California Independent
System Operator Corporation

Memorandum

To: ISO Board of Governors

From: Keith Casey, Vice President, Market and Infrastructure Development

Date: August 18, 2011

Re: **Briefing on Renewable Integration**

This memorandum does not require Board action.

EXECUTIVE SUMMARY

California's 33% renewable portfolio standard is transforming the state's electric generation sector in many important ways. Growing renewable energy production is displacing increasing amounts of gas-fired generation, and over time technology, regulatory policy and markets will develop to give storage, demand response and electric vehicles a meaningful role in balancing the electric system. In addition, California is simultaneously implementing policies to eliminate or mitigate the use of once-through cooling in coastal power plants, increase levels of distributed generation, and achieve the state's greenhouse gas reduction goals.

The ISO shares California's vision of a transformed industry and as the system operator for most of the state is keenly aware of its responsibility for maintaining reliability as cost-effectively as possible through the transition. Nothing will undermine the state's policy goals more quickly than power outages and major rate increases, hence the ISO's keen focus on having efficient, flexible resources available to maintain reliability in the decade ahead.

The ISO and state regulators are actively coordinating and preparing for these changes in several forums. Currently the most pressing involves the California Public Utility Commission's long-term procurement plan proceeding, which will drive the future long-term procurement obligations of the state's investor-owned utilities.

In the long-term procurement plan proceeding, the ISO and investor-owned utilities have presented studies regarding the need for utility procurement of additional resources in 2020 with 33% of load supplied by eligible renewable resources. Those studies:

- Quantify the operational reserve requirements necessary;
- Assess the capability of the fleet of resources expected to be available in 2020; and
- Quantify shortfalls and incremental resource needs.

This memo outlines Management's preliminary conclusions regarding the flexible operating characteristics needed to maintain reliability in the face of the transformation underway in the California electric industry. Management will update the board in coming months as we refine our studies in consultation with stakeholders and prepare for CPUC hearings.

This memo also describes the analyses that we prepared in the context of the long-term procurement proceeding with two important additions:

First, the material reflects concerns that certain assumptions specified by the CPUC are based on the expectation that state agencies and others will successfully implement new demand response and energy efficiency measures that are not yet in development. We believe it is more prudent to plan on these measures not materializing which results in higher expected demand and generation needs. Accounting for the possibility that state energy efficiency and demand response goals will not materialize is not an indictment of the goals. These goals are among the most important and least cost steps California can take to successfully integrate the expected levels of new renewable generation. However, the consequences of having insufficient resources to reliably operate the grid are much more significant than the consequences of over-procurement. In addition to severe economic consequences, electricity outages caused by a shortage of the flexible resources needed to reliably operate the system would put renewable goals themselves at risk.

Second, the analyses incorporate a preliminary view of the need for minimum levels of local generation necessary to maintain reliable electric service.[1] Local reliability is an essential consideration, especially given the state's implementation of new restrictions on the use of once-through cooling in coastal power plants. In some cases, once-through cooling plants are essential to meeting local reliability requirements and provide much of the flexibility we use today to integrate variable generation. These fossil plants face compliance requirements between now and the end of the decade, making it essential for state procurement policy to ensure that capacity and operating characteristics of the existing fleet remain available during transition. Moreover, the procurement policy must provide sufficient lead time to ensure that sufficient resources are available to maintain reliability as new renewable resources come on-line and existing once-through cooling plants go out of service.

The summary of this preliminary work is displayed in Table 1 below. Additional detail regarding the study methodology and key assumptions follows.

