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

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| Order Instituting Rulemaking to Integrate And Refine Procurement Policies and Consider Long-Term Procurement Plans | ) ) ) | R.10-05-006 |

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**POST NOVEMBER 30 WORKSHOP REPLY COMMENTS OF THE CALIFORNIA INDEPENDENT SYSTEM OPERATOR CORPORATION**

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In the December 23 ruling, ALJ Allen provided questions and issues upon which parties could direct comments with respect to the November 30, 2010 renewable integration workshop (Appendix A). The ruling also included updates to the Standardized Planning Assumptions to be used for the individual utilities' procurement plans for their bundled customers (Appendix B) and a review of the ISO and PG&E renewable integration models prepared by the Lawrence Berkeley National Laboratory (LBNL)(Appendix C). Initial comments were filed on January 14, 2011. At the request of the ISO, the parties were given until January 26, 2011 to filed reply comments.

The purpose of these reply comments is: (1) to respond to and clarify matters raised in the initial comments by certain parties about the ISO's renewable integration model; and, (2) to provide updates on the ISO's Step 1 inputs and assumptions that were discussed at the workshop and in Section I of Appendix A. These updates will be incorporated into the ISO's development of the additional scenarios and model runs discussed during the December 20, 2010 prehearing conference.

# I. RESPONSES TO COMMENTS

## A. California Wind Energy Association (CALWEA)

### 1. Resource Adequacy Capacity of Intermittent Renewables

CALWEA states that the current Commission-adopted counting rules for intermittent resources are not appropriate for long-term planning purposes because better estimates of net qualifying capacity (NQC) for RA purposes are currently available. According to CALWEA's calculations of the RA capacity for new wind resources, as well as NREL data and the current CPUC counting rules for intermittent technologies, the RA value of new wind resources in California, as a percentage of nameplate capacity, should equal or exceed the RA value of existing wind in 2010.[1]

The ISO is aware of CALWEA's concern and is updating its input data based on the new scenarios and any new information on the NQC for new wind resources using fixed NQC percentages by technology regardless of the wind/solar penetration in different scenarios.

### 2. Solar Forecast Error

CALWEA points out that the ISO's November 30, 2010 presentation shows that the impact of PV on the regulation requirement is greatest when the sun is rising or setting and is more moderate in the middle of the day when the only source of PV output variability is cloud cover. CalWEA observes that the morning increase in PV output due to sunrise and the evening decline as a result of sunset are not random or variable events, and, indeed, are completely known and can be precisely forecasted. The only variability in PV output during these morning and evening periods should be the result of clouds, just as in the middle of the day. As a result, the ISO is urged to reexamine its results for

[1] CALWEA comments at 5.

PV variability in the morning and evening periods to make certain that it is not treating the predictable morning rise and evening fall of PV output as a source of variability or forecast error.[2]

The ISO disagrees with this conclusion. While solar variability in sunrise and sunset is predictable and should not have large forecast errors, it is still variable and such variation will need to be accounted for in the ISO's studies.

### 3. Treatment of Load Following as a Capacity Reserve

CalWEA states that it has a "fundamental concern" with the CAISO's approach to the treatment of the load following requirement as a capacity reserve that should be set aside above and beyond the capacity that is needed to meet the demand, in exactly the same way that reliability-based reserves such as spinning and nonspinning reserves are set aside.[3] CALWEA believes that this approach is incorrect because load-following capacity actually is used to follow forecasted load variations on a five-minute basis and is not set aside to address system reliability concerns. According to CALWEA, such a modeling assumption calls into question the current use of the hourly production simulation analysis over a full annual period to determine the system resources needed for meeting the load following requirement and could seriously over-estimate the need for system resource capacity. CALWEA suggests that the system capacity requirements for load following should be calculated using the same Step 1 process used to determine the load following requirement itself – i.e., as part of the same stochastic five-minute simulation analysis.

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[2] *Id.*
[3] CALWEA at 6.

