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Commissioner	:	Michael Picker
Admin. Law Judge	:	David Gamson
DRA Project Mgr.	:	Patrick Luckow
	:	

OFFICE OF RATEPAYER ADVOCATES
CALIFORNIA PUBLIC UTILITIES COMMISSION

TESTIMONY OF ROBERT M. FAGAN AND PATRICK LUCKOW, SYNAPSE ENERGY ECONOMICS, ON BEHALF OF THE OFFICE OF RATEPAYER ADVOCATES (ORA)

Order Instituting Rulemaking to Integrate and Refine Procurement Policies and Consider Long-Term Procurement Plans
Phase 1a

(R.13-12-010)

San Francisco, California
August 13, 2014

102059481

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I. INTRODUCTION AND SUMMARY OF FINDINGS

Q1. What is the purpose of this testimony?

A. The purpose of this testimony is to report the results of three Phase 1a modeling scenarios for the 2014 Long-Term Procurement Plan (LTPP) proceeding that Synapse executed on behalf of the California Public Utilities Commission's Office of Ratepayer Advocates (ORA). The August 6, 2014 "Administrative Law Judge's Ruling Modifying Schedule for Phase 1a" (Schedule Ruling) directed modeling parties to submit testimony on August 13, 2014. The Schedule Ruling clarified that testimony "describing options to CAISO [California Independent System Operator Corporation] deterministic study is due by September 24, 2014."[1] ORA is submitting its testimony on scenarios based on the CAISO deterministic studies in advance of the September 24, 2014 deadline in order to allow parties more time to consider the results.

The Assigned Commissioner issued a ruling on May 14, 2014 that included an attachment that set forth the assumptions to be used in Phase 1a modeling, along with the planning scenarios that will help answer critical resource questions pending in the 2014 LTPP proceeding.[2] Synapse used the Plexos modeling tool[3] to first replicate the CAISO's Trajectory scenario run, for twelve months of 2024; and then to run two alternative scenarios ("ORA scenarios") that each used underlying load and resource parameters of the Trajectory scenario, but also included certain additional resources. We limited our ORA scenarios model run period to July 2024, because July was the only

[1] Schedule Ruling, p. 3.

[2] Assigned Commissioner's Ruling (ACR) Technical Updates to Planning Assumptions and Scenarios for Use in the 2014 Long Term Procurement Plan and 2014-15 CAISO TPP (Planning Assumptions ACR) and the attached "Amendment to February 27, 2014 Assigned Commissioner Ruling Attachment: Planning Assumptions and Scenarios for use in the CPUC Rulemaking 13-12-010 (The 2014 Long-Term Procurement Planning [LTPP] Proceeding), and the CAISO 2014-15 Transmission Planning Process, May 14, 2014, (Attachment to the Planning Assumptions ACR), p. 33.

[3] Plexos is a detailed hourly production cost model used to analyze system performance. The analytical structure of Plexos (hourly dispatch and associated unit commitment) is intended to capture the capability of individual resources (and in the aggregate, system-wide resources) to provide energy required for operating reserve for each hour of the year.

month with an indicated "shortage"[4] of capacity shown as a result of the Trajectory scenario run. Trajectory scenario results showed surplus capacity in all hours of all other months of the year. All Plexos modeling analysis explicitly, and in a highly-detailed manner, recognizes and accounts for flexible resource requirements in the CAISO region.

Q2. What are the ORA scenarios?

A. ORA's two alternative scenarios start with the Trajectory scenario parameters. As explained in the Attachment to the Planning Assumptions ACR:

> "The Trajectory scenario is the control scenario for resource and infrastructure planning, designed to reflect a modestly conservative future world with little change from existing procurement policies and little change from business as usual practices."[5]

ORA's two scenarios add supply-side resources[6] to the Trajectory scenario. The supply-side resource additions include:

1. a "high" level of incremental small photovoltaic (PV) customer –side resources (ORA scenario 1), and
2. a minimum amount of conventional and preferred resources authorized in the Track 1 and Track 4 decisions of Rulemaking (R.).12-03-014[7] but not specified as part of the Trajectory scenario in the Attachment to the

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[4] The terms "shortage" and "shortfall" are used throughout this testimony. The terms refer to any hourly periods when fully meeting energy and ancillary service requirements *requires* the model's operation (for energy or ancillary service needs) of a proxy resource. This proxy resource is not an existing or planned resource, but is used purely to indicate "shortage."

[5] Attachment to the Planning Assumptions ACR, p. 34. Other scenarios, and the order in which the Planning Assumptions ACR indicates they should be studies are: the High Load Scenario ,which explores the impact of higher than expected economic and demographic growth, the High DG [distributed generation] scenario, which explores the implications of promoting high amounts of DG; the 40% [Renewable Portfolio Standard]RPS in 2024 Scenario, which would assess the operational impacts associated with a higher RPS target post-2020, and the Expanded Preferred Resources scenario, which would assess the impact of broadly pursuing higher levels of preferred resources. Attachment to the Planning Assumptions ACR, pp. 37-38.

[6] The resources are *modeled* as supply-side sources in Plexos.

[7] Decision (D.)13-02-015 (Track 1) and D.14-03-004 (Track 4).

Planning Assumptions ACR[8] for use in Phase 1a of this proceeding (ORA scenario 2).

Each of these scenarios is considered separately. ORA scenario 1, the incremental small PV scenario, used the same amount of small PV (customer-side PV[9]) as the Attachment to the Planning Assumptions ACR's Expanded Preferred Resources Planning Assumption scenario.[10] ORA scenario 2 includes additional resources authorized in Tracks 1 and 4 of the 2012 LTPP proceeding: 600 megawatts (MW) from a conventional gas-fired resource in San Diego Gas & Electric Company's (SDG&E) service territory area,[11] and 725 MW of preferred resources (550 MW in Southern California Edison Company's (SCE) service territory, and 175 MW in SDG&E's service territory).[12] The preferred resources were modeled as incremental demand response (DR) capability because 1) that type of preferred resource is a good fit for the shortage duration reflected in the Trajectory scenario results (e.g., low frequency of events and limited duration of event); and 2) because the total level of dispatchable DR in 2024 in ORA scenario 2 falls within the targeted range indicated in the Attachment to the Planning Assumptions ACR

[8] Attachment to Planning Assumptions ACR, p. 29.

[9] Table 6: Scenario Matrix of the Planning Assumptions ACR uses the column heading "Customer PV" to categorize this input parameter. Attachment to Planning Assumptions ACR, p. 39. The CPUC's Scenario Tool and the Plexos input data set refers to this resource as BTMPV, or behind-the-meter PV.

[10] Attachment to the Planning Assumptions ACR. pp. 38-39.

[11] We include this gas-fired resource in our modeling based on SDG&E's planned procurement of a nominal 600 MW gas turbine (GT) resource, the Carlsbad Energy Center. See SDG&E LTPP/Track 4 Procurement Plan (Conventional Procurement), submitted to the Commission's Energy Division May 1, 2014 pursuant to D.14-03-004, at pp. 2-3. On July 23, 2014, SDG&E submitted Application of San Diego Gas & Electric Company (U 902 E) for Authority to Partially Fill the Local Capacity Requirement Need Identified in D.14-03-004 and Enter into a Purchase Power Tolling Agreement with Carlsbad Energy Center, LLC, (A. 14-07-009) for Commission approval. Synapse's inclusion of this resource for modeling purposes does not imply ORA support for or assume Commission approval of the Application or the facility. Inclusion of this resource in the modeling does not imply that other resources could not also be used or considered for local reliability purposes in the SDG&E territory.

[12] D.14-03-004, pp. 3-4.

for DR resources in the years 2020 to 2030.[13] Other types or combinations of preferred resources could also resolve shortages.

Q3. Why did you run alternative scenarios with incremental Track 1 and 4 resources in this phase of the proceeding, when the ACR's planning assumptions indicated those resources would be considered in Phase 1b of this proceeding?

A. Phase 1a is intended to assess the level of surplus or shortage of resources to meet system reliability requirements in 2024 under a pre-determined set of assumptions and scenarios. While the Attachment to the Planning Assumptions ACR stated that Phase 1b of this proceeding would evaluate how different resources could fill any need determined in Phase 1a, it also stated that parties could run alternative scenarios of their choosing.[14] In our view, it is important to test the effect of a "minimum"[15] level of Track 1 and Track 4 authorized resources in order to determine how patterns of surplus or shortage of capacity would change, thus providing greater insight into a determination of need. Also, in order to assess any possible need for conventional resources (that require longer time to develop than preferred resources), we wanted to 1) gauge the effect of the minimum level of nearer-term preferred resource procurement, and 2) to simultaneously consider how SDG&E's planned Track 4 procurement of a gas-fired resource for *local* reliability requirements would affect overall *system* reliability requirements in 2024.

Q4. What are the summary findings from your modeling of the Trajectory scenario for all 12 months of the year 2024?

A. Synapse's results show the projected patterns of capacity "headroom"[16] in 2024 during all hours of the year for the Trajectory scenario as defined in the Attachment

[13] Attachment to the Planning Assumptions ACR, p. 22.

[14] Attachment to the Planning Assumptions ACR, p. 35.

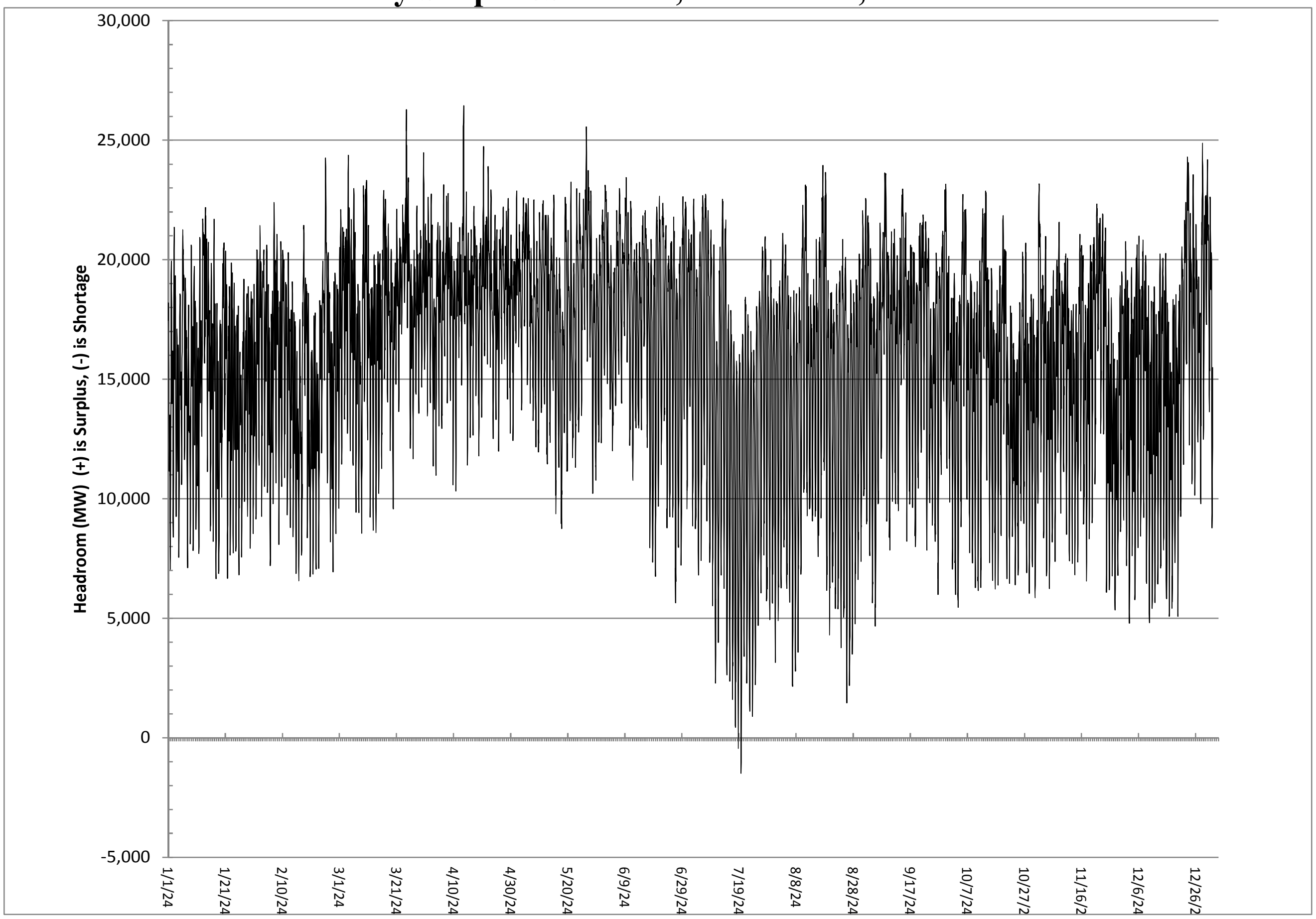
[15] "Minimum" level in this instance means the minimum preferred resources as listed in the first line of the "SCE Procurement Authorization and Requirements (Track 1 + Track 4)" table at page 3 of D.14-03-004 (i.e., 550 MW total authorization) and as listed in the first line of the "SDG&E Procurement Authorization and Requirements" table at page 4 of D.14-03-004 (i.e., 175 MW total authorization).