Table 1
Potential Capacity Needed for Renewable Integration[2]

Operating Characteristic	Potential Capacity Shortage in 2020
Upward Balancing Flexibility	4,600 MW[3] (Of this, 2,000 MW may be supplied by OTC replacement generation to meet local reliability.)
Downward Balancing Flexibility	800 MW (Downward flexibility may be satisfied using curtailment and/or additional storage)

[1] A more complete, ten-year view of local capacity needs that incorporates compliance with once-through cooling regulations will be completed in December of this year and will be introduced into the long-term procurement proceeding record at the next opportunity.
[2] These results are based on CPUC trajectory high load scenario. Other scenarios with lower load assumptions based on energy efficiency showed no incremental need.
[3] Based on generic combustion turbine capacity meeting requirements.

DETAILED DISCUSSION

California's renewable portfolio standard requires 33% of retail energy sales to be met by eligible renewable energy by 2020. This standard has triggered a tremendous surge in renewable energy resource development in California and the rest of the west. Several thousand megawatts of new solar generation, whose output can vary quickly, are expected to come on line in the ISO's balancing authority area in the next few years. As a result, more conventional generation will be called on to reduce output in the morning when solar generation comes on line and to increase output in the late afternoon as solar output wanes. Neighboring balancing authorities face similar increases in variable generation as developers there strive to meet contractual on-line dates. This surge in development has raised practical concerns about the ability and responsibility of each balancing authority to balance the variable output from renewable resources, including the need for additional flexible generation resources to compensate for the inherent variability of renewable resource technology.

In addition to renewable resource integration, there is another state policy objective scheduled for implementation during the 2011-2020 planning horizon: the State Water Resource Control Board environmental protection goal that will result in the retirement or repowering of 8,099 MW by 2018 and 12,079MW of once-through cooling plants by the end of 2020 according to the planning assumptions in the long-term procurement proceeding. Today the once-through cooling generation capacity significantly contributes to meeting local reliability requirements and at times provides as much as 80% of operating reserves, with an average contribution of 8%-14% of reserves and real-time balancing services.

These state policy objectives directly affect the quantity and type of generation needed to maintain reliability through the transition to 33% RPS and implementation of the state's once-through cooling policy and thus impact long term resource procurement by California load serving entities. Accordingly, one of the objectives of the current CPUC long-term procurement proceeding is to quantify the need for new resources to meet system or local resource adequacy over the 2011-2020 planning horizon, including issues related to long-term renewable integration planning and the need for replacement generation infrastructure to eliminate reliance on once-through cooling power plants. In addition to maintaining an adequate reserve margin, the CPUC anticipates that system requirements may be driven by the need to: 1) integrate renewable resources; 2) support once-through cooling policy implementation; 3) maintain local reliability; and 4) meet greenhouse gas goals. The system need determination is also a function of the CPUC assumptions regarding the levels of new energy efficiency and demand response that will be available to meet or reduce future needs.

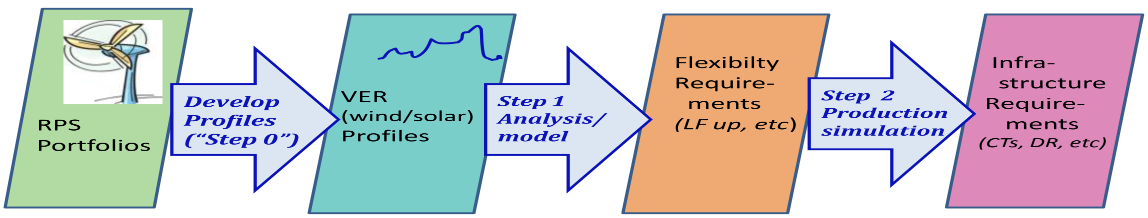
To assist the CPUC in making long term procurement decisions, the ISO conducted a preliminary analysis of system needs in 2020 assuming 33% renewable resources and presented the study results during workshops held in the summer and fall of 2010. The ISO then agreed to evaluate potential system needs using resource portfolio assumptions developed by the CPUC staff and described in a ruling issued in December 2010. These study results were recently submitted as testimony in the long-term procurement proceeding. In its testimony, the ISO also highlighted the need for further study using different assumptions about once-through cooling resources, load growth, energy efficiency and demand response.

