Report on the Integration of Renewable Resources
Summary of Stakeholder Comments
December 2007

Background: In 2007, the California ISO undertook an engineering study to investigate key technical issues that must be addressed to integrate large amounts of renewable generation resources into the transmission system. CAISO engaged stakeholders to provide comments on the draft report, and utilized those comments in developing the final document. Below are the comments received by the CAISO, along with the disposition of each comment.

Topic Area	Submitter (name and company)	Comment submitted	California ISO response
Transmission Planning Issues Associated with Integration of Renewables	Ernest Hahn, Metropolitan Water District of Southern California (MWD)	The ISO's staff is to be commended for performing a much needed study that focuses on operating the grid beyond the first point of interconnection with large amounts of renewables. However: • more operational impact studies are needed during the initial transmission planning stages, rather than just focusing on the transmission costs. • The generator interconnection process should include operational assessments concurrently with impact studies	The CAISO does focus on system impact beyond the point of interconnection when doing all interconnection studies. Also, potential operation impacts are addressed by evaluating different operating conditions during normal and emergency conditions. The CAISO does not look at load following or regulation issues when doing routine interconnection studies.

		performed for generator interconnections. • Any major network upgrades required to support the interconnection should be the subject of cost-benefit analysis, including operational impacts.	
Transmission Planning Issues	MWD	As noted in the ISO's report, 20,000 MW of wind and 20,000 MW of solar are in the ISO interconnection queue. If only 20% of these renewables are developed, another 8,000 MW of renewables will create more operational problems than just 4,000 MW of wind at Tehachapi.	The operational issues are directly related to the type of renewable resources added to the system. 8,000 MW of geothermal generation would not be a problem as geothermal energy production is typically quite constant and can easily be scheduled on an hour to hour basis. 8,000 MW of intermittent resources such as wind and solar represent more of an operating problem as they can be difficult to forecast and schedule on an hourly basis. Therefore large amounts of additional intermittent resources will require additional studies on the operational impact.
Transmission Planning Issues	MWD	The CAISO should include operational assessments in its other planning studies, such as those undertaken to facilitate remote resource interconnections or reduce reliance on old thermal generation.	The CAISO does include operational assessment when necessary but not as detailed as was done for this integration study.

Transmission Planning Issues	Pamela Mills, San Diego Gas & Electric (SDG&E)	As the CAISO is currently studying the retirement of power plants with once through cooling as a separate study. Each report should document how the results of one study are or are not applicable to the other study. This should include how the various input assumption differ. Thus the report needs to clearly identify how these two studies are to be coordinated.	The CAISO is addressing this coordination issue in different forums including holding high-level meetings with regulatory agencies. This report assumes that the existing generation fleet is available to meet the additional integration requirements. The CAISO also pointed out that any conventional unit being replaced would have to have similar or even more flexible operating characteristics as the one being replaced.
Transmission Planning Issues	SDG&E	Since the CAISO only performed transmission studies for the Tehachapi wind generation, does the CAISO believe that these result are applicable to other areas, such as the Imperial Valley area as there are a number of renewable generators in the CAISO generator interconnection queue in this area?	The more diverse the locations where wind generation and other renewable resources are installed, the more we benefit from aggregation with a corresponding reduction in variability & uncertainty in the energy production. More data is required on the wind generation characteristics of the Imperial Valley area to analyze the similarities and differences between the two areas.
Transmission Planning Issues	SDG&E	If the CAISO is unsure how these results would translate to other areas of the CAISO Grid, the report should clearly state that additional studies are needed to determine the specific requirements of that area, such as the SVC & dynamic reserve requirements,	The transmission upgrade requirements for Tehachapi are unique to that area. The CAISO is currently reviewing the need for additional studies for other areas as well as the process for implementing the

		as well as any impacts to the necessary ramp up and ramp down requirements.	recommendations from the final report.
Transmission Planning Issues	SDG&E	The CAISO should include in the report, the process and timeline for completion of any additional studies that are needed.	The CAISO is currently reviewing the need for additional studies as well as the process for implementing the recommendations from the final report. Decisions and work plans for future studies will be shared with the stakeholders when they are available.
Transmission Planning Issues	SDG&E	The base case assumptions and any associated workpapers should be available on the CAISO website, so that stakeholders can review these inputs and provide comments.	Most of the information relating to generation assumptions is confidential. In order to share the data SDG&E would have to obtain NDA with 20 to 30 generation projects in the Tehachapi area.
Transmission Planning Issues	SDG&E	The report states the CAISO studied the 2010 Heavy Summer Peak load and the 2012 Light Spring load system conditions. Is the CAISO confident that these studies are comprehensive such that it will cover the wide range of operational conditions? Additionally, the report could go further in documenting during the light load conditions how reliability can be maintained with high wind generation. How much wind can be integrated while maintaining reliability?	The CAISO believes that the two base cases used for the analysis are fairly representative of expected extreme operating conditions. Also, the Planning and operating engineers were confident that the various sensitivities and contingencies studied were comprehensive enough. The CAISO believes that grid reliability under light conditions is adequately covered in the transmission and over-generation sections of the report.