[16] We define the term "headroom" or "capacity headroom" to mean a measure of capacity surplus or,

to the Planning Assumptions ACR. These results are consistent with CAISO's Trajectory scenario findings and show surplus capacity (i.e., positive headroom) in almost all hours of the year, with the exception of a total of five hours of resource shortage across two consecutive peak summer days: Thursday, July 18, 2024 during the hours 5 p.m. and 6 p.m. and Friday, July 19, 2024 during the hours 5 p.m., 6 p.m. and 7 p.m. Figure 1 shows the annual pattern of headroom.

when negative in value, shortage or shortfall. Surplus is the measure of additional CAISO available capacity that exists in any given hour after meeting all energy and ancillary service requirements for that hour. Shortage and/or shortfall are defined in footnote 4.

Figure 1.
Capacity Headroom – Trajectory Scenario
Hourly Surplus/Shortfall, All Months, 2024



Source/note: Synapse Trajectory scenario modeling results using the July 31, 2014 Plexos input file. Surplus/shortage defined as [Available CAISO Capacity + Net Imports] minus [Load + Upward Reserve Requirements]. Corrected for available capacity limitations on units returning from outage (see Question and Answer 20).

Q5. Please summarize what is seen in Figure 1.

A. Figure 1 shows the hourly pattern of capacity headroom in the CAISO region as reflected by the modeling.[17] We label this hourly metric as indicating surplus or shortage. It is the sum of the available CAISO-region capacity, plus the amount of net imports in that hour, minus the CAISO hourly load and associated ancillary service requirements, which include spinning and non-spinning reserve, and load-following and regulation up requirements. This can be represented as:

[17] Twelve month model run using the CAISO July 31, 2014 posted Plexos input file.

[Available CAISO Capacity + Net Imports] minus [Load + Upward Reserve Requirements] = Surplus (or Shortage), in MW for any given hour.

The graph above illustrates the broad pattern we observe: in most hours, the CAISO region has more than sufficient capacity to meet load and ancillary service requirements, including operating reserves needed to account for the variable output of increased levels of renewable resources.

Q6. What are the summary findings from your modeling of the Trajectory scenario and the two alternative scenarios for the month of July 2024?

A. Table 1 shows the key results for July 2024 for the Trajectory scenario and the two alternative ORA scenarios 1 and 2.

Table 1.
July 2024 Shortage Day Results from Trajectory and ORA Scenarios Model Runs

Scenario	Shortage Duration and Period, each day	Maximum Shortage (MW) and Hour of Day	Shortage Type	Planned/forced Outage[18] at Max Shortage Hour, MW
Trajectory Scenario	7/19, 3 hours (5-7 p.m.)	1,489 MW (5 p.m.)	LFU* & NS**	2,931 MW
	7/18, 2 hours (5-6 p.m.)	451 MW (6 p.m.)	LFU	2,708 MW
ORA Scenario 1 Trajectory w/ High Incremental Small PV	7/19, 3 hours (5-7 p.m.)	1,188 MW (5 p.m.)	LFU	2,931 MW
	7/18, 1 hour (6 p.m.)	451 MW (6 p.m.)	LFU	2,708 MW
ORA Scenario 2 Trajectory w/ Tracks 1and 4 Resource Additions	7/19, 1 hour (5 p.m.)	164 MW (5 p.m.)	LFU	2,931 MW

*Load following up
**Non spinning reserve
Source: Synapse modeling of Trajectory scenario and ORA Scenarios for July 2024.

[18] Outages are an input to the model and account for scheduled maintenance or unplanned shutdowns. While this modeling exercise is not intended to address the nature of fossil resource outage, we note that improvement in rates of resource outage during particularly high peak load summer days can have a potentially significant effect on potential capacity shortage.

Q7. Please describe the results listed in Table 1.

A. Table 1 summarizes modeling results for the month of July 2024 for the Trajectory scenario and ORA scenario 1 and ORA scenario 2. All other months exhibited a surplus of capacity headroom in every hour. The table shows a Trajectory scenario shortage of five hours over two consecutive days, July 18 and 19, 2024, exhibiting a maximum shortage of 1,489 MW at 5 p.m. on July 19. ORA scenario 1 shows a shortage of four hours over the same two days, but at a lower level on the peak day of July 19: 1,188 MW at 5 p.m. ORA scenario 2 shows a shortage of 164 MW for just one hour of the year on July 19 at 5 p.m.

Q8. Please summarize what your findings mean for consideration of Phase 1a need.

A. ORA's modeling results reveal that in the Trajectory scenario, system reliability need and a shortage in system capacity is limited to only a few hours a day on two days in July 2024. This shortage occurs without accounting for all of the resource additions SCE and SDG&E have been authorized to procure per the LTPP Track 1 and 4 decisions. The Trajectory scenario modeling results demonstrate that the CAISO region will be under the most stress during peak summer days in 2024, however, these results do not show a need for any additional capacity resources in the spring, fall, or winter months. In fact, surplus capacity appears abundant during all times **except** peak summer days in the late afternoon and early evening hours. **A modeled capacity shortage exists for only five hours in total in 2024**, which all occur over two consecutive days in July during the same critical 5-6 p.m. timeframe.

The results of ORA's two alternative scenarios significantly reduce system capacity shortage. After assuming minimum levels of authorized preferred resources in SCE and SDG&E's service territories (modeled as DR capability), and the availability of a 600 MW gas-fired resource in SDG&E's service territory, the model results show just a single hour of capacity shortage (equal to 164 MW) on July 19 at 5 p.m. (reflected in ORA scenario 2). Assuming increased amounts of small PV (equal to the incremental

PV assumed in the Expanded Preferred Resources scenario), the 5 p.m. shortage on July 19 is reduced by 301 MW from 1,489 to 1,188 MW.

We did not run a scenario that combined ORA scenarios 1 and 2 together (incremental small PV and minimum levels of Track 1 and Track 4 resources). However, based on the results of the two ORA scenarios, it does appear that the modeled shortage would be eliminated – and that a surplus would exist under such a scenario. The incremental PV resources in ORA scenario 1 reduce the shortage by 301 MW in the 5 p.m. hour on July 19. ORA Scenario 2 shows a shortage of just 164 MW in that same hour of July 19. If the same level of incremental PV (as is seen in ORA scenario 1) were added to the model in ORA scenario 2, we would expect it to further reduce the July 19 5 p.m. shortage in that scenario by roughly 301 MW, thus creating a surplus in that hour, rather than a shortage.

Fossil resource outages (a model input) exceed the modeled shortage in all five hours and are roughly double the shortage amount in the hour with maximum shortage. While this modeling exercise is not intended to address the nature of fossil resource outage, and we recognize that resource outages are already close to their minimum annual levels in later summer periods, we note that improvement in rates of resource outage during particularly high peak load summer days can have a significant effect on any potential capacity shortage.

Based on our analysis, we therefore conclude the following:

1. The trajectory scenario shortage indications are extremely limited in duration.
2. ORA scenario 2 resolves the limited duration shortage for all but 1 hour, with that one hour of capacity shortage reduced to 164 MW (from a Trajectory scenario shortage of 1,489 MW).
3. ORA scenario 1 reduces the magnitude of the shortage amounts, and allows for non-spin requirements to be fully met. The only shortage seen in that scenario is for load-following up requirements.
4. Resource additions within the parameters of Track 1 and Track 4 decisions are highly likely to result in zero modeled shortages in a Trajectory scenario.

5. Resources outages at the hour of maximum shortage in the Trajectory scenario are modeled as equal to roughly twice the shortage amount in that hour.
6. There is no indication of need for system reliability procurement beyond Track 1 and Track 4 determinations at this time, based on the Trajectory scenario.

Based on the duration of shortage seen in the Trajectory scenario results, and considering the effect of a minimum level of additional resources already authorized by Track 1 and Track 4 decisions, there is no need for additional system reliability resource procurement at this time. Surplus capacity exists through the year with the exception of two days in July. These two days exhibit a shortfall in only five hours. The maximum shortfall is 1,489 MW at 5 p.m. on July 19 as shown in Table 1. ORA therefore recommends that the Commission find that there is no need to procure additional system resources at this time.

II. PHASE 1A SYSTEM RELIABILITY MODELING

1. Approach

Q9. What is Phase 1a System Reliability Modeling?

A. The focus of Phase 1a of the 2014 LTPP is whether system resources—as opposed to local resources—in the CAISO region in 2024 are sufficient to reliably meet demand under the State's 33% Renewable Portfolio Standard (RPS) mandate.[19] Meeting the State's 33% RPS mandate has raised reliability concerns due to the intermittent nature of the production of some renewable resources. Phase 1a modeling allows an analytical estimate that takes into account a myriad of system operational details and whether additional resources (beyond those reflected in the Attachment to the Planning Assumptions ACR) will be needed in 2024 to balance supply and demand in all hours of

[19] Meeting the State's 33% RPS mandate is one aspect of the LTPP planning process. The May 5, 2014, "Scoping Memo and Ruling of Assigned Commissioner and Administrative Law Judge" (Scoping Memo) notes at page 3 that maintaining reliability on CPUC-jurisdiction areas requires consideration of "the potential retirement of existing plants, the likelihood of relicensing of nuclear power plants, changes in penetration levels of renewable power, development of energy storage facilities, increased energy efficiency and demand response resources, more flexible end-use of electricity, the development of distributed generation resources, and deeper 2030 and 2050 greenhouse gas reduction targets."

the year. The modeling is much less granular spatially, and much more granular temporally, than the modeling conducted for local reliability studies. Local reliability analysis uses power flow modeling tools;[20] while Phase 1a's system reliability modeling relies on chronological dispatch and unit commitment modeling tools.

