Rulemaking No.: 13-12-010
Exhibit No.:
Witness: Dr. Karl Meeusen

Order Instituting Rulemaking to Integrate and Refine Procurement Policies and Consider Long-Term Procurement Plans.

Rulemaking 13-12-010

PHASE I.A. STOCHASTIC STUDY TESTIMONY OF DR. KARL MEEUSEN ON BEHALF OF THE CALIFORNIA INDEPENDENT SYSTEM OPERATOR CORPORATION

Dated November 20, 2014

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BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

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I. BACKGROUND AND TESTIMONY SUMMARY

Q. What is your name and by whom are you employed?

A. My name is Karl Meeusen. I am employed by the California Independent System Operator (CAISO), 250 Outcropping Way, Folsom, California. I currently work in the CAISO's Markets and Infrastructure Policy group as the Market Design and Regulatory Policy Lead, a position I have held since 2011.

Q. Have you previously submitted testimony in this proceeding?

A. Yes. On August 13, 2014 and October 22, 2014, I submitted testimony addressing policy conclusions and recommendations based on the CAISO's Phase 1a deterministic studies conducted as of that date in this Long-Term Procurement Plan (LTPP) rulemaking.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to provide an overview of the results of the CAISO's stochastic modeling and to make recommendations regarding how those results should inform the Commission's findings on capacity needs in this proceeding.

Q. Please provide an overview of your recommendations.

A. I recommend the following:

1) The CAISO's stochastic modeling results complement provide context and support for the deterministic studies conducted to date. The results inform the Commission that there exists a greater potential of reliability risk, larger and more frequent capacity shortages, and renewable curtailments than was observed through the deterministic study results.
2) Even though the stochastic model results show larger capacity shortfalls than were seen in the deterministic model, the Commission should not make conclusions regarding needed capacity until the CAISO has identified the flexibility characteristics needed.
3) Additional studies are necessary to determine the nature of the flexible capacity needs and the effect that limited curtailment may have on these needs. These additional flexibility studies should examine both the Trajectory and 40 Percent RPS scenarios with no curtailment.

II. SYSTEM AND FLEXIBLE CAPACITY NEEDS

Q. Describe how the capacity shortfalls observed in the stochastic study should be interpreted in conjunction with the deterministic study results.

A. The CAISO's stochastic model results provide context and support for the deterministic model results. The nature of the CAISO's Monte Carlo simulation is to produce combinations of load, wind generation, solar generation and forced outages that were not observed in the deterministic model, but were possible based on statistical analysis of historical data. The stochastic model identifies potential conditions that increase the stress on the CAISO system. In summer this means higher peak loads, exposing potential for larger capacity shortages. In non-summer months, this means lower net loads exacerbating over generation conditions and potential curtailment. The stochastic model captures these conditions in order to quantify the risk of shortfalls or impacts of higher and more frequent over generation conditions produced by inherently uncertain variables.

The deterministic model identified a maximum capacity shortfall of 1,489 megawatts (MW). The stochastic study shows a relatively higher probability of shortfall in excess of 1,489 MW. In the deterministic model, the CAISO observed one hour with a deficiency of 1,489 MW and a total of five hours with any capacity shortfall. The stochastic model produced an average expected frequency of about 19.9 hours per year with a capacity deficiency, of which 11.6 hours are expected to be in excess of 1,489 MW maximum shortfall observed in the deterministic case.

Q. How can the Commission use the results of the CAISO's stochastic study to evaluate system need?

A. The CAISO examined several different approaches to evaluating and expressing the capacity shortfalls identified in the stochastic model results. Before explaining the results, it is import to first explain the different evaluations that CAISO provides in the tables that follow:

- Stochastic Model Shortfall – Represents the shortfalls identified from the stochastic model and includes shortfalls for load-following up, non-spinning reserves, spinning reserves, regulation and energy.
- Stage-1 Emergency Shortfall – Represents the shortfalls identified in the stochastic model for only non-spinning reserves, spinning reserves, regulation and energy. Shortfalls in one of these four categories represents a Stage-1 emergency. Shortfalls in load-following reserves are not reported in this metric.
- Stage-3 Emergency Shortfall – Represents the shortfalls identified in the stochastic model for only spinning reserves, regulation and energy. Shortfalls in one of these three categories represents a Stage-3 emergency. Shortfalls in load-following and non-spinning reserves are not reported in this metric.
- "Tracks 1 and 4" Shortfall – Represents the identified shortfalls after the subtracting 2,315 MW of un-modeled authorized Track 1 and 4 capacity from the Stochastic Model Shortfall.