REVIEW OF ISO ANALYSIS

Methodology

The ISO's study methodology of resources needed to achieve 33% renewable by 2020 employed an industry state-of-the-art methodology developed over four years in collaboration with industry experts. The methodology builds on the study method used in the 20% Renewable Integration Study published on August 31, 2010[4]. The study methodology is divided into steps. Step 0, the first step, is the development of detailed 1-minute load, wind and solar profiles for every minute of the year. The load and existing wind and solar profiles are based on actual operational data. The wind and solar profiles for future resources are synthesized based on the location, time, resource characteristics, wind variation and solar irradiance conditions. The profiles are then used as inputs into the Step 1 statistical analysis to calculate operational balancing requirements for regulation and load following. These requirements, along with hourly load and other operating reserves, are then used as inputs to a production simulation in Step 2 to assess the resource fleet's ability to simultaneously meet the hourly load, operating reserve, regulation and intra-hour balancing requirements.

Figure 1: Renewable Integration Study Process



The intra-hour balancing requirements are sometimes referred to as load following requirements but they reflect capacity that is flexible and is able to be dispatched to balance the system differences between hourly average net load conditions and average five minute net load condition within an hour. Regulation is balancing service that is responsible for balancing the difference between actual net load and the average five minute net load. Figure 1 illustrates the study process.

[4] Link 20% Renewable Integration Study: http://www.caiso.com/Documents/Renewables%20integration%20reports/Integration-RenewableResources-OperationalRequirementsandGenerationFleetCapabilityAt20PercRPS.pdf

Study Scenarios and Assumptions

The CPUC proposed seven scenarios for analysis, as summarized in Table 2 below.

Table 2: Scenarios Studies in CPUC Long-Term Procurement Proceeding

Scenario		Description
1	33% trajectory base load	Intended to model a future similar to the IOU's current contracting and procurement activities.
2	33% environmentally constrained	High solar and distributed generation
3	33% cost constrained	Focuses on resources that are lowest cost
4	33% time constrained	Focuses on resources that can come online quickly
5	20% trajectory	Intended to use for comparison
6	33% trajectory high load	Reflective of future uncertainties in load growth and/or program performance
7	33% trajectory low load	Reflective of future load uncertainties

Due to the procedural schedule, the CPUC prioritized and ISO agreed to analyze the first four scenarios. The ISO also studied scenario 6, the 33% trajectory high load, in order to establish a realistic "bookend" for its study results. The four priority scenarios all share the same load assumption, which includes CPUC assumption of more than 10,000MW of load reduction due to demand response and energy efficiency. The trajectory high load case assumes 10% higher peak load than the four priority scenarios to reflect any combination of future uncertainties (e.g., increased load growth and programmatic performance). Table 3 below summarizes and compares the load assumptions with the ISO all time peak load of 50,085MW in 2006 and 2010 peak load of 47,127MW.

Table 3: Peak Load Comparison

Load / Adjustment	All-time Peak (MW)	2010 Summer Peak (Mw)	CPUC assumption for priority scenarios 1-4 in 2020 (MW)	CPUC High Load Scenario 6 in 2020 (MW)
ISO system Peak Load	50,085	47,127	55,298	60,828
- Assumed New Energy Efficiency	Historical peak values reflect existing energy efficiency, demand response and CHP		5,687	5,687
-Assumed New Demand Response			5,145	5,145
-Assumed New Behind the Meter CHP			819	819
ISO net system peak	50,085	47,127	43,647	49,177

The four priority scenarios differ in the amount and technology mix of renewable resources expected to be added to the system. The 33% trajectory scenario reflects a mix of wind and large solar build out with moderate amounts of out of state resources. The 33% environmentally constrained scenario is a high distributed solar scenario containing more than 9000MW of distributed solar resources. The 33% cost constrained scenario contains the highest wind assumption of the four scenarios. The 33% time constrained scenario has the highest amount of out-of-state renewable resource imports. The 33% high load scenario is similar to the trajectory scenario except that it contains an additional 1,477MW of renewable resources. Table 4 summarizes renewable resource build out assumptions for the different scenarios.