The ISO does not agree with CALWEA's suggested approach to determining load following requirements. Stochastic 5 minute production simulation is not necessary because the window of statistical variation is captured in the Step 1 analysis. Running the production simulation with an hourly time interval and setting a load following requirement constraint accounts for the fact that the load following capacity would be available to 5 minute real-time dispatch and therefore the ISO methodology is not expecting the load following capacity to be maintained in reserve during actual 5 minute dispatch. The ISO agrees the actual operational requirements on any given day will be determined on an hourly basis based on system conditions, but in the planning horizon that the 33 % RPS integration studies are trying to cover, the ISO's modeling technique is needed to ensure that sufficient flexible fleet capacity is available on top of meeting the expected load condition to provide for the variation

### 4. Use of an Hourly, not a Seasonal Maximum, Flexibility Requirement

CalWEA argues that the CAISO's Step 2 modeling approach should be changed to provide that the flexibility requirement used for every hour of the production simulation study is specific to that same hour, and notes that the CAISO's use of the seasonal maximum flexibility requirement in all hours is too conservative.[4] CALWEA states that treating the load following capacity requirement as a reliability reserve requirement can lead to a severe over-estimation of integration needs for load following. In addition, CALWEA is concerned that all of the current studies are based on the assumption that the ISO will continue to procure all of its flexibility requirements in the day-ahead timeframe, where forecast errors and the uncertainties associated with both the

[4] *Id.* at 7.

load forecast and intermittent renewable generation are expected to be large. Hence, according to CALWEA, by procuring services to meet its flexibility needs a day in advance, the ISO will end up procuring more capacity than is really needed to meet the system flexibility needs. Arguing further, CALWEA expects that by 2020 the ISO will effectively replace a significant portion of its day- ahead scheduling process with a number of day of scheduling procedures that will better address system uncertainty, reduce the procurement of unneeded system resources, and respond to the changing characteristics of both the conventional and renewable resources that are expected to operate in the ISO footprint in 2020. Accordingly, CALWEA states that the ISO should accounting its modeling efforts today for this eventual process change, at a minimum by adjusting the level of uncertainty (from the 95th percentile to the 50th percentile) that it uses in determining system flexibility requirements and the associated fleet capacity needs.

This suggested modeling adjustment should not be adopted. It is not operationally reasonable to reduce to the 50th percentile at this point. Using a 50 percentile would imply that the ISO on average does not need to balance the system half of the time, whereas, in fact, , the ISO has a Balancing Authority Area (BAA) obligation to continuously balance the system and not rely on the rest of the interconnection for balancing except during short term and infrequent conditions. CALWEA's recommendation is not consistent with the ISO's obligation to operate the system in manner that it maintains a balance and meets applicable reliability criteria.

Furthermore, the ISO still believes it is appropriate to use a requirement value other than hourly to determine the flexibility needs of the fleet in order to ensure that the

fleet is sufficient to manage the system under a wide range of possible operating conditions. On the other hand, the ISO feels it is appropriate to use hourly requirements for determining production costs, and emission values.

### B. California Large Energy Consumers Association (CLECA)

CLECA notes that the LBNL draft report does not address the issue of limitations on the resources that the ISO can use flexibly, due to self-scheduling or other constraints.[5] According to CLECA, the ISO currently has a proposal to make output from qualifying facilities (QFs) under utility contracts and DWR pumping load must-take that will further reduce the flexibility that might be available from such resources.

CLECA is mistaken. The ISO proposal[6] for protecting QF and pump load will not reduce flexibility. Rather it provides the ability for a QF to better define only the portion of its output that needs protection to provide for its primary process. The pump protection will only protect the portion of pump schedule that is already self-scheduled or is using existing transmission contract rights. Therefore the proposal will make it possible for QF resources and pump resources to offer the portion of resources that are flexible and are not offered today while providing flexibility to dispatch other portions of the resources.

