

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. DIRECT TESTIMONY OF DR. KARL MEEUSEN
ON BEHALF OF THE
CALIFORNIA INDEPENDENT SYSTEM OPERATOR CORPORATION**

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

3
4
5 Order Instituting Rulemaking to Integrate
and Refine Procurement Policies and
Consider Long-Term Procurement Plans.

Rulemaking 13-12-010

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8 **PHASE I.A. DIRECT TESTIMONY OF DR. KARL MEEUSEN**
9 **ON BEHALF OF THE**
10 **CALIFORNIA INDEPENDENT SYSTEM OPERATOR CORPORATION**

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13 **I. BACKGROUND AND TESTIMONY SUMMARY**

14
15 **Q. What is your name and who is your employer?**

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

20
21 **Q. Please describe your professional and employment background.**

22 **A.** Prior to joining the CAISO, I served as Energy Advisor to CPUC President Michael
23 Peevey, advising on issues such as resource adequacy, long-term resource
24 procurement, demand response, and Federal Energy Regulatory Commission
25 (FERC) related issues. I also worked as a Public Utility Regulatory Analyst in the
26 Energy Division of the CPUC as the lead analyst on demand response and FERC
27 related issues. Prior to joining the CPUC, I held research positions at the National
28 Regulatory Research Institute and the U.S. Department of Justice, Antitrust Division
29 and worked as an independent consultant. I hold a Ph.D. in Agricultural,
30 Environmental, and Development Economics from The Ohio State University and a
31 Bachelor's of Science in Philosophy and Economics from the State University of
32 New York, College at Brockport.

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1 **Q. What are your job responsibilities?**

2 **A.** My primary responsibilities include developing and evaluating new wholesale
3 electricity market designs related to the CAISO's ongoing efforts to integrate
4 renewable resources into the CAISO electricity market and electric grid. This
5 includes assessing changing resource adequacy needs as a result of the increased
6 penetration of renewable resources to ensure that sufficient flexible capacity
7 resources are available to effectively integrate resources. I also represent the
8 CAISO in several other CPUC proceedings, including the resource adequacy
9 proceeding and the joint reliability framework, and am leading the CAISO studies
10 on shorter-term flexibility requirements in the multi-year proceedings.

11
12 **Q. Are you familiar with the CAISO's system flexibility studies addressed in Dr.
13 Liu's initial testimony?**

14 **A.** Yes, I am. Although I did not directly participate in the modeling, creation of the
15 input assumptions, or running of the studies, I am very familiar with how the studies
16 were conducted and what each renewable portfolio scenario demonstrates about
17 long-term system flexibility needs.

18
19 **Q. Have you conducted any flexible capacity studies?**

20 **A.** As the lead analyst on the shorter term multi-year flexibility studies the CAISO is
21 conducting for the resource adequacy proceeding, I am responsible for determining
22 the CAISO's flexible capacity needs for the upcoming resource adequacy year.
23 Those studies are based on the similar input assumptions used in this case. As the
24 CAISO lead analyst for the Flexible Resource Adequacy Criteria and Must Offer
25 Obligation (FRACMOO), I was responsible for designing the study methodology
26 the CAISO uses to determine its each year's flexible capacity resource adequacy
27 need.

28

1 **Q. What is the purpose of your testimony?**

2 **A.** The scope of testimony for Phase 1a was set out in the May 6 Scoping Ruling and
3 the ALJ's June 2 scheduling ruling. In particular, the rulings request the parties to
4 evaluate whether there is a need for additional flexible resources to meet operational
5 flexibility through 2024, and whether additional system resources are required to
6 meet grid reliability needs through 2024.

7
8 As described by witness Dr. Shucheng Liu, the CAISO conducted deterministic
9 flexibility studies using, among other things, the assumptions and scenarios
10 specified in the May 14, 2014 Assigned Commissioner's ruling. His testimony
11 discusses in detail the input assumptions, study methodology, and study results. My
12 testimony (1) explains the conclusions that should be drawn from the flexibility
13 study results, (2) discusses the public policy implications of the results, and (3)
14 recommends actions for the Commission to consider in Phases 1a and 1b.

