California ISO
Shaping a Renewed Future

August 1, 2011

VIA ELECTRONIC MAIL

Mr. L. Jan Reid
Coast Consulting
3185 Gross Road
Santa Cruz, CA 95062-2091

Re: ISO Response to the L. Jan Reid First Set of Data Requests

Dear Mr. Beach:

Enclosed please find the ISO response to the L. Jan Reid Data Request No. 1 propounded in the Long Term Procurement Proceeding, CPUC Docket R.10-05-006.

Please do not hesitate to contact me if you have any questions.

Sincerely,

/s/ Judith B. Sanders

Judith B. Sanders
Senior Counsel
California Independent System Operator

cc: Service List R.10-05-006

BEFORE
THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

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

RESPONSE OF
THE CALIFORNIA INDEPENDENT SYSTEM OPERATOR CORPORATION
TO THE FIRST SET OF DISCOVERY REQUESTS OF
L. JAN REID

Below are responses by the California Independent System Operator Corporation to the First Set of Discovery Requests of L. Jan Reid.

RESPONSES

Request No. 1

1. In regard to modeling small solar profiles, the CAISO states that "Due to numbers geographic and size diversity, and other factrs, we decided to model these projects at an aggregate level." (CAISO testimony, p. 23) In the CAISO's opinion, if these small solar profiles had been modeled individually, would this have caused the CAISO's estimate of renewable integration needs (RIM estimate) to increase or to decrease?

ISO RESPONSE TO No. 1

Had these small solar profiles been modeled individually, the CAISO's estimate of renewable integration needs would have resulted in the needs to increase as determined through the Step 1 process because each profile would have a certain level of variability and forecast error which would have to be balanced independently. Geographic diversity inherently allows the upward variability of one profile to balance the downward variability of another profile. Thus, when all profiles are aggregated, the overall variability is expected to decrease which reduces the integration needs.

Request No. 2

2. Please define the term "operational violation" as used in Exhibit I of the CAISO's testimony.

ISO RESPONSE TO No. 2

An "operational violation" as used in Exhibit 1 refers to a condition in which a constraint to meet the requirements for spinning reserve, non-spinning reserve, regulation or load-following could not be satisfied.

Request No. 3

3. The CAISO states that "Results are sensitive to assumptions about load level, requirements based on forecast error, mix of resources, and maintenance schedules." (CAISO Exhibit A, Slide 12) Holding all other factors constant:

   A. Will an increase in load tend to increase or to decrease the CAISO's RIM estimate?
   B. Will an increase in the forecast error tend to increase or to decrease the CAISO's RIM estimate?
   C. If the amount of solar generation increases and the amount of wind generation decreases, will this cause the CAISO's RIM estimate to increase or to decrease?
   D. Will an increase in maintenance tend to increase or to decrease the CAISO's RIM estimate?
   E. Will an increase in natural gas prices tend to increase or to decrease the CAISO's RIM estimate?

ISO RESPONSE TO No. 3A

Holding all other variables constant, an increase in load would increase the load-following and regulation requirements determined in Step 1. In Step 2, holding all other factors constant, an increase in load could result in an increase in the CAISO's need for additional capacity since more capacity will be devoted to meet energy demand and less capacity will be available to meet ancillary service and load following requirements.

ISO RESPONSE TO No. 3B

Holding all other variables constant, an increase in forecast error would increase the load-following and regulation needs determined in Step 1. In Step 2, holding all other factors constant, the increased regulation and load following requirements may or may not result in an increase in the CAISO's need for additional capacity.

ISO RESPONSE TO No. 3C

Holding all other variables constant, an increase in solar generation and a decrease in wind generation may or may not result in an increase the load-following and regulation needs determined in Step 1 or capacity needs in Step 2. The ISO did not conduct sensitivity runs only with substitution between wind and solar and cannot provide a definite answer to this question.

ISO RESPONSE TO No. 3D.