CAISO uses Plexos, a detailed hourly production cost model that optimizes unit commitment and dispatch for this analysis. Synapse also uses Plexos in support of the ORA scenarios run for Phase 1a of the LTPP process. The analytical structure of Plexos represents in fine detail the capability of individual resources (and in the aggregate, system-wide resources) to provide energy and all required operating reserves for each hour of the year. These resources include all supply and demand-side resources available for the CAISO region consisting of multiple types of generating and DR units using different fuels, and imports from both other California regions and the rest of the Western Electricity Coordinating Council (WECC) region. We note that this 2014 LTPP version of the Plexos model has an enhanced resolution for resources in the rest of the WECC, relative to the rest-of-WECC resource resolution used in the 2012 LTPP proceeding (i.e., more individual unit representation instead of aggregation of resources). This results in longer run times for Plexos model execution.

Plexos also accounts for additional reserve needed within every hour to balance within-hour fluctuations of supply and demand, and account for forecast errors for load, and wind and solar output. These additional reserves are referred to as "Step 1" inputs to the Plexos modeling process, and include load following and regulation requirements. The Plexos modeling method is intended to capture the hour-to-hour changes in resource

[20] Transmission power flow studies assess the capability of the electric system to operate under normal and emergency conditions. This involves determining whether an initiating fault (short circuit) and subsequent loss of electric facilities (such as transmission lines, generators, transformers, bus sections and breakers) violates system performance requirements specified by the NERC [North American Electricity Council Reliability Standards.]" Track 4, R.12-03-014, Exhibit Southern California Edison Company (SCE) 1/Chinn, p. 20:20-21:2. The Scoping Memo states at page 3 that the record developed in R.12-03-014 is "fully available for consideration in this proceeding" and is therefore incorporated into the record of this proceeding.

output as the aggregate of all resources used to meet fluctuating demand across each day of the year.

Q10. Please explain your approach in using the Plexos modeling tool to run the Trajectory scenario, and the two ORA alternative scenarios that use different combinations of input assumptions than those used by CAISO.

A. Synapse obtained a license from Energy Exemplar, the Plexos vendor, and used the same version of the software as used by CAISO.[21] Synapse executed the Trajectory scenario for all 12 months of 2024. Synapse then executed monthly (July, 2024) model runs for two different resource assumption scenarios because July is the only month exhibiting resource shortage in the model's Trajectory scenario results.

Q11. Please explain how you obtained and used data for the Plexos modeling.

A. Synapse downloaded multiple versions of the CAISO-posted Plexos input files for the Trajectory scenario as they became available, including those posted on July 3, July 21, July 26 and July 31, 2014. All of ORA's runs, including the 12-month Trajectory scenario, the July only Trajectory scenario and both ORA scenarios were updated using the July 31, 2014 CAISO input files. Our findings on the results of the ORA scenarios and the graph of annual headroom are based on the model runs using the July 31, 2014 posted inputs.

Q12. Were your capacity shortage results the same as CAISO's for the shortage hours seen in the Trajectory scenario for July?

A. Yes. We found our shortage period results to be the same as CAISO's Trajectory scenario results for the shortage periods in July 2024. Generally, our results were consistent with CAISO's results for the Trajectory scenario.[22]

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[21] PLEXOS 6.208 R08

[22] In some hours in July, there are minor, or even *de minimis* differences in some output parameters between the CAISO run and Synapse's Trajectory scenario run. We attribute this to different settings for certain solution parameters in the model and we do not see these differences as affecting any of our substantive findings or conclusions.

2. Key Modeling Inputs

Q13. What Track 1 resources, or other resources authorized by the Commission, are included in the Trajectory scenario?

A. Both the Trajectory and ORA scenarios account for some resources authorized during Track 1 of the 2012 LTPP, including 900 MW of combined cycle (CC) and 300 MW of GT resources in SCE's service territory.[23] Both the Trajectory and ORA scenarios include 310 MW of GT resources in SDG&E's service territory.[24] Both the Trajectory and ORA scenarios include 1,325 MW of storage resources distributed across the territories.[25] Excluded from the Trajectory scenario are preferred resources authorized in Track 1, and all resources authorized in Track 4.

Q14. Please list the changes to modeling inputs used in the ORA Scenarios.

A. Table 2 contains Synapse's key modeling inputs. Synapse ran the Plexos model for July for each of the Trajectory and the ORA scenarios using the July 31, 2014 CAISO-posted input file. We modified the input file for the two ORA scenarios.

[23] Attachment to Planning Assumptions ACR, pp. 28-29.

[24] D.13-03-029 (approving Escondido power purchase tolling agreement (PPTA)) and D.14-02-016 (approving Pio Pico PPTA); Attachment to Planning Assumptions ACR pp. 28-29.

[25] D.13-10-040; Attachment to Planning Assumptions ACR, pp. 17-20.

Table 2 ORA Scenario Input Parameters - Changes from Trajectory Scenario

Scenario	Incremental (to IEPR levels) Small PV (Behind the Meter), MW	Demand Response Resources Total, MW	Fossil Resources
Trajectory	0	2,176	Planning Assumptions
ORA Scenario 1Trajectory plus Incremental Small PV	3,223 Installed 1,647 (NQC including loss effect)	2,176	Planning Assumptions
ORA Scenario 2 Trajectory plus Track 1 and Track 4 minimum additions	0	2,176 + 725 = 2,901 (550 SCE, 175 SDG&E)	Planning Assumptions + 600 MW GT (SDG&E)

Source: Scenario Tool V2, and Synapse assumptions. Incremental Small PV for ORA scenario 1: scenario Tool V2, "Demand Individual Assumptions" tab. Row 174 (installed capacity value) and row 177 (NQC + loss effect value), for year 2024. Demand response for Trajectory and ORA scenario 1: "Assumptions" tab, row 106, for year 2024.

Q15. Please comment on the input changes made to the Trajectory scenario for the two ORA scenarios.

A. ORA scenario 1 reflects an increased level of behind-the-meter, customer-side, small PV. ORA scenario 1 uses the same level of incremental small PV as the Expanded Preferred Resource scenario.[26] ORA scenario 2 contains minimum levels of preferred resources authorized in D.13-02-015 and D.14-03-004[27] and SDG&E's requested authorization for a 600 MW gas-fired resource.[28]

We note that many possible combinations of conventional and preferred resources may arise as a result of Track 1 and Track 4 solicitations. This modeling exercise, which examines the effects of ORA scenarios 1 and 2, is not intended to presume a particular amount or type of resource deployment, but instead is meant to analyze the sensitivity of need to the presence of fairly standard preferred and conventional resources.

[26] Attachment to the Planning Assumptions ACR, pp, 38-39.

[27] Track 1 and Track 4 of R.12-03-014, the 2012 LTPP proceeding.

[28] See footnote 11.

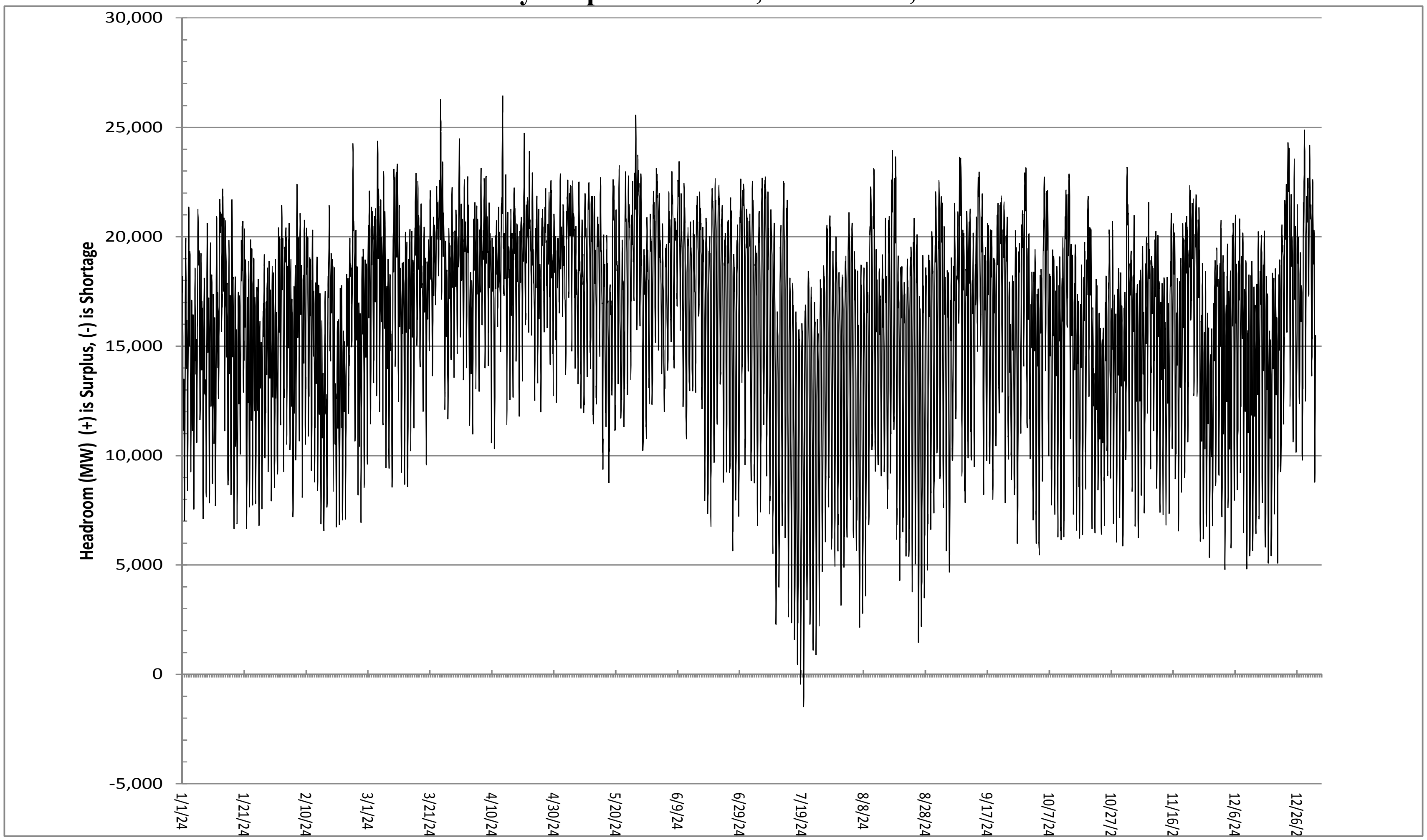
III. MODELING RESULTS

1. Surplus/Shortfall Summary Results - Trajectory and ORA Scenarios

Q16. What are the results of your Trajectory scenario modeling for all 12 months of 2024?