15
16 **Q. Please summarize conclusions and recommendations based on CAISO studies
17 performed for Phase 1a.**

18
19 **A.** 1) The CAISO studies to date are not sufficient, by themselves, to determine the
20 additional capacity needed to meet flexibility and reliability requirements.

21
22 2) The CAISO results show a significant amount of renewable curtailment because
23 the studies assumed unlimited renewable curtailment of the renewable resources
24 identified in table 11 of Dr. Liu's testimony. This may be masking the need for
25 flexible capacity because it allows renewable curtailment as the solution to provide
26 flexibility and mitigate over-generation. Without additional studies, it is not
27 possible to identify the specific flexible capacity shortfall that is leading to the
28 curtailment of renewable resources, or if curtailment of renewable resources is the
29 optimal solution to flexible capacity shortfalls.

30

1 3) The Commission needs to examine, in phase 1b, the benefits and trade-offs
2 between meeting state policy goals and alternative solutions to meeting any
3 observed flexibility shortfalls. To analyze all of the trade-offs effectively, the
4 CAISO proposes to conduct at least two other studies. One study will book end the
5 effect of having no renewable curtailment and the other can explore a moderate
6 level of curtailment as opposed to the curtailment capability currently assumed in
7 the studies.

8

9 4) There are many possible solutions to address system capacity needs. The
10 Commission needs to establish priorities that strike an appropriate balance between
11 the needed mix of resources and state policy objectives. As such, in Phase 1b the
12 Commission needs to examine the extent to which we should rely on renewable
13 curtailment to meet flexibility needs and RPS mandates, and then reconcile these
14 priorities with curtailment provisions in power purchase agreements.

15

16 **II. THE CAISO'S STUDIES SHOW THAT THERE ARE FLEXIBILITY NEEDS**
17 **IN ADDITION TO CAPACITY SHORTFALLS.**

18

19 **Q. Please describe the capacity (MW) shortfalls shown in the CAISO's study**
20 **results.**

21 **A.** In the deterministic models conducted by Dr. Liu, the CAISO identified capacity
22 deficiencies in all but one of the scenarios and sensitivities tested. The most notable
23 of these capacity shortfalls is that in the High-Load scenario, where we see a 5,353
24 MW capacity shortage. The Trajectory scenario shows a more limited capacity
25 shortage of 1,489 MW, which is virtually all attributable to a load following up
26 shortfall. The Expanded Preferred Resource scenario shows that there is no
27 capacity shortfall.

28

29 Each of the capacity shortfalls identified were for upward capacity needs. Because
30 the CAISO assumed unlimited economic curtailment of grid-connected renewables

1 identified in table 11 of Dr. Liu’s testimony in each of the scenarios and
2 sensitivities, no specific flexibility shortages could be identified. The observed
3 curtailments of renewable resources may, therefore, be best read as a need for
4 flexibility products. These curtailments may also be masking the need for
5 downward, upward or commitment flexibility. For example, two possible causes of
6 a curtailment include downward ramping constraints and upward ramping
7 constraints. In the first instance, the CAISO may need to curtail renewable output
8 because the resources on-line at that time cannot ramp down as quickly as the
9 renewable resources are ramping up. In the latter instance, the CAISO may need to
10 curtail renewable output to ensure it has a portfolio of resources available to address
11 an impending ramp that may be amplified by the renewable resource output
12 declining due to the sun setting. I discuss this issue in more detail later in my
13 testimony. However, based on the current results it is not possible to identify which
14 of these specific needs causes the curtailment without additional studies using
15 different assumptions with respect to renewable resource curtailment.

16
17 The Expanded Preferred Resource scenario presents an interesting case in which the
18 load assumptions are equivalent to the trajectory need but it is shaped by the
19 introduction of additional MWs behind the meter small solar PV. The lack of a
20 finding for need should not be a conclusive finding in the context of the
21 curtailability assumption we adopted in this phase. As noted above, his assumption
22 could be masking 1) the lack of downward flexibility that may be needed during
23 times of high curtailment of on-grid renewables as reflected in Table 18 of Dr. Liu’s
24 testimony and 2) an upward flexibility shortage in the hours that we did not observe
25 renewable curtailment. This scenario in fact presents a risk to be managed with the
26 increased penetration of small solar PV without the availability of downward
27 flexibility.