### C Large- Scale Solar Association (LSA)

#### 1. Solar Forecast Error

The LSA has requested that the ISO provide additional information on its methodology and assumptions for computing the persistence method forecast errors in detail at least comparable to the forecast error calculation description provided in the

[5] CLECA comments at 4.
[6] http://www.caiso.com/286e/286e9662522f0.pdf

ISO's 20% RPS technical appendices. In addition, LSA seeks clarification on whether the ISO has already switched to the persistence methodology in the renewables integration work it has underway, or whether the forecast error approach is still an open question.[7]

The ISO intends to reconstruct the T-2 hour and T-1 hour analysis after developing the new profiles for the additional sensitivity runs described in the scoping ruling. At that time the ISO will determine whether there is a need to perform a different forecast error methodology (e.g. a possible different methodology for sun up / sun down hours). The ISO will make the results of the updated analysis of the new scenario profiles available to the parties.

**2. Incorporating the Hoff Research Data**

According to LSA, the Hoff research suggests that solar PV variability over the one-minute timeframe could be significantly overstated, and that the Hoff methodology warrants changes to the ISO methodology. LSA recommends that the ISO and PG&E make initial proposals on how to integrate the Hoff research and that the Commission provide an opportunity for stakeholders to comment on those proposals moving forward.[8]

The ISO does not propose to incorporate Hoff research results at this time. For the ISO methodology, the ISO makes use of time series profiles for the solar and wind technologies. The ISO looks forward to having the Hoff research develop to the point that a time series set of data or profile can be produced from a set of individual diverse set of resources. Until a time series can be produced, the ISO expects that there is value in re-running the comparative analysis of variability and commits to doing so. It should

[7] LSA comments at 2.
[8] *Id.* 5-6.

again be noted that the ISO analysis incorporates variability as a result of both cloud cover and sun position while the Hoff data on variability addresses the impact of diversity on variability due to cloud cover only.

### D. L. Jan Reid

Mr. Reid states that the T-1 persistence method is the default choice and is consistent with long established modeling practice, and that if a party proposes another method (such as T-2), that party must show that their alternative method is superior to the T-1 method. He concludes that "the ISO has made no such showing."[9]

Mr. Reid misunderstands the ISO's analysis and results with respect to the use of the T-2 persistence method. The ISO has not proposed to use the T-2 method nor has there been any claim that it is superior to T-1. Rather, the ISO was guided by LBNL to use the T-2 assessment to compare to the previous forecast error rates used. These results were then compared T-1 to see the potential improvement in forecast errors. The ISO is continuing to refine its solar forecast error methodology considering these results and will share the methodology when complete.

### E Pacific Environment

#### 1. General Observations

Similar to comments submitted in earlier stages of this renewable integration modeling process, Pacific Environment notes that if the Commission intends to use the ISO model to inform the process, it should ensure that enough information is produced to allow complete evaluation of the resource options to be considered. According to Pacific

[9] Reid comments at 5.

Environment, full quantification of the ISO results is necessary to ensure that options like demand response and energy storage can be evaluated.[10]

Pacific Environment's concerns about whether necessary information about resource options will be produced by the ISO's modeling is misplaced. The current Step 2 process is the first phase of the process of determining the mix of resources needed to successfully integrate renewable resources. This phase of the project quantifies the capacity needs. The next phase will focus on additional studies to determine the characteristics of the capacity needs which would look at options like demand response, storage and others. While the ISO believes some of these additional studies could be incorporated into the RPS scenario analysis, it is not clear at this point that priorities and the schedule in this proceeding will accommodate this next study phase.

