| **Imports** (based on total maximum import capability of 10,193 MW) | |
| Contracted Imports | 5,340 MW was used for 2020 through 2022. Based on average of historical contracted imports from 2015 through 2018 for September, which includes both drought and non-drought years. (Values are: 4,486 MW in 2015; 5,178 MW in 2016; 5,885 MW in 2017; and 5,813 MW in 2018.)<br><br>Includes Palo Verde and Hoover. |
| Uncontracted Imports | Calculated as the difference between the maximum import capability and Contracted Imports. |

Tables B-2, B-3, and B-4 below are the tabular data used to create Figures 2, 3, and 4, respectively.

## Table B-2: 2020 CAISO Load and Resource Calculations for Operational Analysis

| | | HE 15 | HE 16 | HE 17 | HE 18 | HE 19 | HE 20 |
|---|---|---|---|---|---|---|---|
| [1] | **Gas Generation** | **28,689** | **28,689** | **28,689** | **28,689** | **28,689** | **28,689** |
| [2] | Existing Gas Generation | 24,349 | 24,349 | 24,349 | 24,349 | 24,349 | 24,349 |
| [3] | Once Through Cooling Units | 4,239 | 4,239 | 4,239 | 4,239 | 4,239 | 4,239 |
| [4] | Mothballed | 101 | 101 | 101 | 101 | 101 | 101 |
| [5] | New Units | 0 | 0 | 0 | 0 | 0 | 0 |
| [6] | **Hydro (incl. pumped storage)** | **6,078** | **6,114** | **6,131** | **6,177** | **6,252** | **6,161** |
| [7] | Large Hydro | 3,796 | 3,796 | 3,796 | 3,796 | 3,796 | 3,796 |
| [8] | Small Hydro | 444 | 444 | 444 | 444 | 444 | 444 |
| [9] | Hydro & Pump Providing Ancillary Services | 817 | 853 | 870 | 917 | 991 | 900 |
| [10] | Pumped Storage | 1,020 | 1,020 | 1,020 | 1,020 | 1,020 | 1,020 |
| [11] | **Nuclear** | **2,280** | **2,280** | **2,280** | **2,280** | **2,280** | **2,280** |
| [12] | **Solar** | **9,322** | **5,673** | **1,087** | **6** | **0** | **0** |
| [13] | Existing Solar | 8,596 | 5,232 | 1,003 | 5 | 0 | 0 |
| [14] | Future Solar | 726 | 442 | 85 | 0 | 0 | 0 |
| [15] | **Wind** | **1,718** | **1,884** | **2,165** | **2,694** | **2,876** | **2,828** |
| [16] | Existing Wind | 1,628 | 1,784 | 2,050 | 2,552 | 2,724 | 2,679 |
| [17] | Future Wind | 91 | 99 | 114 | 142 | 152 | 149 |
| [18] | **Geothermal** | **1,141** | **1,141** | **1,141** | **1,141** | **1,141** | **1,141** |
| [19] | **Other Renewables** | 814 | 814 | 814 | 814 | 814 | 814 |
| [20] | **Battery** | **566** | **566** | **566** | **566** | **566** | **566** |
| [21] | Existing and Procured | 566 | 566 | 566 | 566 | 566 | 566 |
| [22] | Resolution E-4949 | 0 | 0 | 0 | 0 | 0 | 0 |
| [23] | **Demand Response** | **1,660** | **1,660** | **1,660** | **1,660** | **1,660** | **1,660** |
| [24] | **Imports** | **10,193** | **10,193** | **10,193** | **10,193** | **10,193** | **10,193** |
| [25] | Contracted Imports | 5,340 | 5,340 | 5,340 | 5,340 | 5,340 | 5,340 |
| [26] | Uncontracted Imports | 4,853 | 4,853 | 4,853 | 4,853 | 4,853 | 4,853 |
| [27] | **Total Resources (excl. Uncontracted Imports)** | **57,608** | **54,160** | **49,872** | **49,367** | **49,617** | **49,479** |
| [28] | **Hourly Capacity Need** | **49,955** | **51,543** | **52,069** | **51,626** | **51,115** | **49,417** |
| [29] | Load | 43,439 | 44,820 | 45,277 | 44,892 | 44,448 | 42,971 |
| [30] | Planning Reserve Margin (15%) | 6,516 | 6,723 | 6,792 | 6,734 | 6,667 | 6,446 |
| [31] | **Hourly Capacity Sufficiency (Shortfall)** | **7,654** | **2,617** | **(2,196)** | **(2,259)** | **(1,498)** | **62** |