28

1 **Q. What conclusions can be drawn from comparing these capacity shortfall**
2 **levels?**

3 **A.** The 40 Percent RPS scenario had a 2,242 MW deficiency affecting load following
4 and non-spinning reserves while the Trajectory case had a 1,489 MW shortfall
5 affecting load following and non-spinning reserves. The High Load scenario had
6 5,353 MW of upward shortage affecting load following, spinning and non-spinning
7 reserve as well as affected small energy shortfall. The difference between these
8 outcomes is a result of the magnitude of the upward shortage.

9

10 **Q. How will the Track 1 and 4 resource procurement impact the capacity**
11 **shortfalls you discuss above?**

12 **A.** As Dr. Liu explains in his testimony, the CAISO did not model 2,315 MW of
13 approved capacity additions from LTPP R.12-03-014, Track 1 and Track 4.
14 Without additional studies that include these resources, it is not possible to
15 determine the impact this additional capacity would have on the need for system or
16 flexible capacity. Based on the upward capacity shortfalls identified in the
17 scenarios as studied thus far it seems likely that the authorized procurement would
18 reduce and possibly eliminate the magnitude of the upward shortages. However,
19 while the additional capacity from Tracks 1 and 4 is greater than the overall
20 deficiency identified in the Trajectory and the 40 Percent RPS scenarios, it is not
21 clear if the additional capacity could avoid shortfalls in load following, non-
22 spinning and spinning reserves, and regulation in these or any other scenario tested.

23

24 **Q. Should the Commission's inquiry as to the need for additional flexible capacity**
25 **end with the level of capacity shortfall observed in the scenarios?**

26 **A.** No. Capacity shortfalls are just one measure of system need. For example, flexible
27 capacity should not simply be a measure of whether or not the CAISO can follow
28 load. The need for flexible capacity should also consider the portion of a resource
29 available for dispatch and the amount a resource's minimum operating levels may
30 increase the probability of over-generation at certain times and under certain

1 circumstances. This is a key operational consideration the CAISO must consider at
2 all times.

3

4 **Q. Please explain this operational concern.**

5 **A.** The scenario results show that in spring months, wind and solar resources start to
6 taper off in the mid afternoon. As shown in the CAISO’s “Duck Chart” (attached to
7 this testimony), the CAISO will have to address significant net load ramps that are
8 forecasted to exceed 13,000 MW by 2020. In order to have resources set at a
9 position to meet this ramp, the CAISO may be required to turn on or keep on
10 dispatchable conventional resources at their minimum operating limiting, PMin, in
11 preparation for this ramp. The CAISO refers to the PMin that comes with the
12 flexible capacity as the “PMin burden”. In short, this is the PMin the CAISO must
13 accept to get access to flexible capacity from a resource. The larger the PMin
14 burden is as a portion of resources needed to address flexibility needs, the greater
15 the risk of over-generation. If the PMin burden is low, then this will reduce the
16 probability of over-generation. The combination of low load, high wind and solar
17 output, and the need to set dispatchable conventional resources to prepare for the
18 evening net load ramp leads to the possibility of over-generation in the middle of the
19 day. To address this over-generation, the CAISO will need to either curtail other
20 generation resources or increase demand on the system. In both situations it is
21 possible that the state would not meet its RPS goals if the amount of renewable
22 curtailment or load increase is great. If, on the other hand, we do not curtail
23 renewable curtailment and instead decommit dispatchable flexible resources to
24 address the over-generation condition, we jeopardize reliability if we are unable to
25 commit or maintain sufficient dispatchable capacity online for the evening ramp.