Transmission Planning Issues	SDG&E	The report does not state what, if any, impact on the Southern California Import Transmission (SCIT) nomogram there is from the addition of significant amounts of wind generation.	The CAISO engineers performed detailed studies based on transient stability and post transient voltage stability studies and no criteria violations were noted.
Transmission Planning Issues	SDG&E	The CAISO states on page 19 “Major new transmission facilities and upgrades of the existing transmission will be required, for the 20% RPS target and especially to accommodate the 33% RPS target.” Does the CAISO have a list of these major new transmission facilities that will be required for the 20% goal and which are required for the 33% goal? Is the Sunrise Powerlink assumed as one of these facilities?	The CAISO was quoting one of the assumptions of the CEC Intermittency Analysis Project study that was prepared by GE Consulting. The list of new transmission facilities required for the Tehachapi area is included in the Integration of Renewables Report.

Transmission Planning Issues	SDG&E	The CAISO states on page 20 “Regulatory policies that present barriers to the successful development of renewable resources must be identified and eliminated wherever possible.” Has the CAISO identified any of these regulatory barriers? If so, what actions does the CAISO plan on taking to eliminate these barriers?	An example is the WECC scheduling practice of doing block hour interchange schedules. The transfer of energy from intermittent resources such as wind generation will vary substantially over a one hour period. If the WECC scheduling process was changed to allow 30 minute interchange schedules between BA’s for moving wind generation energy, then it will be easier to schedule the energy and it would reduce the regulation burden between balancing authorities. This response was added to page 21 of the report.
Transmission Planning Issues	SDG&E	On pg 34 (pg 42 in the final report) the CAISO lists the contingencies performed for the post transient voltage deviation analysis. It is recommended that since DPV2 and the Sunrise Powerlink were modeled, that these contingencies (Imperial Valley to Central 500kV for Sunrise) be studied for impacts.	The CAISO Planning engineers looked at these and determined that they had no impact on the study results.
Transmission Planning Issues	SDG&E	For the contingency on page 35 (now page 43 of the final report), SONGS G-1-1 (one SONGS out of service initially, system readjusted, followed by the second unit outage), what was the system readjustment? If there was no system readjustment this contingency should be corrected to state	The contingency is really an N-2. There was no system adjustment. This is updated on page 43 of the final report

		SONGS G-2 (two nuclear units) outage.	
Transmission Planning Issues	MWD	The CAISO Board, regulators, and market participants need to know the full cost of implementing proposed policies in order to fairly assign cost responsibilities.	The issue of the cost of implementing the state's 20% RPS is beyond the scope of this study. This study is focused on the engineering issues associated with the expansion of the transmission system and the operational impact of the additional wind generation planned for the 20% RPS. Significant additional work would be required to develop market models that could predict energy and ancillary services prices & the financial impact of large amounts of renewables. Under the legislation that requires the IOU's to meet the 20% RPS, the IOU's are required to show which contracts meet the "least cost/best fit" criteria. The CAISO's role is to determine how the grid can be operated reliably to meet the 20% RPS.
Transmission Planning Issues	Edward G. Cazalet Megawatt Storage Farms, Inc. (MWSF)	Storage devices such as batteries can be located anywhere on the grid (and can be moved) to support the dual needs of integrating intermittent renewables and mitigating congestion. Mitigating congestion includes deferring or eliminating the need for transmission upgrades near the renewables generation, and for transmission and distribution upgrades near the loads. How	The CAISO agrees that storage facilities can provide a number of benefits that will help with the integration of large amounts of renewable resources. Storage provides a mechanism for saving off peak energy production from wind generation and delivering the energy during on-peak periods. Some storage