## Table B-3: 2021 CAISO Load and Resource Calculations for Operational Analysis

| | | HE 15 | HE 16 | HE 17 | HE 18 | HE 19 | HE 20 |
|---|---|---|---|---|---|---|---|
| [1] | **Gas Generation** | **25,833** | **25,833** | **25,833** | **25,833** | **25,833** | **25,833** |
| [2] | Existing Gas Generation | 24,349 | 24,349 | 24,349 | 24,349 | 24,349 | 24,349 |
| [3] | Once Through Cooling Units | 0 | 0 | 0 | 0 | 0 | 0 |
| [4] | Mothballed | 101 | 101 | 101 | 101 | 101 | 101 |
| [5] | New Units | 1382 | 1382 | 1382 | 1382 | 1382 | 1382 |
| [6] | **Hydro (incl. pumped storage)** | **6,078** | **6,114** | **6,131** | **6,177** | **6,252** | **6,161** |
| [7] | Large Hydro | 3,796 | 3,796 | 3,796 | 3,796 | 3,796 | 3,796 |
| [8] | Small Hydro | 444 | 444 | 444 | 444 | 444 | 444 |
| [9] | Hydro & Pump Providing Ancillary Services | 817 | 853 | 870 | 917 | 991 | 900 |
| [10] | Pumped Storage | 1,020 | 1,020 | 1,020 | 1,020 | 1,020 | 1,020 |
| [11] | **Nuclear** | **2,280** | **2,280** | **2,280** | **2,280** | **2,280** | **2,280** |
| [12] | **Solar** | **10,049** | **6,115** | **1,172** | **6** | **0** | **0** |
| [13] | Existing Solar | 8,596 | 5,232 | 1,003 | 5 | 0 | 0 |
| [14] | Future Solar | 1,452 | 884 | 169 | 1 | 0 | 0 |
| [15] | **Wind** | **1,718** | **1,884** | **2,165** | **2,694** | **2,876** | **2,828** |
| [16] | Existing Wind | 1,628 | 1,784 | 2,050 | 2,552 | 2,724 | 2,679 |
| [17] | Future Wind | 91 | 99 | 114 | 142 | 152 | 149 |
| [18] | **Geothermal** | **1,141** | **1,141** | **1,141** | **1,141** | **1,141** | **1,141** |
| [19] | **Other Renewables** | 814 | 814 | 814 | 814 | 814 | 814 |
| [20] | **Battery** | **1,223** | **1,223** | **1,223** | **1,223** | **1,223** | **1,223** |
| [21] | Existing and Procured | 666 | 666 | 666 | 666 | 666 | 666 |
| [22] | Resolution E-4949 | 558 | 558 | 558 | 558 | 558 | 558 |
| [23] | **Demand Response** | **1,660** | **1,660** | **1,660** | **1,660** | **1,660** | **1,660** |
| [24] | **Imports** | **10,193** | **10,193** | **10,193** | **10,193** | **10,193** | **10,193** |
| [25] | Contracted Imports | 5,340 | 5,340 | 5,340 | 5,340 | 5,340 | 5,340 |
| [26] | Uncontracted Imports | 4,853 | 4,853 | 4,853 | 4,853 | 4,853 | 4,853 |
| [27] | **Total Resources (excl. Uncontracted Imports)** | **56,135** | **52,403** | **47,758** | **47,168** | **47,418** | **47,280** |
| [28] | **Hourly Capacity Need** | **49,553** | **51,257** | **51,732** | **51,593** | **51,170** | **49,470** |
| [29] | Load | 43,089 | 44,572 | 44,984 | 44,863 | 44,495 | 43,018 |
| [30] | Planning Reserve Margin (15%) | 6,463 | 6,686 | 6,748 | 6,729 | 6,674 | 6,453 |
| [31] | **Hourly Capacity Sufficiency (Shortfall)** | **6,582** | **1,146** | **(3,974)** | **(4,425)** | **(3,752)** | **(2,191)** |