- Capped Load Shortfall – Represents the identified shortfalls after limiting the maximum allowable load from the stochastic model to 58,000 megawatts (MW), the estimated peak 1-in-10 year 2024 load from the California Energy Commission's (CEC's) Integrated Energy Policy Report (IEPR) forecast.
- Combinations – Represent combinations of the above assessments. Any combination is an overlay of one assessment onto the other.

In his testimony, Dr. Liu describes the "1-day-in-10 years" standard used by the CAISO to evaluate system need. The "1-day-in-10 years" is used industry-wide, but it is subject to varying interpretations. For example, the "1-day-in-10 years" standard used in the CAISO's analysis identifies capacity needs for cumulative shortfalls in excess of 7 hours in 10 years or 0.7 hours in one year. Other interpretations may identify cumulative shortfalls based on 24 hours of capacity shortfall in 10 years (*i.e.*, 2.4 hours in one year) or, in the alternative, one hour of shortfall in 10 years (*i.e.*, 0.1 hours in one year). These varying interpretations of the standard have different implications for the risk for reliability events and ultimately lead to differing levels of identified capacity shortfalls. For example, Table 1 provides the differing capacity shortfalls using the CAISO's stochastic study results and applying three different interpretations of the "1-day-in-10 years" standard.

Table 1

Reliability Standard (hours-in-1 year)	0.1	0.7	2.4
Stochastic Model Shortfall (MW)	11,822	8,292	5,414

As can be seen from Table 1, the 1 hour in 10 year interpretation of the standard, which can be interpreted as a higher reliability standard, produces relatively higher capacity shortfalls than the 7 hours in 10 or the 24 hours in 10, which can be interpreted as lower reliability standards. .

Q. How might the capacity shortfall results change if the Commission only considers the capacity necessary to prevent 1-day-in-10 years staged emergencies?

A. The CAISO notes that shortfalls in load-following and non-spinning reserves can trigger staged emergencies and should not be discounted. This was also noted in the CAISO's reply testimony regarding the deterministic model results. Specifically, the CAISO stated:

> An inability to follow load means that the CAISO is unable to ensure that its supply is equal to its demand. If the CAISO is unable to follow load, it must lean on adjacent balancing authority areas to provide the additional energy. Sustained leaning on neighboring balancing authorities is prohibited by NERC balancing standards and therefore presents a Stage 1 emergency risk.[1]

Conducting forward planning that does not fully consider the need for load following and non-spinning reserves is planning a system that puts the CAISO at risk of not being able to meet its NERC requirements. The CAISO's stochastic study results show the reliability risks of a planning approach geared toward preventing 1-day-in-10 year staged emergencies. While this standard may indicate a lesser need for capacity, the significant strain on the CAISO's ability to provide reliable service within NERC criteria require mitigation down the road. Table 2, Row (2), presents information regarding the capacity necessary to prevent Stage-1 shortfalls using the three interpretations of the 1-day-in-10 year standard referenced above. Capacity necessary to prevent 1-day-in-10 year Stage-3 emergencies is shown in Row (3). Rows (4) through (8) of Table 2 are discussed in greater detail below. The Commission should plan its procurement consistent with the CAISO's ability to provide reliable service consistent with the 0.7 hours in one year standard, without leaning on neighboring systems in contravention of NERC standards.

[1] *See* Reply Testimony of Dr. Meeusen on behalf of the CAISO, served October 22, 2014, at 12.

Table 2

	Reliability Standard (hours-in-1 year)	0.1	0.7	2.4
(1)	Stochastic Model Shortfall (MW)	11,822	8,292	5,414
(2)	Stage-1 Emergency Shortfall (MW)	10,500	6,930	4,050
(3)	Stage-3 Emergency Shortfall (MW)	9,145	5,521	2,690
(4)	"Tracks 1 and 4" Shortfall (MW)	9,507	5,977	3,099
(5)	Combination of "Tracks 1 and 4" Shortfall and Stage-3 Emergency Shortfall (MW)	7,192	3,662	784
(6)	Capped Load Shortfall (MW)	10,635	7,660	5,158
(7)	Combination of Capped Load Shortfall and Stage-1 Shortfall (MW)	9,276	6,370	3,811
(8)	Combination of Capped Load Shortfall and Stage-3 Emergency Shortfall (MW)	7,948	5,023	2,470

Q. Describe how the authorized Track 1 and Track 4 capacity not modeled in the CAISO's studies may affect the capacity shortfalls identified above.