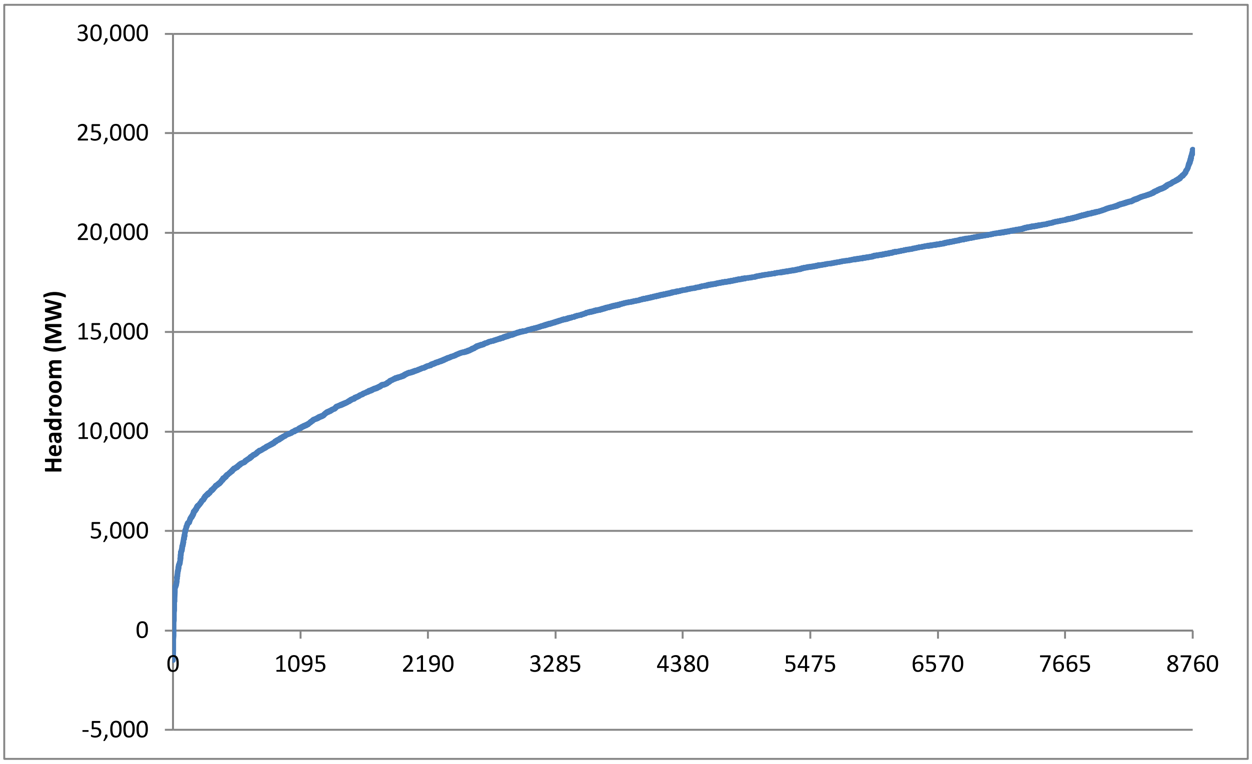
A. We present the results of our 12-month modeling in terms of capacity headroom, which is a measure of resource surplus or shortage. We compute this metric for each hour of the year. A modeled resource surplus exists if there is excess available capacity in any given hour of the year as indicated by the Plexos model outputs. A modeled resource shortfall exists if the hourly load plus the ancillary service requirement cannot be met by existing and planned resources and import capacity. Figures 1 and 2 below show the pattern of surplus and shortfall hours over the course of 2024 for the Trajectory scenario.

Figure 1.
Capacity Headroom – Trajectory Scenario
Hourly Surplus/Shortfall, All Months, 2024



Source/note: Synapse Trajectory scenario modeling results using the July 31, 2014 Plexos input file. Surplus/shortage defined as [Available CAISO Capacity + Net Imports] minus [Load + Upward Reserve Requirements]. Corrected for available capacity limitations on units returning from outage (see Question 20 and associated answer).

Figure 2.
Duration Curve of Capacity Headroom - Trajectory Scenario
Hourly Surplus/Shortfall, All Months, 2024



Source: Synapse modeling results, Trajectory scenario, July 31, 2014 posted model.

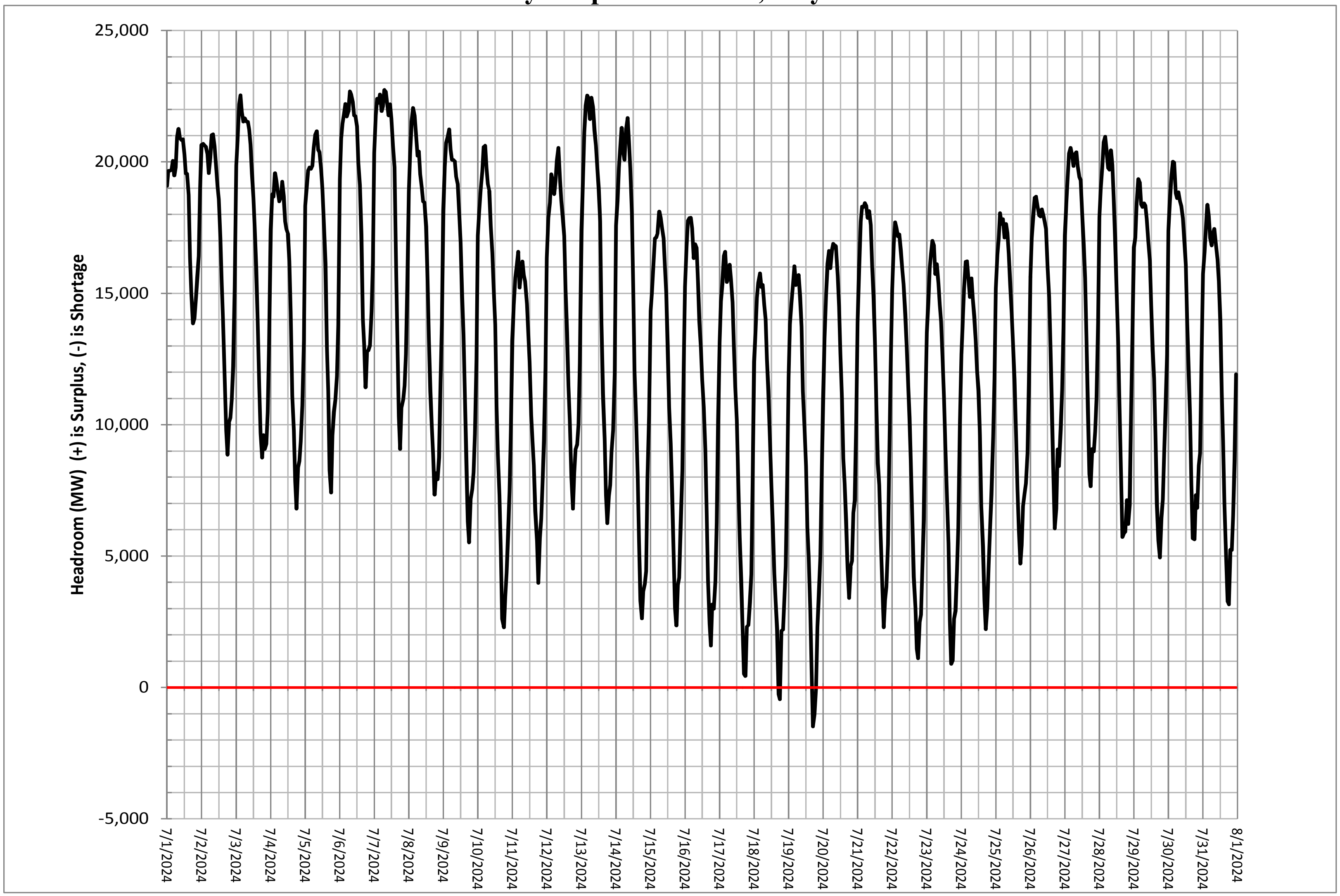
Q17. What do Figure 1 and Figure 2 show?

A. Figure 1 illustrates a pattern of modeled surplus capacity for all but five hours of the year in 2024. The surplus capacity dips roughly below 5,000 MW primarily during peak periods in the months of July and August. November and December also see a number of periods where the surplus dips to or just below 5,000 MW. Figure 2 uses the same data from Figure 1, but sorts it into a duration curve. The duration curve indicates the amount of time each year the capacity headroom (y-axis) lies at or below a certain number of hours (x-axis). In the Trajectory scenario there are a total of only five hours where the headroom dips below zero and indicates a capacity shortage.

Q18. What are the results of your Trajectory scenario modeling for July, 2024?

A. As indicated in Figure 3 below, July is the only month with an indicated shortage of resources. The figure presents the same data seen in the annual headroom graph (Figure 1), but allows for closer observation of daily and intra-day patterns in July. Each of the vertical gridlines on the Figure 4 graph represents half-day (12-hour) increments.

Figure 3.
Capacity Headroom - Trajectory Scenario
Hourly Surplus/Shortfall, July 2024



Source: Synapse modeling of Trajectory scenario. Note: vertical axis lined increments = 12 hours.

Q19. Please explain the patterns seen in Figure 3 above.

A. Figure 3 above shows the hourly pattern of capacity headroom, or resource availability above (i.e., surplus) or below (i.e., shortage) what is needed – for energy and ancillary service requirements, including flexibility needs – for all hours of the month of July 2024. It shows the pattern of headroom over the two-day period – July 18 and 19 – when the system exhibits its only hours of calculated shortage; two hours on July18 and three hours on July 19 (we note that the quantity of shortage at 7 p.m. on July 19 is only 3 MW). Figure 3 demonstrates that generally a maximum level of system surplus capacity exists in the very early morning hours and minimum surplus capacity exists in the later afternoon hours.

Q20. Does the headroom graph account for the presence of resource outages, and availability limitations for those units in the hours immediately following their return to service?

A. Yes. The graph accounts for units that are not available because of planned maintenance or unscheduled shutdowns. During such resource outages, the resource's "available capacity"[29] is counted as zero. However, the internal calculation of available capacity in Plexos includes the full capacity of units in the hour after they return from an outage, even though such full capacity may not be immediately available.

In our construction of a headroom metric we have accounted for this effect by adjusting (downward) the available capacity in the two hours immediately following return from an outage. We make this adjustment for hours without any capacity shortage; this ensures we do not overestimate capacity headroom contribution from these units, since their ability to provide energy or reserves at their full output level may be limited by unit ramping parameters in the hours immediately following its return.