Step 1 does not consider maintenance in its analysis. In Step 2, an increase in maintenance will reduce the capacity and ramping capability available to meet energy demand and ancillary service and load following-up requirements. It may or may not increase the need for additional capacity.

ISO RESPONSE TO No. 3E.

Step 1 does not consider natural gas prices in its analysis. In step 2, an increase in natural gas price will increase the cost of supply, but not the availability of supply resources. So it will not change the need for additional capacity. The model will exhaust all available existing supply resources before adding new ones.

Request No. 4

4. The CAISO states that "Costs associated with emission are tracked separately from fuel and VOM costs." (CAISO Exhibit A, Slilde 13) Please provide a detailed explanation of the assumptions used regarding emissions costs.

ISO RESPONSE TO No. 4.

The model reports emission based on fuel usage. Emission cost is calculated by applying a fixed emission cost rate ($36.3 per short ton CO_2, in 2010 dollars). Neither fuel cost nor VOM cost includes emission cost.

Request No. 5

5. Elasticity is the ratio of the percent change in one variable to the percent change in another variable. For example, if a one percent change in Variable A causes a 1.5 percent change in Variable B, the elasticity of Variable B with respect to Variable A is 1.5. Please provide the elasticity of the following variables with respect to the CAISO's RIM estimate (in MW): load, forecast error, number of standard deviations, solar

generation (GWh), wind generation (GWh), natural gas prices ($/mmBtu), and electricity prices ($/MWh).

ISO RESPONSE TO No. 5.

The elasticity of capacity need with respect to natural gas price is zero, as discussed in response to Question 3.E. Similarly, the elasticity of capacity need with respect to electricity price is zero. Electricity price is the outcome of the balance of supply and demand. It does not change the need for additional capacity, even though high electricity price may provide incentives for investments in new capacity. The CAISO did not calculate the elasticity of capacity need with respect the other variables as the impact of each individual variable cannot be isolated in the calculations the CAISO has conducted.

Request No. 6

6. Please provide a correlation matrix for the following variables: RIM estimate (MW), number of standard deviations, load (GWh), forecast error (%), solar generation (GWh), wind generation (GWh), natural gas prices ($/mmBtu), and electricity prices ($/MWh).

ISO RESPONSE TO No. 6.

As stated in response to Data Request No. 5, the ISO did not calculate these matrices.

Request No. 7

7. For the years 2012-2020, please provide the CAISO's best estimate of the incremental renewable integration need and renewable integration costs.

ISO RESPONSE TO No. 7.

The ISO did not perform studies for every year between 2012 and 2020 and the study results vary greatly based on the scenarios assumptions. However, the ISO has determined that the assumptions in the high load trajectory scenario are a reasonable starting point for an operational needs study. Since the high load trajectory scenario has not considered resources needed in local areas to meet reliability as a result of retirement of OTC resources, the ISO intends to conduct further analysis of local capacity requirements. However, the timing, quantity of needs requires additional study and depends on a variety of factors including retirements of existing resources and load growth.

Request No. 8

8. Did the CAISO employ a historical trend to estimate the forecast error for the period 2011-2020?

ISO RESPONSE TO No. 8.

No the ISO did not employ a historical trend to estimate the forecast error for the period 2011-2020. The CAISO used actual 2010 forecast errors realized for loads. The forecast errors used for wind and solar were based on a T-1 persistence model for load and wind production.

Request No. 9

9. Did the CAISO scale the 20005 load profiles to statewide 2020 levels as suggested by PG&E?

ISO RESPONSE TO No. 9.

Yes, the 2005 load profile was scaled and shifted to align weekdays with weekdays and weekends with weekends in the 2020 timeframe.

Request No. 10

10. Has the CAISO provided a copy of its RIM to the CPUC's Energy Division?

ISO RESPONSE TO No. 10.

The ISO has provided all input and output data. The ISO has also provided information how to acquire the PNNL and Plexos software.