		will the CAISO assist storage resource developers in locating the storage resources to meet these dual needs, as well as providing for capacity payments based on location?	technologies can also provide ancillary services such as regulation and contingency reserves and reactive power for voltage support. The major barrier for construction of new storage facilities is not the technology but the absence of market mechanisms that recognize the value of the storage facilities and financially compensate them for the services and benefits they can provide. The CAISO should work with the IOU's, stakeholders, and potential providers of storage technology to design market products that properly compensate storage facilities for the benefits they can provide This comment will be added to the storage section of the report.
Transmission Planning Issues	MWSF	The report suggests that additional transmission control devices such as SVC's, reactors, and capacitors may be needed. The contributions of fast response of the power electronics on battery and flywheel storage could also be part of the solution. Alternatively, instead of a multiplicity of device types, it may be feasible to add burst power capability to battery storage to permit some multiple of normal output for short durations. The storage operator would need to be compensated accordingly due to higher initial system cost and shortened battery	A very innovative idea. This concept should be included in the market design for storage technology workshop suggested above.

		lifetime arising from high power bursts.	
Transmission Planning Issues	Gary Chen, Southern California Edison (SCE)	In order to provide review for a study of this complexity, CAISO should publish all the work papers and assumptions. Without the benefit of this study material, it appears to that many of the assumptions used in the Draft Report may not be valid and/or may not reflect real-world conditions including the specific data corresponding to generation interconnection requests already in the queue. For example: • The Draft Report assumed that all existing thermal plants remain on-line & concluded that additional units will be needed to meet regulation requirements. However, policy issues re: "once through cooling" could result in decommissioning of many of the existing fleet of steam generators which are crucial for load following, ramping and regulation. • Additionally, many of the existing plants are quite old and may need repairs at some point in the future. Because they are owned by multiple parties, there is no guarantee that those parties will find it economic to maintain the plants operational and the plants may simply be retired.	The CAISO shares SCE's concerns that some of the existing thermal power plants may be permanently shut down for a variety of reasons including "once through cooling" restrictions, other environmental reasons and economic reasons. The CAISO is working with state agencies and regulators to encourage the continued availability of these plants until they can be replaced by new facilities that provide the needed operating flexibility for successful integration of large amounts of intermittent resources.

		• The Draft Report does not indicate how the new resources would be constructed, by whom, and how the costs would be allocated to customers on the grid. This is especially troubling given the size and complexity of the CAISO queue and the 2010 date the CAISO assumed in the Draft Report. It is unrealistic to assume any meaningful amount of the new generation identified by the CAISO can be online by 2010. • The CAISO also makes a significant and challengeable assumption that all existing generation will remain available during this time frame. This assumption is in direct conflict with the separate study initiative recently proposed by the CAISO on the "Mitigation of Reliance on Old Thermal Generation."	
Transmission Planning Issues	SCE	Further, SCE recommends that the Draft Report's assumptions be updated to be consistent with the year Tehachapi is expected to be in service, e.g. 2013-2014. Throughout the Draft Report, the CAISO has used 2010 as the relevant date of the study assuming renewables will be at 20%. Due to the lack of transmission available for interconnecting numerous renewable	The CAISO has eliminated the references in the report to the year 2010 and replaced it with 20% RPS target. We agree that reaching the 20% RPS target is dependent on the transmission upgrades that must be completed for interconnection of the new renewable resources so the energy can be delivered to loads.

		projects, the IOUs have represented that it is unlikely to achieve meter spin of 20% renewables by 2010.	
Transmission Planning Issues	SDG&E	Given that the report talks about meeting the 20% renewable goal in 2010 & the two study assumptions are a 2012 Light Spring case & that the build out at Tehachapi is expected to be in service around the year 2013, the report could be misconstrued as indicating that the Tehachapi generation will be available by 2010 & that only this generation is required to meet the 20% goal by 2010. The CAISO should revise the language to clarify these issues and assumptions.	The CAISO has revised the report to more clearly state that the integration is dependent on the transmission upgrades. Also, all reference to 2010 has been removed.
Transmission Planning Issues	SCE	The underlying assumptions used in the power flow & stability studies are not clear. SCE would like the CAISO to provide a list of all generation & transmission assets & assumptions used for the studies including, but not limited to: • Load – Study should utilize appropriate in-service date of the Tehachapi Renewable Transmission Project (2013-2014) and light load assumptions should be consistent with values expected during spring conditions during the times of high wind generation (super off-peak). This study should include those light load conditions were "must-take" generation is	The underlying assumptions in the heavy summer power flow base case were agreed to by SCE during the initial studies to evaluate the necessary Tehachapi transmission upgrades. As stated above, the Tehachapi integration is highly dependent on the completion of the transmission upgrades. Also, all reference to 2010 has been removed from the final report. The CAISO has recommended that all new turbines should be of Type 3 and Type 4. Any installation other than