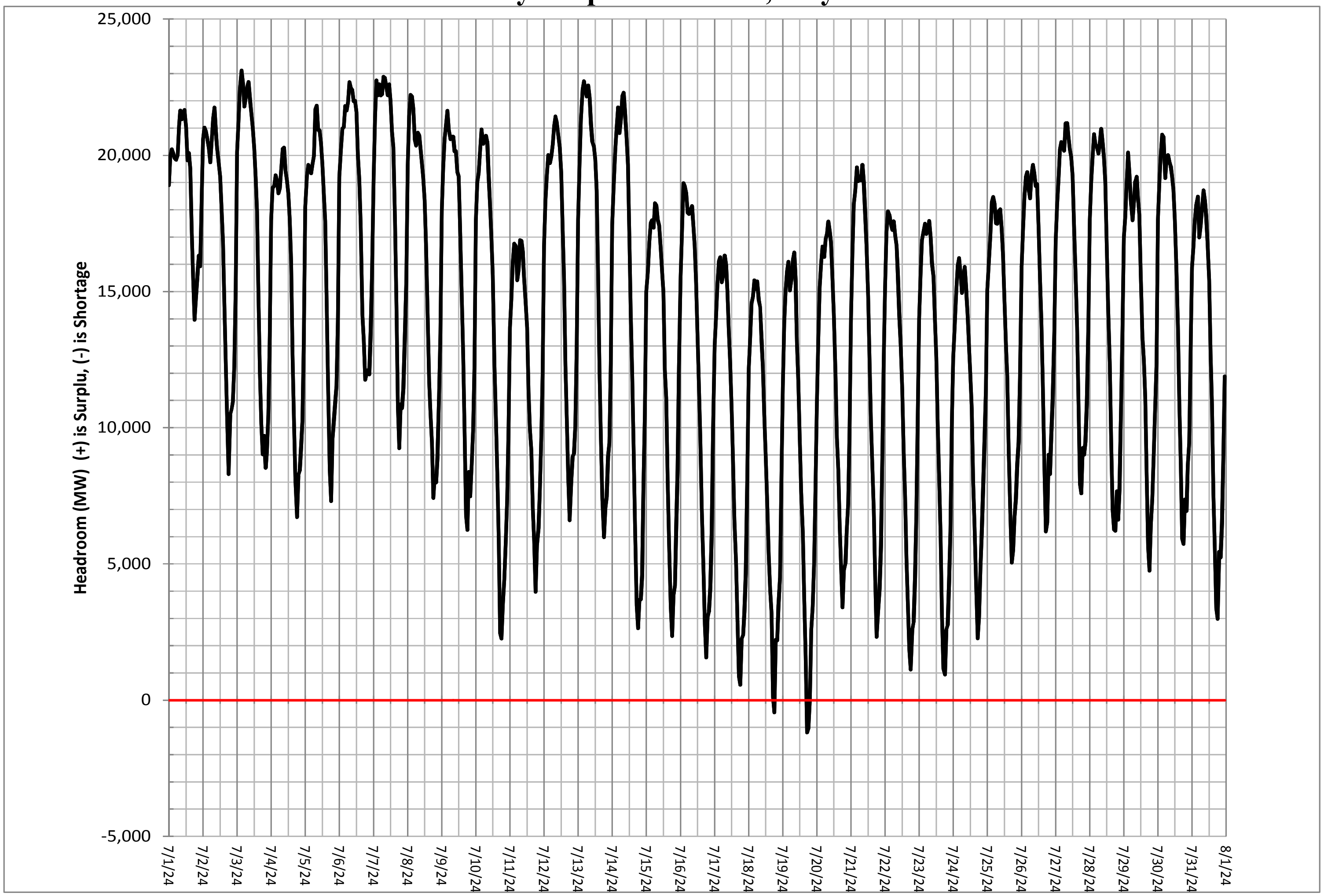
[29] "Available Capacity" is a Plexos model output that represents all capacity not on outage in the CAISO, or in a specific modeled zone or group of zones. This metric reports the full capacity value for units that are online, but only recently returned from outage and still ramping to their minimum level. For such units the true available capacity is something less reported by this metric.

On days with an indicated shortage, the Plexos dispatch methodology fully accounts for this limited availability of a unit returning from an outage. Our graphs reflect this for those shortage hours.

Q21. What are the results of your ORA Scenarios 1 and 2 for July 2024?

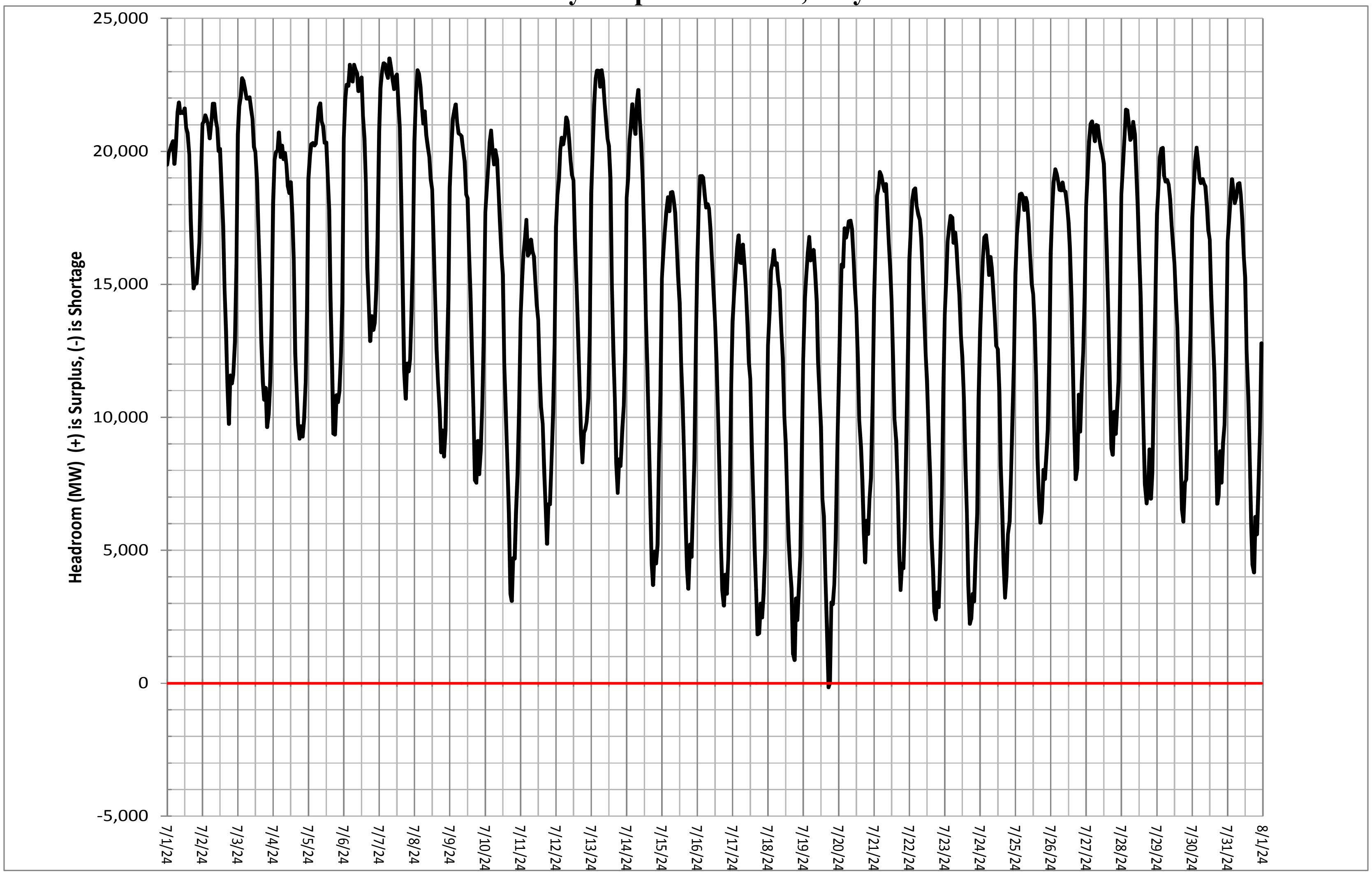
A. Figures 4 and 5 below show the chronological patterns of surplus/shortage in July for each of the two ORA alternative resource scenarios.

Figure 4.
Capacity Headroom - ORA Scenario 1 – Incremental Small PV
Hourly Surplus/Shortfall, July 2024



Source: Synapse modeling of ORA Scenario 1. Note: vertical axis lined increments = 12 hours.

Figure 5.
Capacity Headroom - ORA Scenario 2 – Track 1/Track 4 Resource Additions
Hourly Surplus/Shortfall, July 2024



Source: Synapse modeling of ORA Scenario 2. Note: vertical axis lined increments = 12 hours.

Q22. What are the specific model results for the trajectory and ORA Scenarios for the critical shortage hours on July 18 and July 19, 2024?

A. Table 3 lists the shortage amounts for the critical hours for each scenario.

Table 3. Model Results – Shortage Hours, July 18 and 19, 2024 – MW Shortage

Day	Hour	Trajectory	ORA Scenario 1 (Incremental Small PV)	ORA Scenario 2 (Track 1/ Track 4 minimum)
July 18	5 p.m.	249 MW	surplus	surplus
July 18	6 p.m.	451 MW	451 MW	surplus
July 18	7 p.m.	surplus	6 MW	surplus
July 19	5 p.m.	1,489 MW	1,188 MW	164 MW
July 19	6 p.m.	1,028 MW	1,027 MW	surplus
July 19	7 p.m.	3 MW	surplus	surplus

Source: Synapse modeling of Trajectory and ORA scenarios.

Both the incremental small PV scenario (ORA scenario 1) and the Track 1 / Track 4 resource addition scenario (ORA scenario 2) result in reductions to the maximum shortage amounts seen during the two shortage days, July 18 and July 19.

The profile for the incremental small PV resources is such that almost all output for these resources falls to zero by 6 p.m. During the maximum shortage hour in the Trajectory scenario (July 19, 5 p.m.) the incremental small PV resource contribution to reducing shortage (in ORA scenario 1) is roughly 301 MW, equal to the incremental resource output at that hour.

As seen in Table 3, on July 19 at 5 p.m. the Track 1 / Track 4 additions in ORA scenario 2 reduce the shortage amount by 1,325 MW (down to 164 MW from 1,489 MW in the Trajectory scenario). The 1,325 MW reduction arises from the presence of 725 MW of preferred resources, plus the 600 MW of conventional GT resource. At the shortage hour (5 p.m., July 19), the additional resources are used to provide energy in the shortage hour.

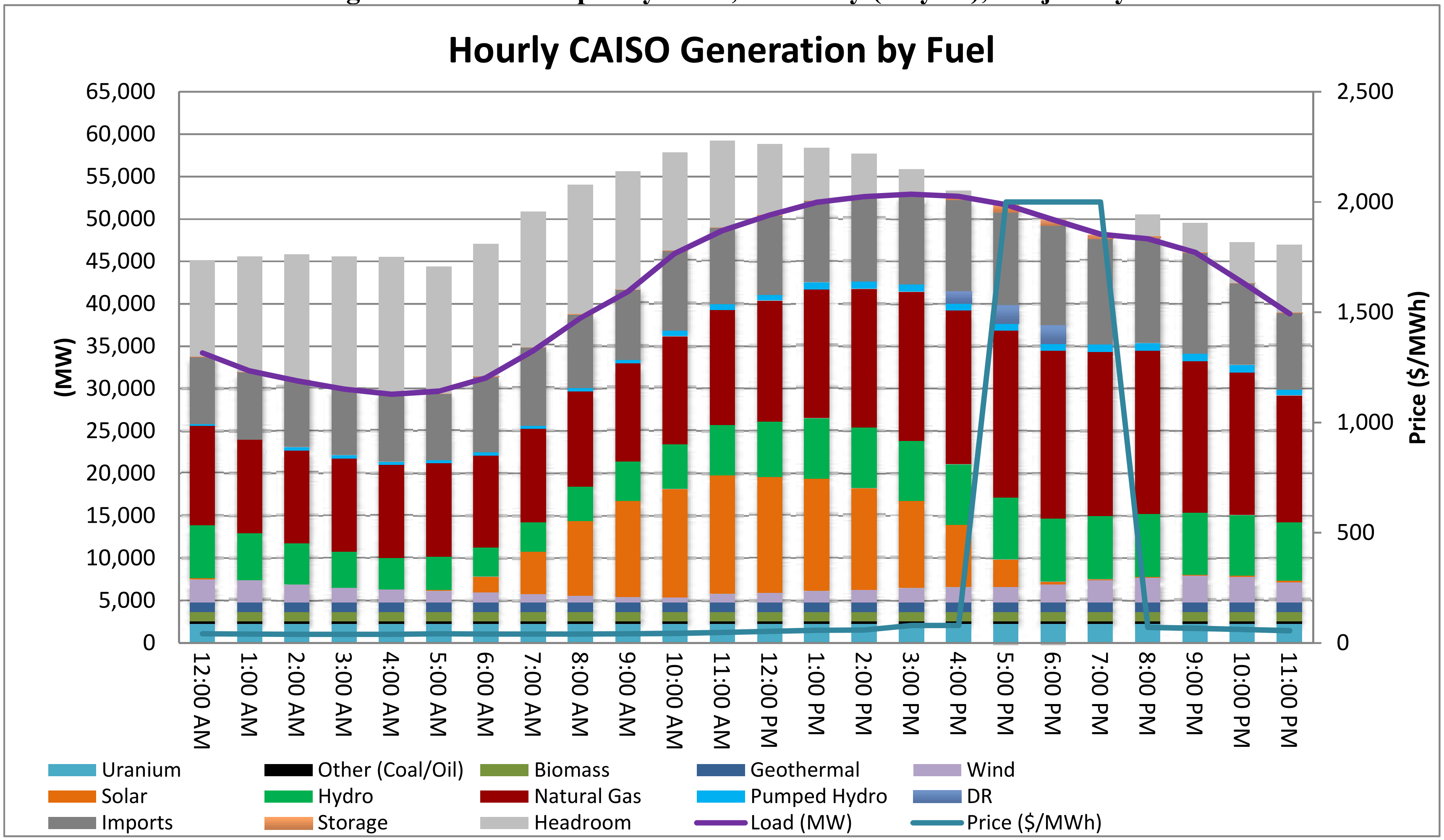
2. Peak Day Resource Output Patterns - July

Q23. What are the Trajectory scenario and ORA Scenario resource output profiles on the peak shortage day, July 19?