26

27 **III. IN BALANCING THE LIKELIHOOD OF OVERGENERATION WITH**
28 **THE STATE’S ENVIRONMENTAL GOALS, THE COMMISSION MUST**
29 **CONSIDER ALTERNATIVE ASSUMPTIONS ABOUT ECONOMIC**
30 **RENEWABLE CURTAILMENT**

1

2 **Q. Please summarize the level of renewable curtailment shown in the CAISO's**
3 **study results.**

4 **A.** Overall, the scenarios tested by Dr. Liu showed curtailments of renewable resources
5 ranging from 26 GWh in the Trajectory scenario without Diablo Canyon to 4,637
6 GWh in the Expanded Preferred Resources scenario. The Diablo Canyon curtailed
7 the fewest resources because it removes 2,240 MW of baseload capacity from the
8 system. However, as noted above, this also leads to increases in upward capacity
9 shortfalls. The Expanded Preferred Resources Scenario shows the greatest
10 curtailment because it assumes the highest planning reserve margin. This is because
11 it has the most resources included in it, including additional rooftop solar, combined
12 heat and power as well as additional renewable to achieve 40% RPS, and, therefore,
13 has a greater probability for renewable curtailment. Indeed, renewable curtailment
14 was observed in all 12 months of this scenario.

15

16 **Q. What assumptions did the CAISO make about achieving the state's RPS goals?**

17 **A.** In each scenario, the CAISO assumed that each RPS target was reached. Therefore,
18 any renewable curtailment can be translated into fewer MWs of delivered energy to
19 fulfill the RPS target requirements. As such, both of the Trajectory Scenarios (with
20 and without Diablo Canyon) as well as the High-Load Scenario were less than 0.5
21 percent under the RPS target for the scenarios. The Expanded Preferred Resource
22 Scenario and 40 Percent RPS scenarios were under a 40 percent RPS target by 6.5
23 percent and 3.4 percent respectively.

24

25 **Q. How did the CAISO model renewable resource economic dispatch?**

26 **A.** Based on the Standard Planning Assumptions, Dr. Liu established economic bids for
27 these resources of -\$300 to reflect variable operating and maintenance costs. For
28 modeling purposes, this means that it will only be economic to dispatch renewable
29 resources downward if, over-generation leads to -\$300 prices. Under these

1 circumstances, curtailing renewable resources is the last economic solution the
2 CAISO could use to address the over-generation.

3

4 **Q. Are there alternative prices that could be used to model renewable resource
5 economic dispatch?**

6 **A.** Yes. As noted above, the -\$300 bid assumption means that renewable resources are
7 curtailed as a last resort, making this curtailment less efficient and effective.

8 Alternative renewable resource economic dispatch assumptions, such as different
9 bidding prices, might yield different results. For example, if renewable resources
10 are bid in at a zero dollar bid, then the CAISO may find options for meeting its
11 ramping need besides using thermal resources that include a PMin burden. Instead,
12 the CAISO may be able ramp wind and solar resources down slowly, allowing the
13 CAISO to rely on slower ramping resources. Further, assuming a zero curtailment
14 would provide additional insight about the causes and magnitudes of the specific
15 reasons for flexible capacity shortfalls discussed above. However, additional
16 modeling is needed before the CAISO could determine the exact effects of
17 alternative renewable resource economic dispatch assumptions on meeting state
18 RPS goals and flexible capacity needs.

19

20 **Q. How does the CAISO's production simulation model handle negative bids for
21 renewable resources?**

22 **A.** Including negative bids into the CAISO market means that the resource could be
23 optimally curtailed based submitted economic bids, instead of through manual over-
24 generation procedures, as is done when manually curtailing self-schedules.

25 However, this is the only economic parameter applied to the renewable resources.
26 Many thermal resources for example also have start-up and minimum load costs.
27 This means that even though a thermal resource may have a higher variable cost, as
28 reflected by its bid, PLEXOS may still select a renewable resource to curtail
29 because it is overall more economical to do so, when other cost and commitment
30 parameters are considered.

1

2 **Q. Is unlimited economic renewable generation downward flexibility (curtailment)**
3 **a practical assumption?**

4 **A.** Not necessarily. I am not aware of any contracts with renewable capacity that
5 allows for unlimited curtailment provisions of the renewable resources identified in
6 table 11 of Dr. Liu's testimony. Further, these contracts may not provide for any
7 economic curtailment. Renewable resources without curtailment provisions are
8 offered into the CAISO as self-schedules. This means that the CAISO can only
9 curtail the output of these resources based on reliability concerns.