Request No. 11

11. Please provide the number of standard deviations that the CAISO used for forecast error coverage, load following, and regulation requirements.

ISO RESPONSE TO No. 11.

The CAISO used three standard deviations for the seasonal load forecast errors. The forecast errors for wind and solar were also truncated at ± three standard deviations.

Request No. 12

12. For all 2011-2012 time period, what CO_2 cost (in $/metric ton) as assumed by the CAISO?

ISO RESPONSE TO No. 12.

The $36.3 per short ton CO_2 cost in 2020 (in 2010 dollars) came from the CPUC LTPP Scoping Memo - ATTACHMENT 1 (http://docs.cpuc.ca.gov/efile/RULC/127543.pdf) on page 39. The $43.52 per short ton cost in nominal dollars was deflated to 2010 dollars. The model simulates only year 2020. There is no CO_2 cost in the model for other years. The CPUC document mentioned above has the cost numbers for 2012-2020.

Request No. 13

13. Please provide the percent of the capacity that counts toward the planning reserve margin (PRM) that CAISO assumed would be available to meet hourly flexibility requirements.

ISO RESPONSE TO No. 13.

The ISO did not assume a percentage of the capacity that counts toward meeting planning reserve margin is available to meet hourly flexibility requirements. Rather, the utilization of each resource to meet hourly demand and/or reserves (including flexibility requirements) is determined based on the resources ramping capability, operating characteristics, outage profile and operating costs in the step 2 production simulation.

Request No. 14

14. It is my understanding that Net Qualifying Capacity (NQC) is being calculated in the CAISO study using a "70% exceedance" method, which sets the resource adequacy (RA) value of a newable resource at the output level exceeded in 70% of the 1:00 pm to 6:00 pm on-peak hours each day. If NQC is calculated using a different method, please provide a detailed explanation of that method.

ISO RESPONSE TO No. 14.

NQC values were provided in the RPS Calculator by technology and CREZ. They can be found on the "a – ProForma" tab of the RPS Calculator, found at: http://www.cpuc.ca.gov/PUC/energy/Procurement/LTPP/LTPP2010/2010+LTPP+Tools+and+Spreadsheets.htm .

Request No. 15

15. Regarding PV Solar, has the CAISO incorporated correlation as suggested by Thomas E. Hoff and Richard Perez of Clean Power on November 30, 2010?

ISO RESPONSE TO No. 15.

Based on the comparison performed previously, the ISO believes the effects of the correlation Thomas Hoff suggested are already incorporated into the methodology. In addition, the CPUC priority scenarios incorporated some more refined data and geographical diversity effects into the methodology. For each CREZ, the solar PV profile is created using NREL's SAM model, based on Solar Anywhere 30 minute irradiance data, plant size, temperature and wind speed. Then the minute-to-minute production level for each solar PV CREZ is aggregated to create the solar PV profile for Step 1 analysis. The aggregated PV 1-minute profile inherently incorporates the impacts of geographic diversity. Similarly, hourly aggregated profiles for wind and hourly solar profiles aggregated by technology take into consideration geographic diversity in Step 2.

Request No. 16

16. Regarding load following requirements, has the CAISO incorporated correlation as suggested by Thomas E. Hoff and Richard Perez of Clean Power on November 30, 2010?

ISO RESPONSE TO No. 16.

The CAISO's Step 1 model does take into consideration the autocorrelation of forecast errors associated with load, wind and solar.

Request No. 17

17. What assumptions did the CAISO make to account for technological changes that may occur to reduce the intermittency level of renewable resources?

ISO RESPONSE TO No. 17.

The CAISO aggregated all the individual wind CREZs as a single profile to gain the benefits of geographic diversity in reducing the overall variability of each individual wind CREZ. Each individual solar CREZ was grouped by technology. For example, all solar PV CREZs were aggregates as one profile. Likewise, all solar thermal resources were aggregated together; all external solar profiles were aggregated; all distributed PV profiles were aggregated; and, all customer side PV profiles were aggregated etc.