A. Figures 6 through 8 below contain charts of the peak shortage day resource outputs, aggregated by resource type, for each scenario. These figures show 1) the hourly load pattern for the day, 2) hourly resource output by fuel type, 3) hourly CAISO prices from the SCE zone,[30] and 4) the computed capacity headroom provided by CAISO-region resources.

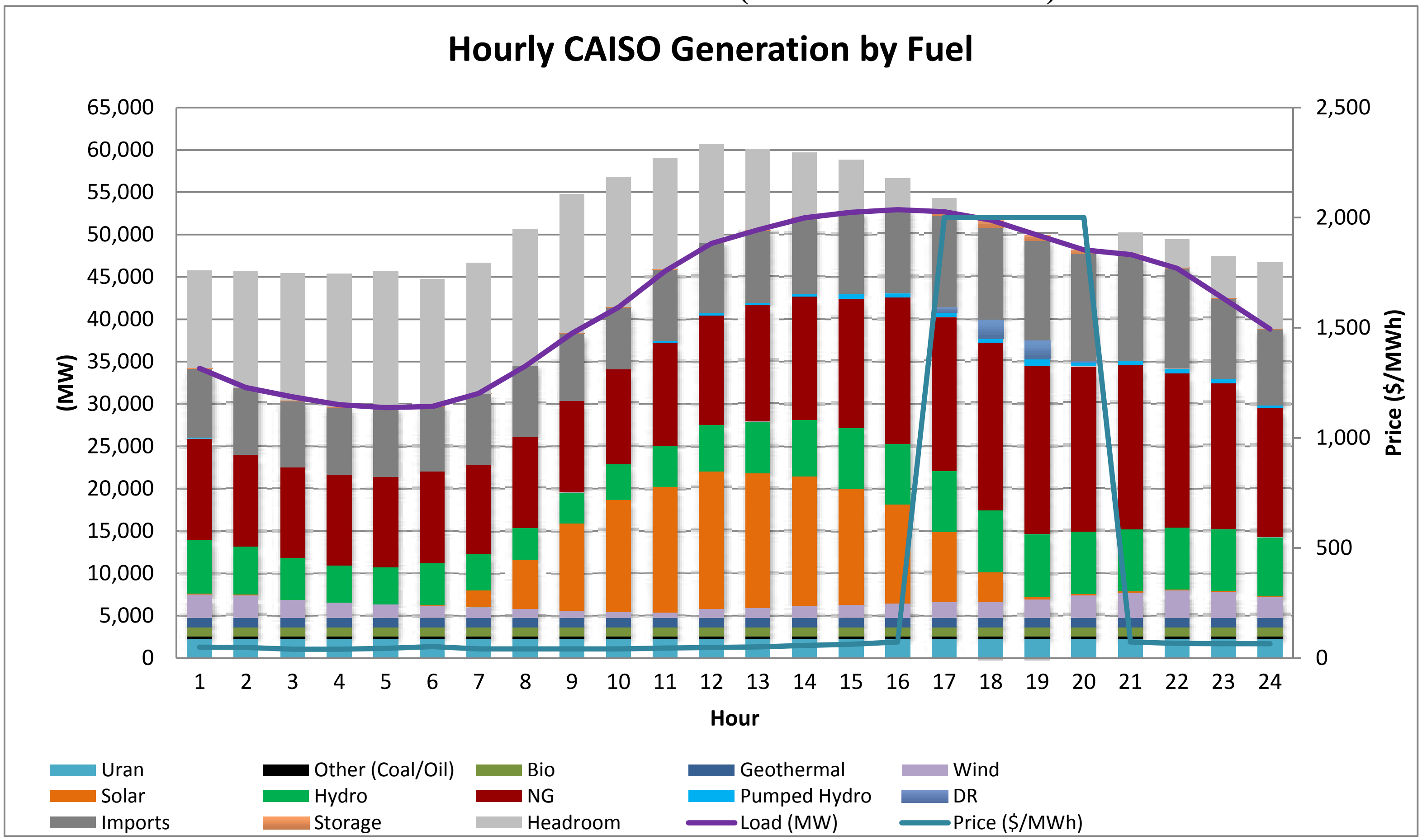
[30] CAISO prices reflect shortage when the price rises to $2,000/MWh, which is the "offer price" associated with the unit that represents shortfall, a generic unit added to the model to allow the model to solve in all hours.

Figure 6.
CAISO Region Resource Output by Hour, Peak Day (July 19), Trajectory Scenario



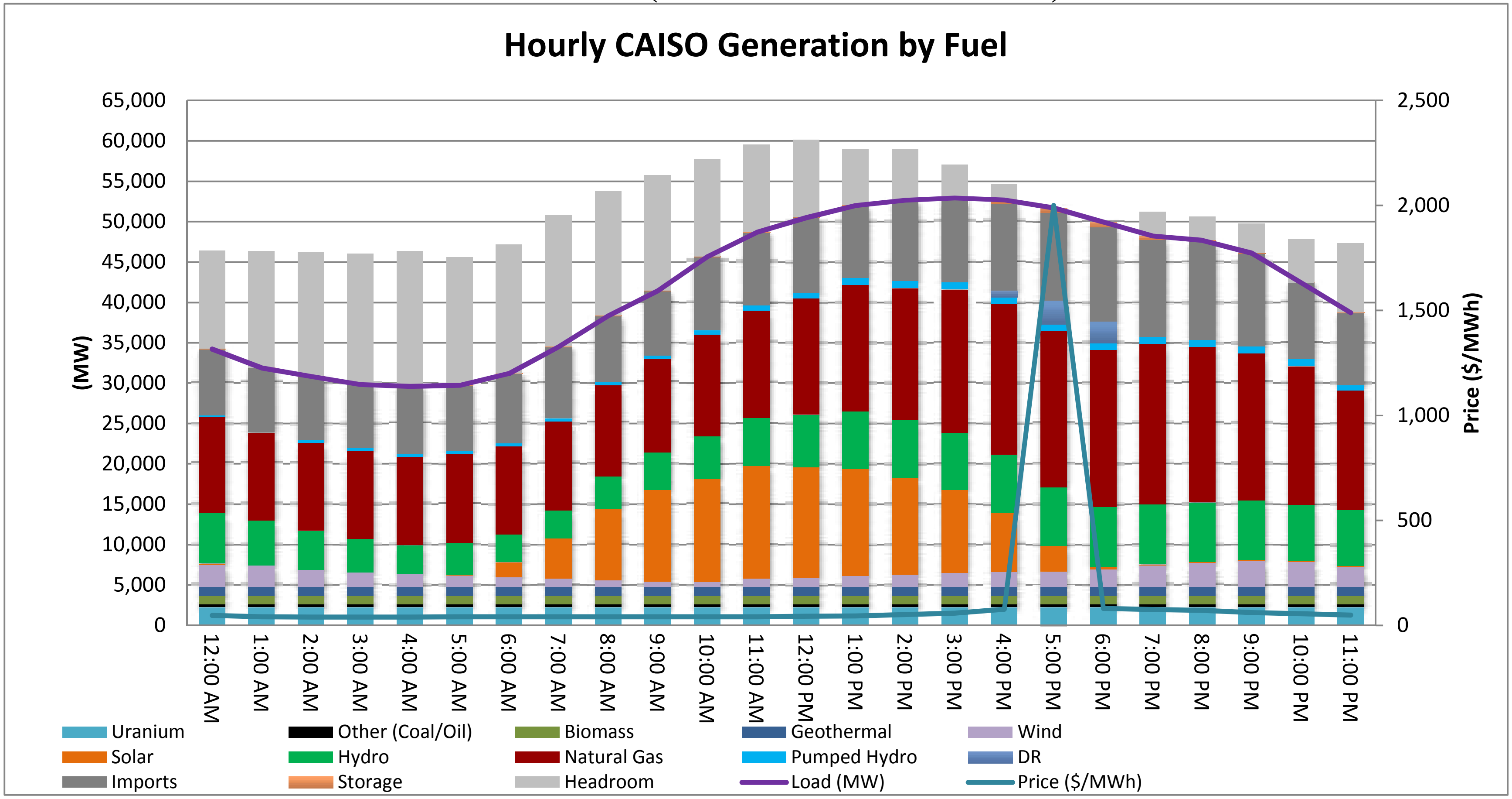
Source: Synapse run of Trajectory scenario, July 31, 2014 model of July 19, 2024.

Figure 7.
CAISO Region Resource Output by Hour, Peak Day (July 19), ORA Scenario 1 (Incremental Small PV)



Source: Synapse run of ORA scenario 1 July 31, 2014 model, of July 19, 2024. "Uran" stands for Uranium, and "Bio" stands for Biomass.

Figure 8.
CAISO Region Resource Output by Hour, Peak Day (July 19),
ORA Scenario 2 (Track 1 and Track 4 additions)



Source: Synapse run of ORA scenario 2, July 31, 2014 model, of July 19, 2024.

Q24. Please describe Figures 6 through 8, the resource output charts for the July 19 peak day for each of the Trajectory and ORA alternative resource scenarios.

A. The resource output charts in Figures 6 through 8 show the 24-hour pattern of resource output in the CAISO region, aggregating some of the resources as seen in the charts. Aggregate solar, wind, and storage resources are shown separately. The chart also plots the load, the CAISO price, and computed headroom, which reflects the difference between available capacity and imports, and the load and ancillary service needs required in each hour.

As seen in Figure 8, the reduced shortage duration in ORA scenario 2 (just one hour) is reflected by the presence of only a single hour where the price rises to $2,000/MWh. There is positive capacity headroom on either side of the shortage hour.

3. Patterns of Preferred Resource Output

Q25. What is the preferred resource output on the maximum shortage day, July 19, 2024?

A. Table 4 below contains the output of demand response, solar (total of all solar resources), storage and wind resources across all hours of July 19, 2024.