A. 2,315 MW of capacity authorized in Track 1 and Track 4 was not modeled in either the stochastic or deterministic studies conducted by the CAISO. The CAISO recognizes that this capacity will likely lower the shortfalls identified above. However, currently, the CAISO cannot reach conclusions on how this authorized capacity will affect the shortfalls identified to date. If this authorized capacity is perfectly flexible and deliverable at all hours, it may reduce the shortfalls on a MW by MW basis. However, if any authorized Track 1 and Track 4 resources do not provide full capacity during hours that are slightly after peak (when most shortfalls occur, see Dr. Liu's Technical Appendix at Table 11) such resources will not resolve the deficiencies. Capacity that is not perfectly flexible may also increase renewable curtailments. Table 2, Rows (4) and (5)

show that even assuming all Track 1 and Track 4 capacity is perfect, all interpretations of the 1-day-in-10 year standard result in a residual capacity shortfall.

Q. How do the high stochastic loads affect capacity shortfall identified under the CAISO's 1-day-in-10 years standard?

A. In the CAISO's stochastic model, there are infrequent occurrences of hourly loads in excess of 60,000 MW. In contrast, the 2024 deterministic peak load is 52,143 MW. The CAISO conducted additional analysis to determine the impact these outlier load events had on capacity shortfalls. To do so, the CAISO analyzed the results with stochastic load cap set at the CEC's projected 1-in-10 peak load forecast for 2024, approximately 58,000 MW.[2] For hours with a capacity shortfall, if the stochastic load value was higher than the cap, the amount in excess of the cap was reduced from the shortfall. For example, if an hour indicated a 13,000 MW capacity shortfall and a load value 62,000 MW, its load exceeds the 58,000 MW cap by 4,000 MW. The capacity shortfall for this hour would then be reduced by 4,000 MW. The adjusted capacity shortfall after imposing the cap on load would be 9,000 MW. For the hours with load value less than or equal to 58,000 MW, there is no change to the capacity shortfall values. The reliability standard can then be applied to determine the capacity shortfalls to be eliminated in order to meet the 1 day-in-10 years reliability standard. Table 2, Rows (6)-(8) show that with this load cap in place, capacity shortfalls persist, even when planning the system only to avoid staged emergencies.

Q. How do the stochastic study results inform the deterministic study results with respect to renewable curtailment?

A. In the stochastic study in non-summer months, lower net loads could increase stress on the system. These decreased net loads in certain hours may lead to an increased

[2] 58,000 MW approximates the CEC's 2013 IEPR 1-in-10 CAISO coincident peak load forecast with an adjustment for additional achievable energy efficiency.

probability of renewable curtailments. The results of the stochastic model shed light on these possibilities. For example, there were 96 hours and 153 GWh of renewable curtailment in the deterministic model. In the stochastic model, the results show that the CAISO should expect an average of 210 hours and 407 GWh of renewable curtailment. Further, the maximum renewable curtailment in the stochastic model (12,756 MW) more closely resembles the maximum curtailment in the 40 percent RPS scenario (13,402 MW) than the trajectory scenario (5,927 MW).

Q. Do the stochastic results provide the Commission with sufficient information to identify flexible capacity needs?

A. No. While the stochastic results show an increase the frequency of renewable curtailment, they do not offer additional information as to the cause of the curtailments, nor do they provide information regarding potential flexible capacity needs that may be needed in lieu of unlimited curtailment. The additional deterministic studies requested in my opening and rebuttal testimony are needed to ascertain the cause of the renewable curtailment and to identify potential flexible capacity needs without unlimited renewable curtailment. As with the deterministic studies conducted to date, the stochastic study allows for unlimited renewable curtailment, thereby smoothing the net load curve and masking flexibility needs that may be present if curtailment is limited. Specifically, the CAISO must be able to determine if renewable curtailment is caused by downward or upward ramping needs, or the PMin burden.