Table 4: Renewable Capacity for Different Scenarios

Capacity (MW)	Location	Biogas	Biomass	Geothermal	Hydro	Large Scale Solar PV	Distributed Solar	Solar Thermal	Wind	Total
33% Trajectory	In-State	178	126	667	0	3,527	1,052	3,589	5,034	14,173
	Out-of-State	0	34	154	16	340	0	400	4,149	5,093
	Total	178	160	821	16	3,867	1,052	3,989	9,183	19,266
33% Env Constrained (High DG)	In-State	178	404	240	0	2,315	9,077	1,072	4,426	17,711
	Out-of-State	66	156	270	132	340	0	400	1,454	2,818
	total	244	560	510	132	2,655	9,077	1,472	5,880	20,529
33% Cost Constrained	In-State	168	291	797	0	1,549	1,052	1,279	5,559	10,696
	Out-of-State	73	129	202	14	340	0	400	5,639	6,798
	Total	241	420	999	14	1,889	1,052	1,679	11,198	17,494
33% Time Constrained	In-State	172	212	0	0	2,543	2,322	1,084	4,895	11,228
	Out-of-State	73	103	158	223	340	0	400	7,276	8,574
	Total	245	315	158	223	2,883	2,322	1,484	12,171	19,802
33% Trajectory High Load	In-State	178	126	1,591	0	3,684	1,052	3,589	5,450	15,670
	Out-of-State	0	34	154	16	340	0	400	4,149	5,093
	Total	178	160	1,745	16	4,024	1,052	3,989	9,599	20,763

All the cases assumed 12,079MW of once-through cooling resource retirements with approximately 2000MW of incremental planned resource additions in addition to the renewable resources build out.

Study Results

The ISO ran production cost simulations to determine the flexible generation needs for each of the five scenarios listed in Table 4. No system capacity shortfalls were identified in the four CPUC priority scenarios. However, 4,600 MW of incremental upward balancing need was observed in the 33% high load trajectory scenario, as well as approximately 800MW of downward balancing shortage. In addition to upward balancing needs, the ISO observed approximately 500-600 MW downward balancing shortfalls in the 33% trajectory and 33% environmentally constrained scenarios. While the magnitude and frequency of downward capacity shortfalls were limited, significant system costs can be incurred by maintaining downward flexibility when loading internal flexible gas resources and reducing more economic imports. As a result, we believe price responsive curtailment of renewable resource may be a more efficient solution to meet downward flexibility requirements. Figures 2 and 3 respectively show the upward and downward balancing shortages.