Table 4.
Patterns of Preferred Resource Output (MW) – July 19, 2024 – Trajectory and ORA Scenarios

MW	Demand Response			Solar			Storage			Wind
Scenario	Trajectory	ORA 2 (Track 1/ Track 4)	ORA 1 (Incremental Small PV)	Trajectory	ORA 2 (Track 1/ Track 4)	ORA 1 (Incremental Small PV)	Trajectory	ORA 2 (Track 1/ Track 4)	ORA 1 (Incremental Small PV)	All Scenarios
Midnight	-	-	-	150	150	150	0	0	5	2,719
1:00 AM	-	-	-	-	-	86	0	0	0	2,627
2:00 AM	-	-	-	-	-	-	0	0	0	2,092
3:00 AM	-	-	-	-	-	-	0	0	0	1,763
4:00 AM	-	-	-	-	-	-	0	0	0	1,563
5:00 AM	-	-	-	142	142	143	0	0	0	1,352
6:00 AM	-	-	-	1,843	1,843	1,983	0	0	0	1,207
7:00 AM	-	-	-	4,981	4,981	5,827	0	0	0	1,019
8:00 AM	-	-	-	8,799	8,813	10,329	0	0	0	796
9:00 AM	-	-	-	11,328	11,314	13,229	0	0	0	655
10:00 AM	-	-	-	12,767	12,767	14,849	0	0	0	624
11:00 AM	-	-	-	13,971	13,925	16,239	0	0	0	1,032
12:00 PM	-	-	-	13,673	13,673	15,904	0	0	0	1,163
1:00 PM	-	-	-	13,259	13,259	15,284	0	0	0	1,359
2:00 PM	-	-	-	12,011	12,011	13,751	0	0	2	1,505
3:00 PM	-	-	-	10,262	10,262	11,688	124	107	32	1,709
4:00 PM	1,411	747	684	7,362	7,362	8,325	408	460	448	1,824
5:00 PM	2,176	2,901	2,176	3,217	3,217	3,519	908	560	851	1,861
6:00 PM	2,176	2,619	2,176	312	312	312	608	558	597	2,149
7:00 PM	-	-	197	150	150	150	460	418	458	2,630
8:00 PM	-	-	-	150	150	150	155	108	169	2,930
9:00 PM	-	-	-	84	150	150	0	11	1	3,189
10:00 PM	-	-	-	150	130	145	0	0	0	3,032
11:00 PM	-	-	-	150	150	142	0	0	0	2,409

Source: Synapse modeling of Trajectory and ORA Scenarios.

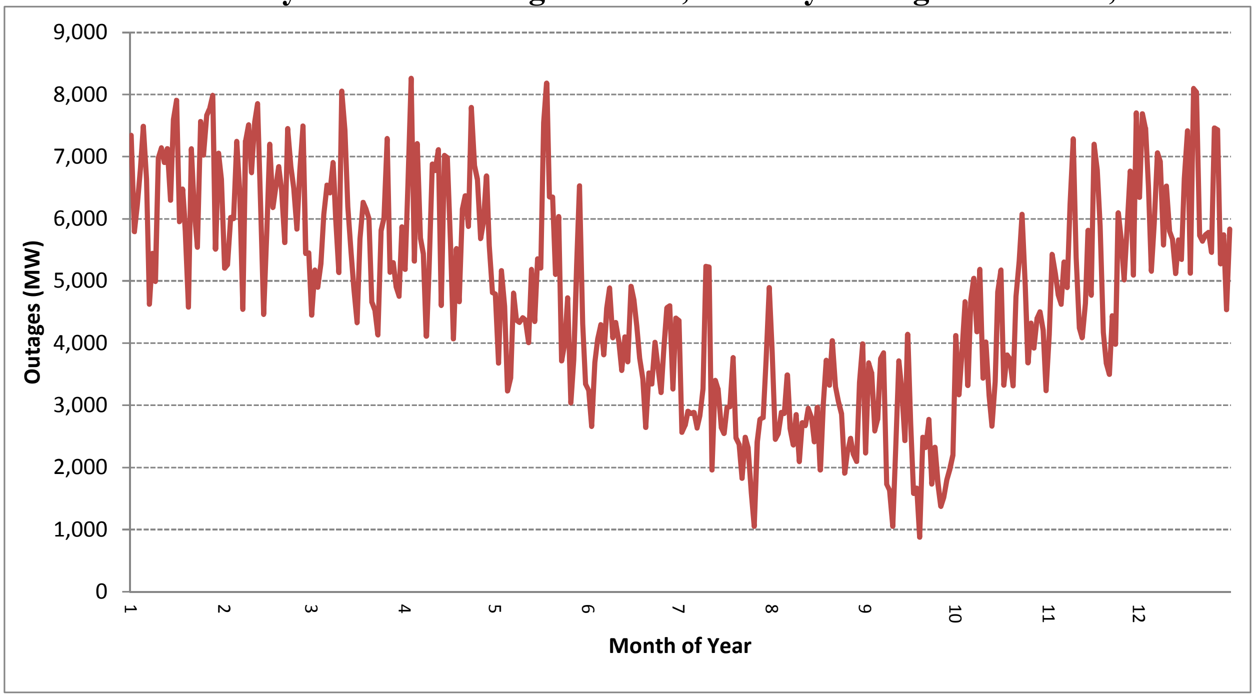
As Table 4 shows, the patterns vary for all but wind resources across the three scenarios. The table does not show ancillary service resource use in these hours. Demand response and storage resource output varies, especially during the tightest hours of the day. The resource output changes in response to different resource availability for energy and ancillary service provision across the scenarios.

4. Resource Outages

Q26. What pattern of resource outage is reflected in the inputs to the Trajectory scenario?

A. Figure 9 below shows the pattern of outages in place throughout the year. The data represent the maximum daily outage represented in Plexos. As seen, outages are at their minimum during the summer and early fall months.

Figure 9.
Maximum Daily Resource Outage Pattern, January through December, 2024

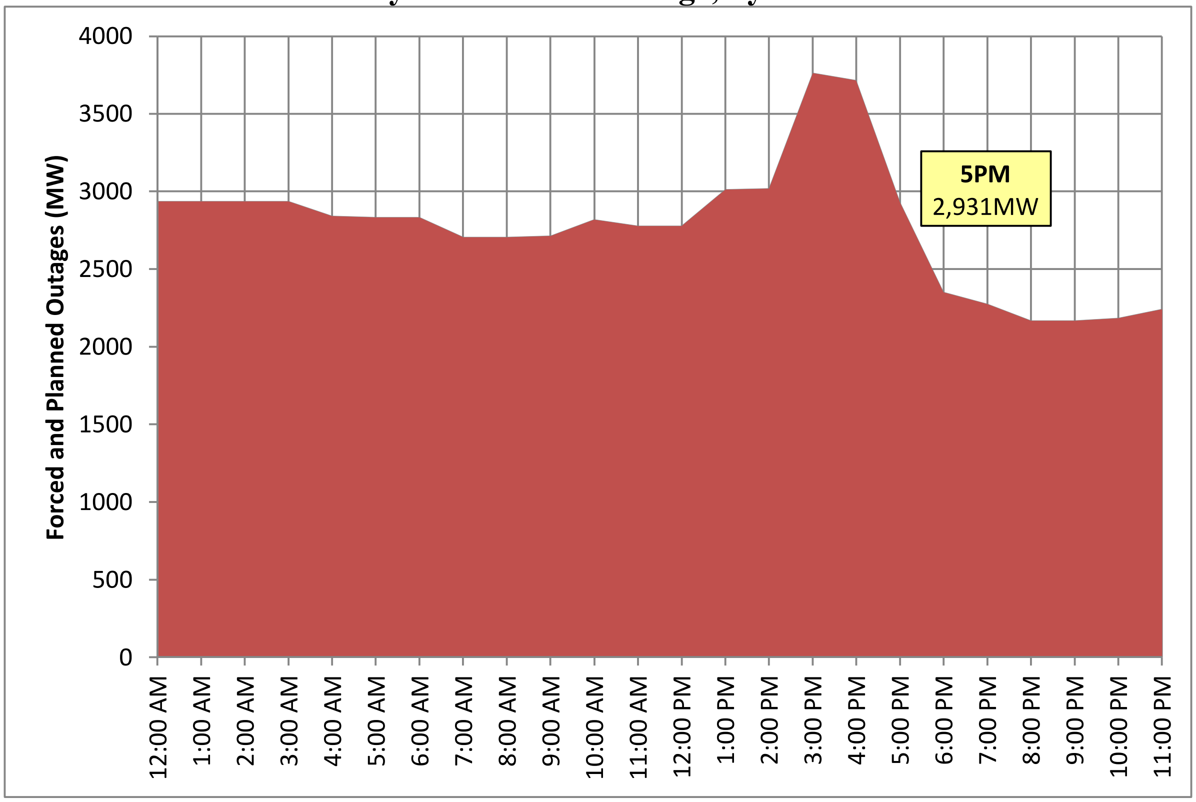


Source: Inputs to Plexos model, trajectory scenario.

Q27. What pattern of resource outage is seen on the peak shortage day in July in the Trajectory scenario?

A. Figure 10 below shows the pattern of outages in place on July 19, the peak shortage day. The ORA scenarios exhibit the same outage pattern as the Trajectory scenario. A total of 2,931 MW of outages exist in the model during the peak shortage hour of 5 p.m.

Figure 10.
July 19 Resource Outage, by Hour



Source: Input values in Plexos model, Trajectory scenario.

5. GHG Emissions

Q28. What are the greenhouse gas (GHG) emissions for the trajectory scenario in 2024?

A. Table 5 below shows the annual GHG emissions from the results of the Plexos modeling for the Trajectory scenario.[31] Since we only modeled ORA scenarios for July, we do not have annual GHG emission values for those scenarios at this time.

[31] These results are computed for the "need" run, which uses a different set of Step 1 input values than that used for the "production cost" run. As part of the Phase 1a modeling process CAISO models a "need" run and posts results. The need run uses LFU and Regulation -up values (step 1 values) based on the maximum level of LFU and Regulation -up indicated for a given hour for a given month. Once need is determined, CAISO models a production cost run with the LFU resources and using the original hourly values of LFU and Regulation-up.

Table 5. Annual GHG Emissions, 2024, Trajectory Scenario

Millions of Short Tons of CO2	Region			
Month	CAISO	Rest of California	WECC Excluding California	Total WECC
January, 2024	0.96	2.76	23.07	26.80
February, 2024	0.86	2.43	21.70	24.99
March, 2024	0.86	1.86	22.89	25.61
April, 2024	0.72	1.59	19.60	21.90
May, 2024	0.82	1.84	19.30	21.95
June, 2024	0.84	2.08	22.38	25.30
July, 2024	1.30	3.77	28.16	33.23
August, 2024	1.22	3.72	29.08	34.01
September, 2024	1.04	2.95	25.85	29.84
October, 2024	1.03	3.19	23.27	27.49
November, 2024	0.95	2.68	20.57	24.21
December, 2024	0.98	2.72	23.96	27.66
Grand Total	11.58	31.58	279.83	322.99

Source: Synapse modeling of Trajectory scenario, 7/31/2014 posted model, "Need run", all months of 2024.

Q29. What is the comparison of greenhouse gas (GHG) emissions across the Trajectory and ORA Scenarios for July of 2024?

A. Table 6 below shows the GHG emissions from the results of the Plexos modeling. As seen, ORA scenario 1 leads to lower emissions across California and the WECC. ORA scenario 2 leads to lower GHG emissions in California, but slightly higher emissions across the rest of the WECC.