Q. Given the results of the stochastic model, are the additional studies recommended in the CAISO opening testimony sufficient to identify the flexible capacity need?

A. The amount of renewable curtailment in the stochastic model are significantly higher than in the Trajectory deterministic scenario. There may be multiple reasons for this curtailment that might not be captured simply by examining the Trajectory scenario without curtailment. Further, it is not possible to reconstruct a stochastic model without

curtailment to identify the causes. However, it may be possible to use the 40 percent RPS scenario to as a proxy assessment. The level of curtailment in the stochastic model falls between the Trajectory and 40 Percent RPS Scenarios providing reasonable bookends for assessing the potential causes of any flexible capacity needs. Therefore, the Commission should also instruct the CAISO to also examine the 40 Percent RPS scenario with no curtailment.

Q. Given the capacity shortfalls and renewable curtailments shown in the stochastic model, should the Commission authorize or identify a discrete capacity need at this time?

A. As noted above, there is still a lack of sufficient information to determine need, particularly as it pertains to flexible capacity. The Commission should not make a determination of need without a complete picture of the flexible capacity needs to be identified on the basis of the additional deterministic studies to be conducted by the CAISO.

III. POLICY DECISIONS

Q. What policy decisions must be made prior to making a final determination of need in this proceeding?

A. The CAISO's stochastic modeling results provide a significant amount of information necessary for identifying capacity shortfalls. In his testimony, Dr. Liu described CAISO's definition of the 1-day-in-10 years standard which it believes is appropriate for identifying capacity need. However, because this definition will directly impact the identified capacity need (*i.e.*, cost risk), the Commission's final determination of need must be based on its consideration of the varying degree of potential reliability outcomes based on how the standard is to be applied, and a recognition that forgoing additional procurement now may have more costly implications in the future to address those needs.

The CAISO is responsible for maintaining the transmission system level reliability, balancing supply and demand and sufficient reserves in compliance with NERC standards. If system resources are not adequate to balance load and demand in a manner consistent with NERC standards, the CAISO will take appropriate actions to avoid violating those standards and leaning on its neighbors. These are policy decisions that the Commission must consider in order to guide both this long-term procurement plan and future procurement decisions.

Q. Why is it important to make these policy decisions now?

A. This proceeding is the first long-term procurement plan in which parties have presented the results of stochastic studies. As can be seen by the results presented to date, the sheer volume of information presented in the stochastic studies significantly outpaces the information typically presented in a deterministic study. In order to allow the Commission to make the best use of this data, the parties should know the standards by which the Commission intends to make need determinations. A better understanding of the applicable planning standards will allow the parties to present probative information in the most meaningful format. Without a clear understanding of the reliability standards, the value of the stochastic data may be lost in an information overload.

Q. Please summarize your testimony.

A. The CAISO's stochastic model results provide context and support for the deterministic model results. The stochastic model identifies potential conditions that increase the stress on the CAISO system in order to quantify the risk of shortfalls or impacts of higher and more frequent over generation conditions produced by inherently uncertain variables. The results of the stochastic model show potential reliability risk of larger and more frequent capacity shortages and renewable curtailments exists and is greater than what the deterministic results reveal.

The 1-day-in-10 years standard is subject to varying interpretations (1 hour, 7 hours, and 24 hours). The CAISO assessed three of these interpretations. The Commission should make a determination of need based on a reasonable level of potential reliability risk. The CAISO believes that for planning purposes the reliability risk is best mitigated through the 0.7 hours in one year approach, as explained in Dr. Liu's testimony, and without leaning on neighboring systems in contravention of NERC standards. However, such a determination of need should not be made without a complete picture of the flexible capacity needs that will be identified using the additional deterministic studies proposed by the CAISO.

While the stochastic results show an increase the frequency of renewable curtailments, they do not offer additional information as to the cause of the curtailments, nor do they provide information regarding potential flexible capacity needs that may be needed in lieu of unlimited curtailment. The level of curtailment in the stochastic model falls between the Trajectory and 40 Percent RPS Scenarios providing reasonable bookends for assessing the cause of any flexible capacity needs. Therefore, the Commission should also instruct the CAISO to examine the Trajectory and 40 Percent RPS scenarios with no curtailment.

Q. Does this conclude your testimony?

A. Yes, it does.