10

11 **Q. Can you provide specific examples of actual renewable curtailment and**
12 **economic dispatch quantities from CAISO real-time operations?**

13 **A.** Year-to-date for 2014, the CAISO has had to curtail a total of 19.39 GWh from
14 renewable resources. On May 1, 2014, the CAISO changed the Participating
15 Intermittent Resource Program (PIRP) bidding rules. This has led to more bids in
16 the CAISO market from renewable resources. Of the total year-to-date curtailment,
17 17.2 GWh was accomplished through the CAISO real-time market optimization
18 through curtailment of self-schedules and economic bids based on reliability need.
19 The CAISO market optimization engine will only curtail self-schedules when all
20 other economic bids to reduce output are exhausted. .

21 **Q. How do the curtailments experienced to date compare with those shown in the**
22 **LTPP studies?**

23 **A.** Between January 1 and July 31, 2014, the CAISO curtailed a total of 19.39 GWh of
24 renewable energy output. Dr. Liu's results show 153 GWh of curtailment during
25 the same time-frame in the Trajectory scenario and 2825 GWh in the 40 percent
26 RPS Scenario. In other words, using an assumption of unlimited renewable
27 curtailment of the renewable resources identified in table 11 of Dr. Liu's testimony,
28 the CAISO operators would be trying to manage between 8 to 146 times more
29 energy of curtailment and redispatch.

30

1 **Q. Should the Commission make system resource flexibility decisions based on**
2 **studies that assume high levels of renewable generation curtailment?**

3 **A.** No. These assumptions may lead to an underestimation of the CAISO's flexible
4 capacity need and, as discussed above may ultimately mask some of the CAISO's
5 flexible capacity needs by allowing the PLEXOS model to curtail renewable
6 resources for a variety of different reasons. Without further analysis it is not
7 possible to determine what the flexible capacity shortfalls actually are. In essence,
8 the assumption of unlimited renewable resources curtailment means PLEXOS will
9 use these resources to address ramping constraints and over-generation constraints.
10 This means it is not possible to make a determination of flexible capacity needs.

11

12 **Q. Is economic renewable curtailment a possible operational tool?**

13 **A.** Yes, some economic dispatchable capability could be an appropriate operational
14 tool; however, economic curtailment of the scale observed in the 40% RPS or the
15 Expanded Preferred Resource scenarios is not a practical operational tool.

16

17 **Q. Please describe the CAISO's operational challenges with dispatching large**
18 **amounts of renewable generation?**

19 **A.** The results imply there are significant operational challenges with an increase in the
20 magnitude of the renewable curtailments. As noted above, CAISO operators would
21 be trying to manage between 8 to 135 times more GWh of curtailment of renewable
22 resources and redispatching other resources in real-time. Another operational
23 challenge of dispatching significant amounts of renewables is the difference
24 between the resource's output at the time of the curtailment and the accuracy of the
25 resource's forecasted output at the time the curtailment event ends. If the forecasted
26 output of the resource has changed since the curtailment began, then the CAISO
27 may be in a situation where it becomes ramp constrained because of the difference.
28 For example, the CAISO may have to dispatch a solar resource down 100 MW with
29 an expectation that, based on the resource's forecast at the time, it would be able to
30 bring the resource back to 100 MW in 3 hours. However, in that time, unexpected

1 cloud cover may mean that the CAISO can only redispatch the resource to 50 MW.
2 The CAISO would then need to dispatch another resource with a similar ramp rate
3 to make up for the additional 50 MW. The challenges created by this forecast
4 difference can be seen more clearly in looking at the curtailments from Dr. Liu's
5 study. For example, in the 40 percent RPS results show that about 12,500 MW of
6 renewable energy was curtailed in a single curtailment. With curtailments of this
7 magnitude, the CAISO may need to prepare resources to cover forecast errors. This
8 may require additional PMin burden, requiring additional renewable curtailment to
9 prevent over-generation. These uncontrollable events related to the fuel source,
10 inherent in renewable energy, means that it is inevitable that an increase in
11 renewable energy, even if dispatchable, would require the presence of other flexible
12 resources.