## Table B-4: 2022 CAISO Load and Resource Calculations for Operational Analysis

| | | HE 15 | HE 16 | HE 17 | HE 18 | HE 19 | HE 20 |
|---|---|---|---|---|---|---|---|
| [1] | **Gas Generation** | **25,779** | **25,779** | **25,779** | **25,779** | **25,779** | **25,779** |
| [2] | Existing Gas Generation | 24,295 | 24,295 | 24,295 | 24,295 | 24,295 | 24,295 |
| [3] | Once Through Cooling Units | 0 | 0 | 0 | 0 | 0 | 0 |
| [4] | Mothballed | 101 | 101 | 101 | 101 | 101 | 101 |
| [5] | New Units | 1382 | 1382 | 1382 | 1382 | 1382 | 1382 |
| [6] | **Hydro (incl. pumped storage)** | **6,078** | **6,114** | **6,131** | **6,177** | **6,252** | **6,161** |
| [7] | Large Hydro | 3,796 | 3,796 | 3,796 | 3,796 | 3,796 | 3,796 |
| [8] | Small Hydro | 444 | 444 | 444 | 444 | 444 | 444 |
| [9] | Hydro & Pump Providing Ancillary Services | 817 | 853 | 870 | 917 | 991 | 900 |
| [10] | Pumped Storage | 1,020 | 1,020 | 1,020 | 1,020 | 1,020 | 1,020 |
| [11] | **Nuclear** | **2,280** | **2,280** | **2,280** | **2,280** | **2,280** | **2,280** |
| [12] | **Solar** | **11,244** | **6,843** | **1,312** | **7** | **0** | **0** |
| [13] | Existing Solar | 8,596 | 5,232 | 1,003 | 5 | 0 | 0 |
| [14] | Future Solar | 2,648 | 1,612 | 309 | 2 | 0 | 0 |
| [15] | **Wind** | **1,718** | **1,884** | **2,165** | **2,694** | **2,876** | **2,828** |
| [16] | Existing Wind | 1,628 | 1,784 | 2,050 | 2,552 | 2,724 | 2,679 |
| [17] | Future Wind | 91 | 99 | 114 | 142 | 152 | 149 |
| [18] | **Geothermal** | **1,141** | **1,141** | **1,141** | **1,141** | **1,141** | **1,141** |
| [19] | **Other Renewables** | 814 | 814 | 814 | 814 | 814 | 814 |
| [20] | **Battery** | **1,233** | **1,233** | **1,233** | **1,233** | **1,233** | **1,233** |
| [21] | Existing and Procured | 676 | 676 | 676 | 676 | 676 | 676 |
| [22] | Resolution E-4949 | 558 | 558 | 558 | 558 | 558 | 558 |
| [23] | **Demand Response** | **1,660** | **1,660** | **1,660** | **1,660** | **1,660** | **1,660** |
| [24] | **Imports** | **10,193** | **10,193** | **10,193** | **10,193** | **10,193** | **10,193** |
| [25] | Contracted Imports | 5,340 | 5,340 | 5,340 | 5,340 | 5,340 | 5,340 |
| [26] | Uncontracted Imports | 4,853 | 4,853 | 4,853 | 4,853 | 4,853 | 4,853 |
| [27] | **Total Resources (excl. Uncontracted Imports)** | **57,287** | **53,087** | **47,853** | **47,125** | **47,374** | **47,236** |
| [28] | **Hourly Capacity Need** | **49,170** | **51,046** | **51,712** | **51,869** | **51,560** | **49,845** |
| [29] | Load | 42,757 | 44,388 | 44,967 | 45,103 | 44,835 | 43,343 |
| [30] | Planning Reserve Margin (15%) | 6,414 | 6,658 | 6,745 | 6,765 | 6,725 | 6,501 |
| [31] | **Hourly Capacity Sufficiency (Shortfall)** | **8,117** | **2,041** | **(3,859)** | **(4,744)** | **(4,186)** | **(2,609)** |