**2. Solar and Wind Forecast Error**

Pacific Environment argues that the use of the persistence model for solar forecast errors is not "entirely appropriate," and that instead of using the real time model recommended by Pacific Northwest National Laboratory, the ISO has "focused on an hour-ahead model that uses the persistence method."[11] In addition, Pacific Environment states that although the ISO made adjustments for forecast errors based on differing technologies, the T-2 results are questionable for several reasons. For example, the solar thermal forecast error for facilities in California is markedly different than the forecast error for solar thermal facilities out of state, and the distributed PV has a solar forecast error that is several percentage points higher than the forecast error for PV during various conditions. Pacific Environment also notes that it is not clear to what extent (if any) the

[10] Pacific Environment comments at 2.
[11] *Id.* at 3.

ISO model considered the use of tracking systems, which can "significantly raise the hourly capacity factor [of PV cells] later in the afternoon to better match production to periods of high demand."[12]

Contrary to Pacific Environment's assertions, the ISO model does not use an hour- ahead model that uses the persistence method based on solar production. Rather, the ISO worked closely with the Pacific Northwest National Laboratory to develop a persistence model based on the Clearness Index to address forecast issues during associated sunrise and sunset hours. Furthermore, the ISO worked closely with Andrew Mills of Lawrence Berkeley National Lab to develop the T-2 methodology to assess and compare the forecast errors for different types of solar technology. The data development process did consider the use of tracking systems for concentrated solar and for PV that was designated in the CPUC defined cases as having tracking systems. For the new profiles being developed, thermal inertia for solar thermal technology is being incorporated in the Clearness Index modeling for these plants.

Pacific Environment also argues that, with regard to wind forecast errors, the LBNL review of the ISO's model found that the model failed to "[a]djust wind variability and forecast error according to the expected wind production level."[13] In actuality, the ISO forecast errors are calculated as the actual production minus forecast production divided by nameplate capacity of the resource. Therefore it is appropriate when calculating the MW forecast for any given hour to multiply the forecast error % by the nameplate. However, to avoid having the error MW exceed the production of a given

[12] *Id.* at 4.
[13] *Id.*

hour, the methodology ensures that production plus or minus the forecast error is between 0MW and the nameplate.

### 3. Variability in Solar PV Output

Pacific Environment supports the use of Hoff's data and analysis with respect to the impacts of geographical diversity on solar PV output. Pacific Environment asserts that detailed modeling of the impacts from geographical diversity can greatly reduce the need for regulation services.[14] To account for the geographical diversity of generation when determining the need for backup, Pacific Environment suggests the model could assume that PV can be anticipated to operate at around a 60% capacity factor during peak hours due to its geographical diversity.

The ISO agrees that geographic diversity reduces the variability and ultimately the regulation needs. The ISO accounts for geographic diversity of the solar PV data by aggregating the minute by minute data for all the individual PV resources. This diversity was reflected in the development of profiles for the 2009 cases by effectively modeling 100s of small PV plants all over the state of California. For 2010, higher numbers of plants will be simulated to further improve upon the capture of the effects of this geographical diversity. This and other modeling enhancements of solar profiles are discussed below. On sunny days, during the peak hours, the forecast error is assumed to be 5% and the capacity factor used for the PV production is higher than 60%; therefore the Pacific Environment suggestion may understate production.

[14] *Id.* at 6-7.

### 4. Hydro Plant Operation

Pacific Environment argues that the availability of ancillary services from hydro pumped storage should be considered in the model to assure that ancillary needs are not overestimated. The ISO was also urged to consider the storage facilities which are currently being developed and will be on-line in the near future. As examples, Pacific Environment point out that Ice Energy is constructing a 53 MW distributed storage project for SCE, SCE will be building a large storage project in the Tehachapi region, Beacon Power constructed flywheels connected to a California wind farm and PG&E is installing a 4 MW battery storage project this year.

Consistent with Pacific Environment's recommendation, the ISO model does take into consideration the ancillary services that can be provided by hydro facilities including the Helms pump storage facility. However, the other projects mentioned are not considered in the ISO's model because the model incorporated projects in which the ISO had a high degree of confidence that they would be built and become operational. As a result, the ISO's considered whether the resource had a signed contract before including it as a resource assumption. When the CAISO updates its model for the new scenarios, it will assess again what resources have signed contracts and incorporate additional resources that meet the criteria, including additional storage resources.