13

14 **IV. THERE ARE OTHER STUDY ASSUMPTIONS THAT MAY MASK THE**
15 **NEED FOR ADDITIONAL FLEXIBILITY**

16

17 **Q. Please describe the CAISO's concerns about the net import assumption.**

18 **A.** As noted in Dr. Liu's testimony, the historical low for imports into the CAISO is
19 about 2000 MW. Although Dr. Liu modeled the CAISO as a net importer, there is
20 no assumption that the CAISO maintain a minimum import constraint consistent
21 with historical import levels. Thus, net imports were allowed to go as low as zero
22 MW. However, Dr. Liu's results show that even the net zero net import constraint
23 is binding at some time in all cases, particularly in the 40 percent RPS scenario.
24 There are significant quantities of resources located outside of the CAISO but
25 owned by California load serving entities that are dedicated imports deliveries into
26 the CAISO. For example, California load serving entities own large portions of
27 Hoover and Palo Verde, which provide dedicated imports into the CAISO. This is
28 energy that has been bought and paid for delivery into the CAISO. These dedicated
29 imports increase the possibility for over-generation, particularly in spring months.

1 As such, before making a determination of flexibility need, the CPUC should
2 consider the impact of these dedicated imports on the risk of over-generation.

3

4 **Q. Are the impacts of additional achievable energy efficiency (AAEE) correctly**
5 **captured in the scenario analysis?**

6 **A.** No. There is no determination of how the additional AAEE assumptions impact the
7 non-peak load. This creates additional uncertainty about flexible capacity needs.
8 Three of the four scenarios run by Dr. Liu include 5,042 MW of AAEE. The
9 Standard Planning Assumptions require that this AAEE be treated as a reduction to
10 peak load. However, there is nothing that describes how it impacts non-peak load.
11 AAEE that lowers both peak and off-peak load will increase the probability of over-
12 generation, while AAEE that focuses only on peak load may reduce the need for
13 flexible capacity.

14

15 **V. POLICY CONSIDERATIONS**

16

17 **Q. Does the CAISO recommend that the Trajectory scenario be used as the**
18 **baseline for system procurement decisions?A.**

19 No. The CAISO views the proposed scenarios as a continuum of possible
20 outcomes. As such, focusing on a single scenario as a baseline is not advisable.
21 The goal of running four scenarios and the “no Diablo Canyon” sensitivity is to
22 create this continuum to inform system need determinations.

23

24 **Q. If a baseline scenario is not selected, how can the Commission use the CAISO’s**
25 **study results to make decisions about system needs?A.**

26 Instead of establishing a baseline scenario, a superior approach would be to
27 establish bookends. Before selecting the bookends, the Commission must first
28 prioritize the different flexibility need measurements reflected by the scenarios. For
29 example, based on the scenarios tested and assumptions used, the Trajectory
30 scenario and the High-Load scenario might provide the bookends if upward capacity

1 is the highest priority need. However, as noted above the assumption embedded in
2 the scenarios that the CAISO has unlimited renewable curtailment capability of the
3 renewable resources identified in table 11 of Dr. Liu's testimony may mask
4 significant needs for downward and possible upward flexible capacity. As such, the
5 Trajectory Scenario and Expanded Preferred Resources Scenarios may provide the
6 correct bookends if the size of renewable curtailment is the highest priority.

7

8 **Q. What policy considerations are raised by these renewable generation**
9 **curtailment issues?**

10 **A.** The Commission must consider the tradeoffs of allowing greater economic
11 curtailment and policy mechanisms that support these tradeoffs. As part of the
12 LTPP proceeding, the Commission should consider the magnitude and frequency of
13 curtailment to determine if the observed curtailment at 33% RPS but more
14 importantly at 40% RPS is consistent with overall state policy objectives. Given the
15 results discussed above regarding the magnitude of curtailment and RPS
16 deficiencies in each scenario, forecast error, and the fact that additional un-modeled
17 flexible capacity from the track 1 and 4 authorization, it is may be possible that the
18 RPS targets could still be met in both of the Trajectory scenarios (with and without
19 Diablo Canyon) as well as the High-Load scenario. However, additional studies are
20 needed before a final determination can be made for any the scenarios.