Figure 2: Capacity Needs to Meet Upward Balancing Shortages - 2020 Scenarios

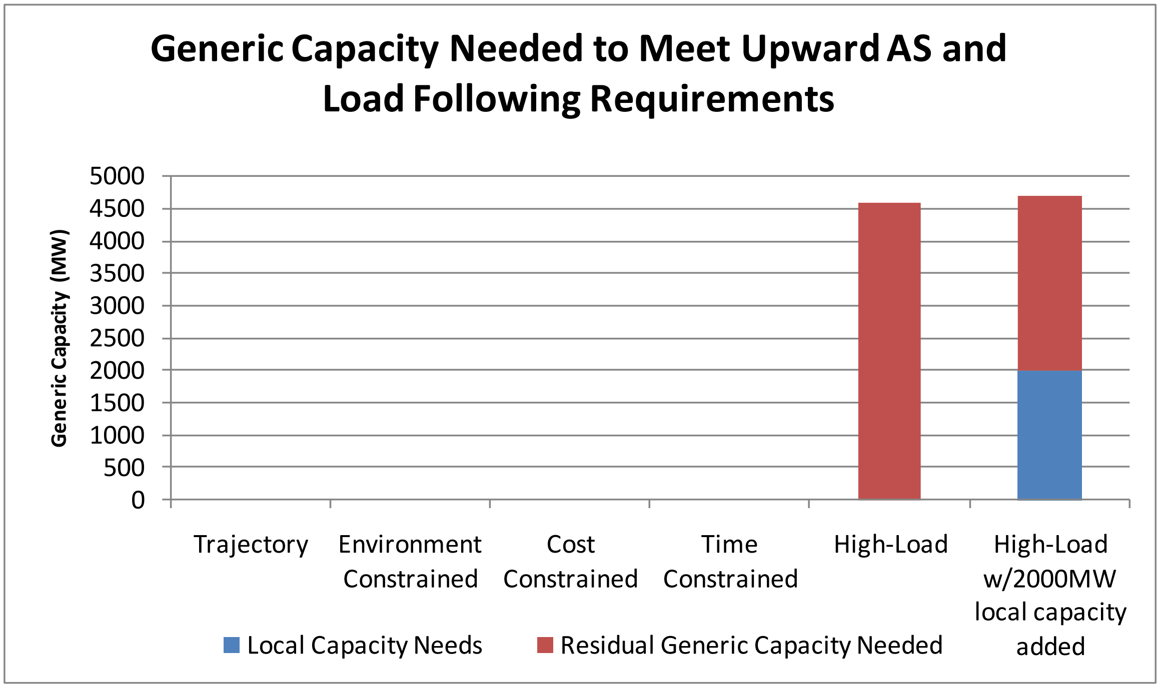
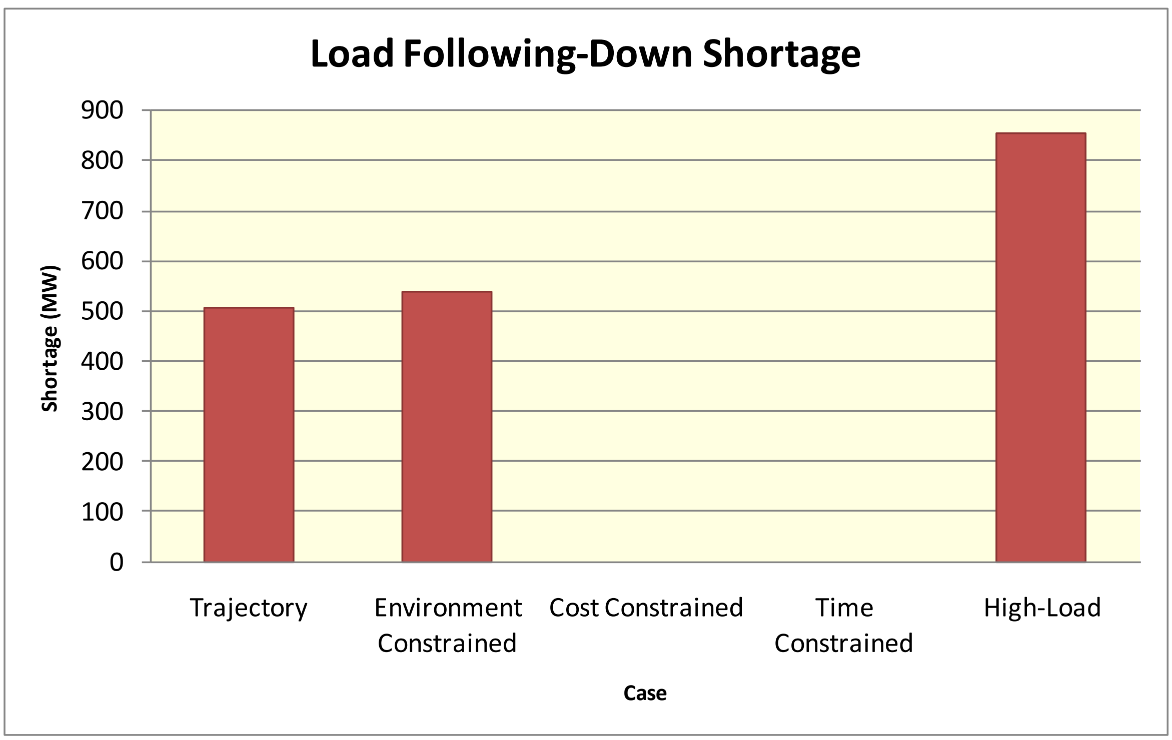