Request No. 18

18. What assumptions did the CAISO make regarding future additions to the existingpump storage hydro?

ISO RESPONSE TO No. 18.

Lake Hodges Pump Storage in SDG&E region is the only pump storage facility considered as a future addition. It comes online in 2011 and has maximum generation capacity of 40 MW.

Request No. 19

19. How many MW of cogeneration in 2020 were assumed by the CAISO in its RIM?

ISO RESPONSE TO No. 19.

There is 3,513 MW of cogeneration in California in 2020 (CPUC LTPP Scoping Memo - ATTACHMENT 1, page 49).

Request No. 20

20. Please explain how the CAISO accounted for geographic resource diversity in its RIM.

ISO RESPONSE TO No. 20.

As stated in response to Question 17, the CAISO aggregated each wind 1-minute profile and aggregated each solar 1-minute profile by technology. This aggregation inherently takes into consideration geographic diversity in Step 1. Similarly, hourly aggregated profiles for wind and hourly solar profiles aggregated by technology take into consideration geographic diversity in Step 2.

Request No. 21

21. How did the CAISO calculate the forecast error for solar thermal resources?

ISO RESPONSE TO No. 21.

The forecast error for solar thermal resources was based on a T-1 persistence model based on an aggregated profile for all the CA solar thermal CREZs output for the 33% RPS trajectory cases.

Request No. 22

22. Please define the term "least regrets procurement decisions" as used in the CAISO's testimony.

ISO RESPONSE TO No. 22.

Any identified needs are based on the findings of multiple feasible resource scenarios. Furthermore the decisions should consider the lead time for development as well as the balance of the operational risks and benefits the decision.

Request No. 23

23. In its RIM, what assumptions did the CAISO make concerning the growth in demand response between 2011 and 2020?

ISO RESPONSE TO No. 23.

The ISO used the demand response assumption for 2020 in the CPUC LTPP scoping memo (ATTACHMENT 1, page 60).

Request No. 24

24. In its RIM, what capacity factor did the CAISO assume for the Helms PumpedStorage facility?

ISO RESPONSE TO No. 24.

Pumping and generation schedules of the Helms Pumped Storage facility were determined optimally by the model. The ISO did not assume any capacity factor for the facility.

Request No. 25

25. The CAISO states that "For Step 2, the ISO used PLEXOS Solutions productionsimulation package and also consulted with PLEXOS Solutions to assist in runningthe production simulation." (CAISO Testimony, p.10)

A. How many simulations were performed?
B. What algorithms (e.g., Marquardt) were used in the simulation(s)?
C. What initial values were used in the simulation(s)?
D. Please provide the number of iterations used in each simulation.
E. Please provide the convergence criteria.

F. What type of distribution (e.g., normal, log normal, etc.) was assumed for the simulation input values?
G. How did the CAISO account for heteroskedasticity?
H. How did the CAISO account serial correlation?
I. How did the CAISO account for multi-colinearity in the input variables?

ISO RESPONSE TO No. 25A.

Monthly simulation for year 2020 for seven cases (Trajectory, Environment Constrained, Cost Constrained, Time Constrained, All-Gas, Trajectory High-Load, and Trajectory with 3 Helms pumps available year round) were performed, including full-year production cost runs and partial year need runs.

ISO RESPONSE TO No. 25B.

The simulation solves a Mixed Integer Programming (MIP) problem. The software uses the Branch-and-Bound algorithm. At each searching node (with a set of given values for the integer variables) a Linear Programming problem is solved. It does not use an iterative algorithm.

ISO RESPONSE TO No. 25C.

The MIP problem is solved one day at a time for a month continuously. For the first day of the month there is no initial condition and no startup cost, no min up and down time constraint, etc. enforced. For the rest of the month the results (commitment, dispatch, etc.) of the previous day are used as the initial condition of the next day.