### 5 Flexibility Characteristics and Dispatch of Existing, Planned, and Generic Resources

Pacific Environment states that although the CAISO model considers flexibility characteristics of existing and planned resources, it is unclear how complete these considerations are. For example, according to Pacific Environment, the ISO to date does

not appear to have considered the availability of ancillary import resources to fill integration needs. It is also unclear to what extent existing and planned storage projects have been considered as well as the extent to which conventional units contribute to integration needs.[15] Pacific Environment also notes that the ramp rates in the ISO model appear to be artificially low especially given the ramp rates in the Western Wind and Solar Integration Study and that the ISO's model fails to identify places where the capability of existing or planned resources could be improved to better meet integration needs.

As described above, while the ISO believes some of these additional studies could be incorporated into the RPS scenario analysis, it is not clear at this point that priorities and schedule in this proceeding will accommodate the ISO's next Step 2 study phase.

### 6 Percentage of In-State and Out-of-State Renewables Requiring Integration by the ISO

Pacific Environment urges the ISO to consider innovation in grid management as a way to integrate renewables without constructing new units, noting the LBNL conclusion that "[i]ntra-hour scheduling (e.g., 5-10 minutes schedules) provides access to flexibility in conventional power plants that lowers the costs of integrating wind energy."[16] In addition, Pacific Environment suggests that the ISO evaluate cooperation between balancing authority areas (BAAs), citing findings in a recent report by Pacific Northwest National Laboratory that such cooperation has been identified as an important strategy to facilitate high-level variable generation.

The ISO fully agrees with Pacific Environment and is exploring sub-hourly interchange schedules in a separate forum. The ISO was involved in the Pacific

[15] *Id.* at 7.
[16] *Id.* at 8-9.

Northwest National Laboratory initial study on sharing real-time balancing needs with BPA. Further studies are needed in this area and the ISO plans to be a part of further studies.

### 7. Use of Seasonal Maximum

Pacific Environment states that the ISO should not rely on the seasonal maximum because it overstates the integration need, pointing to LBNL's finding that the CAISO model could "lead to a situation where reserves are held in the models in preparation for conditions that are not physically possible."[17] As discussed above in response to comments submitted by CALWEA, the ISO is aware of such concerns raised by Pacific Environment and other parties and plans to use hourly values for future production simulations (Step 2).

## II. UPDATES TO STEP I ASSUMPTIONS

In the first section of Appendix A, parties were asked to comment on the ISO's Step 1 inputs, assumptions and methodologies, specifically with respect to solar forecast error and solar PV output variability. At the November 30, 2010, workshop the ISO noted the possibility that changes would be made to the Step 1 modeling assumptions in these areas based on updated studies by third parties as well as internal study refinements. The ISO has responded to specific party comments regarding solar forecast error and solar PV output variability in the previous section. This section describes the enhancements that will be incorporated into the Step 1 assumptions as the ISO develops the profiles for the additional scenarios.

[17] *Id.*

### A. Solar Forecast Error

The CAISO has been working in collaboration with Energy Division Staff and Andrew Mills from LBNL on refinements to the solar forecast error and intends to make the following improvements:

- Improvement 1: Analyze the aggregate solar profiles by technology (Solar Thermal, PV, Distributed PV) as opposed to using the single set of forecast errors for different clearness indices.
- Improvement 2: Compare the T-2 hour persistence difference in the solar technology profiles. The T-2 hour persistence was suggested by Mills at LBNL, based on the premise that at the very least one should be able to forecast the solar condition in one hour based on condition 2 hours earlier.
- Improvement 3: While performing the T-2 hour persistence analysis, it was observed that T-2 persistence was not producing improved results during sunrise and sunset hours. As a result, the persistence analysis was further broken down into hours 12-16 and all hours to establish a more reasonable set of T-2 persistence forecast error facts that are not affected by sunrise and sunset. It is reasonable to assume that absent cloud cover, the affects of sunrise and sunset sun movement are predictable and therefore may be reasonable to use the hour 12-16 analysis for all hours. However, in the case of solar-thermal there are inertia effects that may be worth further investigation.
- Improvement 4: The ISO further analyzed the differences in the production using T-1 hour persistence. The T-1 persistence method could then be used as the basis for improved forecast error capability.