Figure 3: Downward Balancing Shortages - 2020 Scenarios



Local Capacity Requirements

Many of the once-through cooling resources scheduled for retirement are located in local areas containing large amounts of load. These areas require local generation to be available to maintain local reliability. The ISO is currently performing studies to determine the resources needed to replace the retired once-through cooling resources to maintain local reliability. Assuming these local resources respond to ISO dispatch instructions, these resources can also meet system operational requirements created by renewable integration. Although detailed local capacity studies will not be completed until the end of 2011, the ISO has performed some preliminary sensitivity analysis using the high load scenario. For the year 2020, based on load and resources estimates and previous ISO local requirement studies, an estimated 2,000 MW of additional local resources may be needed to meet the local reliability requirements. Assuming 50% of these needs are met by combined cycle resource additions and 50% are met by combustion turbine additions, a residual need of 2,700 MW remains for system operational requirements. This compares to 4,600MWof generic combustion turbines resources identified in the high load scenario that did not consider additional local capacity resources needed to meet local reliability after once-through cooling resource retirement (Figure 2).

CONCLUSION

These studies document that additional flexibility services are needed to maintain reliability with the higher levels of variable renewable generation to meet California's 33% renewable portfolio standard. The ISO's preliminary studies indicate that of the 4600 MW of upward ramping capability needed for renewable integration, approximately 2,000 MW is also necessary to meet local reliability requirements created by implementation of the state's once-through cooling policy. Management plans to expeditiously complete the additional analysis needed to determine the specific local capacity needs that will remain in 2020 once once-through cooling plants retire, and determine the additional flexible generation needs to support the reliability integration of 33% RPS.

Our preliminary results, however, provide a valuable starting point for policymakers. Meeting these needs may require new infrastructure in the form of new green field generation, repowered or technology enhancement to existing generation, new transmission infrastructure, or some combination of the three. All of these require significant lead time to bring on line.

As approximated in Table 5, developing new generation infrastructure has a significant lead time, including development of appropriate definitions of needed generation characteristics, incorporating them into a request for offers, and navigating related contracting, interconnection and permitting processes. In some cases, the process can be completed more quickly because owners of existing generation are already in the permitting process to repower their facilities, so are positioned to reach commercial operation earlier than others. Transmission infrastructure will likely take even longer given the planning required and the permitting challenges associated with linear facilities.

Table 5: Development Timeline

	2012	2013	2014	2015	2016	2017	2018	2019	2020
Long-Term Procurement Proceeding									
Request For Offers Design									
Request For Offers and Contracting									
Interconnection and Permit Preparation									
Permitting									
Construction									

The long lead times inherent in infrastructure development make management of the transition between now and when new infrastructure can be in service critical to system reliability achieving California's renewable generation and once-through cooling goals. To that end, Management intends to focus on:

1) Maintaining the availability of capacity currently on the system to enable successful operations during the transition period;
2) Accelerating ISO market design work to gain access to additional flexibility; and
3) Refining local capacity studies for 2020, incorporating the results in CPUC-directed scenarios, and providing the results to the CPUC in the current long-term procurement proceeding so that timely procurement decisions can be made in the 2011-2012 cycle.

We will continue to update the Board on our progress in these areas as our studies unfold and state regulators adopt key decisions on their view of the need for procurement of additional flexible generation.