Table 6. Comparison of GHG Emissions Across Scenarios, July 2024

Short Tons of CO_2, July, 2024	Trajectory	ORA 1 (Incremental Small PV)	ORA 2 (Track 1 / Track 4)
CAISO	3,766,577	3,602,572	3,766,374
Rest of California	1,304,960	1,286,381	1,297,396
WECC Excluding California	28,158,011	28,057,320	28,172,162
Total WECC	33,229,548	32,946,273	33,235,932

Source: Synapse modeling of Trajectory and ORA scenarios, July 31, 2014 posted model, "Need run," July 2024.

IV. DISCUSSION

1. Trajectory Scenario Results: Implications for Need

Q30. Is there a need for additional procurement of resources to ensure system reliability?

A. No. Based on the duration of shortage seen in the Trajectory scenario results, and considering the effect of a minimum level of additional resources already authorized by Track 1 and Track 4 decisions, there is no need for additional system reliability resource procurement at this time. Surplus capacity exists through the year with the exception of two days in July. These two days exhibit a shortfall in only five hours. The maximum shortfall is 1,489 MW at 5 p.m. on July 19 as shown in Table 1.

There is surplus capacity headroom for almost all hours of the year, with only the peak load summer days showing tightness of resource availability. The projected *patterns and duration* of modeled surplus or shortage should always be considered when weighing procurement decisions, and in this instance those patterns indicate a relatively robust base of system resources, and an extremely low duration of modeled shortage. That shortage is mitigated by resources likely to be deployed as a result of the authorizations in Track 1 and Track 4.

The modeling itself does not inform the question of timing for any resource procurement that is warranted. But as indicated by the results of the ORA scenarios, preferred resource inclusion reduces modeled shortage, indicating that the local reliability procurements authorized in Track 1 and Track 4 also benefit system reliability need.

2. ORA Scenarios 1 and 2 - Effect on Model Results

Q31. Please discuss the effect of the ORA scenarios on resource need.

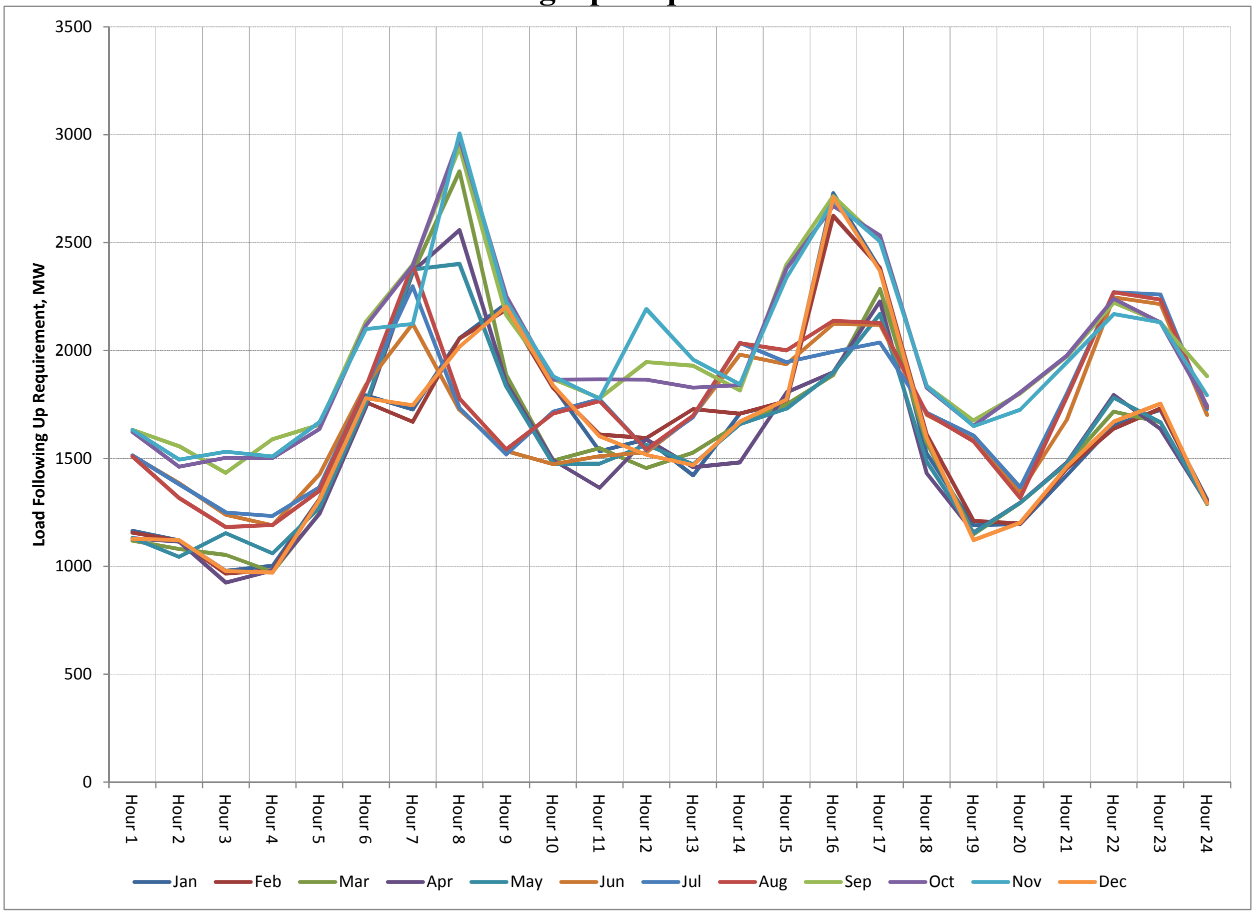
A. ORA scenario 2 results nearly eliminate any indication of resource need. A single hour (July 19, 5 p.m.) shows a 164 MW shortage of load-following up resource. ORA scenario 1 results in a lowering of indicated shortage at the most extreme hour (July 19, 5 p.m.) from 1,489 MW to 1,188 MW.

3. Stochastic and Deterministic Considerations

Q32. Does the "indication of need" arising from the modeling results account for the stochastic nature of renewable resource output?

A. Yes, to a degree. The scenarios executed using the Plexos modeling platform are considered deterministic in nature. That is, the input values such as solar and wind hourly output are fixed, as is the projection of hourly load and hourly resource outages. The value of these inputs varies by hour but is predictable in the model, which has perfect foresight. However, a key constraint enforced in the model is the requirement for additional capacity availability to cover deviations in load and resource availability that occur between the hourly time steps modeled in Plexos. This additional ancillary service requirement imposed on the model is based on a stochastic analysis of wind, solar and load patterns (Step 1 inputs). Further stochastic analysis can refine these values to more accurately characterize this requirement, but it is important to note the presence of this requirement, and to recognize that it forces the model to always have resources available to follow the net load patterns seen on the system that arise in part from renewable resource output variation. Figure 11 below shows the level of load-following up requirement imposed on the model. It illustrates that the model recognizes an increasing need to provide for load-following resources in the hours leading up to key ramping periods of concern, later afternoon and early morning.

Figure 11.
California Load Following Up Requirement Modeled in Plexos



V. CONCLUSIONS AND RECOMMENDATION

Q33. What are your conclusions?

A. Based on our analysis, we conclude the following:

1. The Trajectory scenario shortage indications are extremely limited in duration.
2. ORA scenario 2 resolves the limited duration shortage for all but 1 hour, with that one hour of capacity shortage reduced to 164 MW (from a Trajectory scenario shortage of 1,489 MW).
3. ORA scenario 1 reduces the magnitude of the shortage amounts, and allows for non-spin requirements to be fully met. The only shortage seen in that scenario is for load-following up requirements.
4. Resource additions within the parameters of Track 1 and Track 4 decisions are highly likely to result in zero modeled shortages in a Trajectory scenario.

5. Resources outages at the hour of maximum shortage in the Trajectory scenario are modeled as equal to roughly twice the shortage amount in that hour.
6. There is no indication of need for system reliability procurement beyond Track 1 and Track 4 determinations at this time, based on the Trajectory scenario.

Based on the duration of shortage seen in the Trajectory scenario results, and considering the effect of a minimum level of additional resources already authorized by Track 1 and Track 4 decisions, there is no need for additional system reliability resource procurement at this time. Surplus capacity exists through the year with the exception of two days in July. These two days exhibit a shortfall in only five hours. The maximum shortfall is 1,489 MW at 5 p.m. on July 19 as shown in Table 1. ORA therefore recommends that the Commission find that there is no need to procure additional system resources at this time.

Q34. Does this complete your testimony?

A. Yes.

APPENDIX A

PREPARED TESTIMONY AND QUALIFCATIONS
OF
ROBERT M. FAGAN

Q1. Please state your name, position and business address.

A1. My name is Robert M. Fagan. I am a Principal Associate with Synapse Energy Economics, Inc., 485 Massachusetts Ave., Cambridge, MA 02139. I have been employed in that position since 2005.

Q2. Please state your qualifications.

A2. My full qualifications are listed in my resume, on the following pages. I am a mechanical engineer and energy economics analyst, and I have examined energy industry issues for more than 25 years. My activities focus on many aspects of the electric power industry, especially economic and technical analysis of electric supply and delivery systems, wholesale and retail electricity provision, energy and capacity market structures, renewable resource alternatives including on-shore and off-shore wind and solar PV, and assessment and implementation of energy efficiency and demand response alternatives.

I hold an MA from Boston University in Energy and Environmental Studies and a BS from Clarkson University in Mechanical Engineering. I have completed additional course work in wind integration, solar engineering, regulatory and legal aspects of electric power systems, building controls, cogeneration, lighting design and mechanical and aerospace engineering.

Q3. Have you testified before the CPUC before?

A3. Yes. I testified in Track 1 and Track 4 of the R.12-03-014 proceeding, and in the A.11-05-023, Application of San Diego Gas & electric Complany ((U902E) for Authority to Enter into Purchase Power Tolling Agreements with Escondido Energy Center, Pio Pico Energy Center and Quail Brush Energy Center. I have been involved in California renewable energy integration and related resource adequacy issues as a consultant to the ORA since the late fall of 2010. I have also testified in numerous state and provincial jurisdictions, and the Federal Energy Regulatory Commission (FERC), on various aspects of the electric power industry including renewable resource integration, transmission system planning, resource need, and the effects of demand-side resources on the electric power system.

Q4. On whose behalf are you testifying in this proceeding?

A4. I am testifying on behalf of the California Public Utilities Commission's Office of Ratepayer Advocates (ORA).

PREPARED TESTIMONY AND QUALIFICATIONS
OF
PATRICK LUCKOW

Q1. Please state your name, position and business address.

A1. My name is Patrick Luckow. I am an Associate with Synapse Energy Economics, Inc., 485 Massachusetts Ave., Cambridge, MA 02139. I have been employed in that position since I started work at Synapse in 2012.

Q2. Please state your qualifications.

A2. I am an Associate at Synapse, with a special focus on calibrating, running, and modifying industry-standard economic models to evaluate long-term energy plans, and the environmental and economic impacts of policy/regulatory initiatives.

Prior to joining Synapse, I worked as a scientist at the Joint Global Change Research Institute in College Park, Maryland. In this position, I evaluated the long-term implications of potential climate policies, both internationally and in the U.S., across a range of energy and electricity models. This work included leading a team studying global wind energy resources and their interaction in the Institute's integrated assessment model, and modeling large-scale biomass use in the global energy system.

I hold a Bachelor of Science degree in Mechanical Engineering from Northwestern University, and a Master of Science degree in Mechanical Engineering from the University of Maryland.

Q3. Have you testified before the CPUC before?

A3. No.

Q4. On whose behalf are you testifying in this proceeding?

A4. I am testifying on behalf of the California Public Utilities Commission's Office of Ratepayer Advocates