Lastly, the ISO commits to performing the forecast error analysis in similar way on the new profiles being developed based on the new scenarios. The ISO is willing to provide an update on T-2 hour and T-1 hour analysis as these are available. After reviewing the results of this analysis, the ISO will consider if an additional refinement to differentiate the forecast error during sunrise / sunset hours is needed. One approach to consider is to use the previous day same hour or a T-24 hour approach.

One of the criticisms mentioned by some parties was that the out-of-state solar forecast error presented appeared to be high. The reason that that this appears to be the case is because the out-of –state profile in the 2009 vintage profiles was limited to a single plant. As the new profiles are developed and additional analysis is performed on the new profiles, the ISO expects to have additional out-of-state plants making up the profile and therefore expects the forecast error to improve. The ISO will also consider utilizing the instate solar-thermal forecast error rate for out-of-state to avoid having a small number of plants skew the forecast error used.

**B. Variability in Solar PV Output**

Parties were asked to comment on the Hoff research that estimates much lower impacts of solar PV variability on regulation requirements than the ISO Step 1 estimates and whether such estimates should be incorporated into the ISO and PG&E models for use in this proceeding. As noted above, several parties urged the Commission to use the Hoff results to mitigate the possibility that regulation requirements will be overstated if adjustments are not made to the renewable integration models.

In response to these suggestions, the ISO is making several refinements as the new profiles are being developed based on the new CPUC scenarios. While the Hoff

research is a useful comparison, the Hoff results have not been validated nor developed in such a way that they produce the time series profiles needed for the ISO to perform the aggregate Step 1 analysis. The ISO has continued to collaborate with Hoff to explore opportunities to leverage Hoff's research including eventually developing the necessary time series data profiles. In the meantime, the ISO is making the following improvements to the process it uses to develop solar profiles:

- In place of the somewhat limited hourly point source NREL irradiation data that was used in the solar profiling processes for the 2009 cases, satellite irradiation data that became available for the first time on January 1, 2011 is being used. This satellite data represents the average irradiation over a 1 square kilometer (km) area. This data is available for every 1 km area in California and thus allows the full irradiation diversity that a large solar PV or thermal plant sees to be captured. This data is available through the Clean Power Research website. Having this 1 km data available for the first time makes it possible to use an unlimited number of irradiation data sets to model large solar PV and thermal power plants.
- The number of individual plants that will be used to model the large solar and PV plants will be increased by about 90-% in the 2010 cases compared to the 2009 cases.
- The historical 1 minute SMUD solar irradiation data that was used for the synthesis of 1 minute data will be supplemented with 1 minute data from two additional sites.

- The process of synthesizing 1 minute variability is also being improved including comparing results to other work in the field, including the work of Tom Hoff.
- Modeling of small PV on both the supply and customer side of the meter will also benefit from the diversity improvements (more data points included in the analysis) and the 1 minute variability improvements mentioned above.

Respectfully submitted,
**By: *<u>/s/ Judith Sanders</u>***

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January 26, 2011

**CERTIFICATE OF SERVICE**

I hereby certify that on January 26, 2011, I served, by electronic and United States mail, a copy of the foregoing California Independent System Operator Corporation Proposals on Phase 2 Issues to each party in Docket No. R.10-05-006.

Executed on January 26, 2011
at Folsom, California

/s/ Anna M. Pascuzzo //

Anna M. Pascuzzo
An Employee of the California
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