ISO RESPONSE TO No. 25D.

As discussed in answer to Data Request 25B, no iterative algorithm is used. Therefore there are no iterations in the simulation.

ISO RESPONSE TO No. 25E.

Convergence criterion is based on MIP gap, which is set as 0.05%.

ISO RESPONSE TO No. 25F.

The only stochastic variable in the model is the forced outage draw random number for each generator. They all have a standard uniform distribution, independent from each other.

ISO RESPONSE TO No. 25G.

Not applicable since the all stochastic variables have a standard uniform distribution and independent from each other.

ISO RESPONSE TO No. 25H.

There is no serial correlation assumed.

ISO RESPONSE TO No. 25I.

The Plexos software handles it.

Request No. 26

26. In its RIM, what assumptions did the CAISO make concerning:

A. Ramp rates for new combined cycle gas turbine (CCGT) resources?
B. The number of MW of Once Through Cooling (OTC) units that will be retired by 2020?
C. The use of tradable renewable energy credits as a replacement for physical RPS resources.

ISO RESPONSE TO No. 26A.

The new CCGT has a ramp rate of 7.5 MW per minute.

ISO RESPONSE TO No. 26B.

A total 12,079 MW of OTC units will retire by 2020 ("LTPP Planning Standards, ATTACHMENT 1" on page 51)

ISO RESPONSE TO No. 26C.

33% of out-of-state renewable resources were assumed to be unbundled renewable energy credit.

Request No. 27

27. In the CAISO's opinion, what percentage of out-of-state renewable imports willrequire integration at a 33% RPS?

ISO RESPONSE TO No. 27.

The ISO estimates that 30% of the out-of-state renewable imports will require some form of balancing. For the purposes of the study, the ISO assumed that half or 15% total out-of-state renewable will dynamically schedule. Another half or 15% total out-of-state renewable is assumed to be scheduled on 15 minute intra-hour basis.

Request No. 28

28. Please provide an electronic copy of any CAISO workpapers relative to your answerto Question 27.

ISO RESPONSE TO No. 28.

The ISO has provided all workpapers relative to this answer. These assumptions were based on ISO's opinion in consultation with the working group including CPUC energy division.

Request No. 29

29. If the CAISO has backtested RIM against historical results, please provide an electronic copy of any backtesting studies of the CAISO's RIM.

ISO RESPONSE TO No. 29.

The ISO did not backtest the simulation results against historical results.

Request No. 30

30. In computer science, "robustness" is the ability of a computer system to cope with errors during program execution; or the ability of an algorithm to continue to operate despite abnormalities in input, calculations, etc. Formal techniques, such as fuzz testing,1 are essential to proving robustness, since such types of testing purposely include invalid or unexpected inputs.

Please provide an electronic copy of any robustness tests the CAISO has performed relative to its RIM.

ISO RESPONSE TO No. 30.

The Plexos software has the functions to handle errors encountered in the simulation and will provide warnings when errors happen. The ISO relied on the software vendor (Plexos Solutions) to make sure the software functions properly. The ISO worked closely

with Plexos Solutions and E3, as well as the IOUs to validate the input data and outputs of the model in the process of developing the cases. The intermediate results of the simulation (the outcomes of the tests) were not kept.

Request No. 31

31. For each month from February, 2011 to June, 2011, please provide the aggregatedReal-Time Imbalance Energy Offset (in $).

ISO RESPONSE TO No. 31.

Real-Time Imbalance Energy Offset	
Month	Total
Feb-11	$ 18,657,617
Mar-11	$ 14,948,279
Apr-11	$ 17,926,189
May-11	$ 8,683,420
Jun-11	$ 16,342,819

Request No. 32

32. Please provide an electronic copy of any workpapers used by the CAISO in the preparation of its testimony.

ISO RESPONSE TO No. 32.

The ISO has made all of its workpapers available to the parties in this proceeding.