21

22 If the Commission views the increased economic curtailment as a viable solution to
23 flexible capacity needs, then contracts, market incentives, and operational practices
24 to support curtailment must be designed to ensure this is an achievable solution.
25 Thus, the nature of the curtailment provisions in the contracts are also important.
26 Many RPS contracts contain curtailment limits. However, generally the curtailment
27 considered is for reliability needs rather than economic dispatch. Self-scheduled
28 renewable resources are done through the CAISO optimization, but are done as a
29 means of maintaining reliable system operation. The curtailment provisions need to
30 be made clear as to how the renewable resources should be made available to the

1 ISO (self-scheduled or economically bid) and under what conditions the resource
2 can be curtailed. Thus, contractual limitations may need to be reconsidered in light
3 of meeting environmental goals and future reliability needs cost-effectively.
4

5 Finally, making resource flexibility decisions assuming high levels of renewable
6 curtailment puts the state's renewable energy goals at risk. Curtailment of resources
7 may mean that the CAISO is able to maintain system reliability without additional
8 flexible capacity resources. However, this is only an acceptable solution if it does
9 not come at the expense of our state environmental policy goals.
10

11 If it is determined that the observed curtailment is not consistent with state policy
12 objectives than the proceeding should study the implications and alternatives to
13 curtailment. For example, while increased ability to curtail renewable resources
14 means that the CAISO would require fewer conventional resources to meet flexible
15 capacity needs, it may require the Commission to consider additional renewable
16 energy procurement, ensuring sufficient energy storage capability is available to
17 absorb the over-generation, or crediting a load serving entity for renewable output
18 that would have been produced but for the curtailment to ensure state environmental
19 goals are achieved.
20

21 **VI. RECOMMENDATIONS**

22
23 **Q. What are the CAISO's recommendations for the Phase 1a decision?**

24 **A.** The CAISO was directed to study full renewable curtailment ability. The CAISO
25 does not expect it will have full curtailment capability for all renewable resources.
26 Additionally, the CAISO believes that existing practices would have to change to
27 achieve net imports below historical levels, to zero net imports, or even further to
28 net export. Lastly, consistent with the Assigned Commissioner Ruling, the CAISO
29 studies did not include 2,315 MW of already approved capacity additions.
30 Therefore, the studies to date are not sufficient to determine the additional capacity

1 needed to meet flexibility and reliability requirements. Additional studies
2 incorporating alternative assumptions about curtailment of renewable resources,
3 import limitations, and available capacity are needed before the Commission makes
4 a determination of need. Therefore, without additional studies to assess the impact
5 that these critical assumption have on the shortfalls of capacity needs (both upward
6 and downward), as well as the impact of various levels of renewable curtailment,
7 the CAISO does not believe that the results to date are adequate for making a final
8 determination of need to overall capacity or for assessing the CAISO's ability to
9 address flexible capacity needs.

10
11 The results show significant renewable curtailment. This may mask the level of
12 need for flexible capacity as it assumes unlimited renewable curtailment of the
13 renewable resources identified in table 11 of Dr. Liu's testimony as the solution to
14 provide flexibility and mitigate over-generation. Without additional studies, it is not
15 possible to identify the specific flexible capacity shortfall that is leading to the
16 curtailment of renewable resources or if curtailment of renewable resources is the
17 optimal solution flexible capacity shortfalls.

18
19 Several other tools can provide this capability. The CAISO recommends that the
20 Commission examine in phase 1b the benefits and trade-offs of the range of
21 solutions in the context of meeting state RPS, GHG and other policy goals. Given
22 the range of tools available, the CAISO recommends that the Commission examine
23 in phase 1b the extent that renewable curtailment is used to meet flexibility
24 shortfalls. This conclusion needs to be reconciled with curtailment provisions in
25 power purchase agreements in this or a different proceeding.

26
27 There is likely not one single solution that will solve all the observed upward and
28 over generation issues. It is likely that a combination of tools including some
29 renewable flexibility, enhanced regional collaboration, storage, demand response
30 and increase quantity of fast starting flexible resources with low PMin burden will

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1 be necessary. However, before it is possible to start identifying what this mix might
2 look like, additional studies using alternative assumptions about approved capacity
3 additions, import limitations, and renewable curtailment should be conducted. Only
4 then can there be a reasonably accurate picture of the system needs.

5

6 **Q. Does this conclude your testimony?**

7 **A. Yes, it does.**

8

ATTACHMENT

California Independent System Operator Corporation

“Duck Chart”

Net load - March 31