		in excess of load. • Wind Turbines – Study should assume generation mix corresponding to data submitted by wind developers pursuing interconnection of new generation projects. The study appears to assume two scenarios: a) GE turbines only and b) a turbine mix of 10% Type 1, 70% Type 3, and 20% Type 4. Based on the data provided for new wind generation projects through their corresponding interconnection request, the mix should represent 21% Type 1 (includes existing and some new), 24% Type 2, 35% Type 3, and 20% Type 4. • Transmission Topology – It is unclear if additional transmission was included to support renewable resources to be located in other areas beside Tehachapi. In addition, the study should include scenarios with and without the DPV2 and Sunrise projects.	Type 3 or Type 4 would have to meet the FERC and the WECC criteria.
Transmission Planning Issues	Brian Hitson, Pacific Gas & Electric Company (PG&E)	Assumptions Regarding Current Resources Should Be Carefully Reviewed - The CAISO draft report concludes that additional ramping and regulation capacity would be needed, but that "the CAISO current generating resources seem adequate to meet these	The generator master file is available on the CAISO web site and it lists all the generators available in the operating area. The ramp rates of these units are considered confidential information and therefore can not be

		requirements." PG&E recommends the CAISO publish an inventory of the current generating resources that the CAISO assumes, in its draft report, will be providing such ramping and regulation capacity. Such an inventory will enable a confirmation that the integration of renewables is indeed feasible, and to provide guidance to ensure that the proper amount and type of new resources can be procured and constructed in time. This is important, as the existing thermal generators in California continue to age and some may eventually be retired.	publicly disclosed. Chapter 5 section 5.8.5 of the final report states the total capacity of resources certified to provide regulation service.
Transmission Planning Issues	SCE	The Draft Report should, but does not point out that a policy decision is needed to clarify who is the responsible party to determine the Type of wind turbine that will be procured & connected to the CAISO controlled grid. Currently SCE modeled as part of TRTP a mix of wind turbine Types that resembles the generation interconnection queue. From a planning perspective SCE believed that this is the only reasonable assumption that could have been used. If the generator is responsible for making the decision on turbine Types, & they decide on a heavier mix of Type 1 & 2 machines, then SCE may not have enough reactive compensation planned for TRTP. If the generators decide to install primarily Type 3 & 4 machines, then	The CAISO will make it clear in the Executive Summary that the CAISO's role is to ensure all new wind generators meet LVRT and voltage control standards. The generator owner/operator has the responsibility of selecting the appropriate equipment to meet those standards.

		SCE may have too much reactive support planned. SCE assumed the generators will be making this decision. SCE expects CAISO to provide clarity on who is responsible for making the decision on the Type of wind turbines that will be connected to the CAISO grid.	
Transmission Planning Issues	SCE	The Draft Report does not appear to address a number of technical issues. These issues are critical to understanding how integrating intermittent resources affect SP15. Such issues include: • Impacts of large amounts of wind resources on the Southern California Import Transmission (SCIT) nomogram since wind generation does not contribute significant amounts of inertia to the electric system. Induction motor load composition (especially in the Tehachapi & SP-15 area) for the stability analysis in order to estimate the required mix of static and dynamic reactive requirements to meet CAISO/WECC Grid Planning criteria for the four types of wind machines modeled in the study. Sensitivity studies varying the load composition are required to better understand what type of ancillary services (reactive) may be needed	The CAISO engineers performed detailed studies based on transient stability and post transient voltage stability studies and no criteria violations were noted. The CAISO engineers conducted the studies using the WECC standard of 20% induction motor loads.

		to successfully integrate 4200 MW of wind.	
Transmission Planning Issues	SCE	The conclusions reached in the Draft Report may be inaccurate because the outputs are directly linked to the inputs. The study inputs relative to turbine type appear to be optimistic. SCE would like to request that the specific recommendations made in the draft report be reevaluated with consideration of most current information and assumptions available. Specifically, • Conclusion #9 (page 7) stating that "the proposed SVCs were not necessary to achieve acceptable transient stability performance with a likely mix of wind turbine generator technologies" will likely change to be consistent with the previously published CAISO's South Regional Transmission Plan (CSRTP)-2006 when the specific data for the turbine generators requesting interconnection are used. • Conclusion #11 (page 7) stating that Tehachapi area may be highly compensated will also likely change when the new wind projects properly reflect the data provided by the wind developers seeking interconnection.	Acknowledge, and this issue should be addressed by future joint studies with the CAISO and SCE.

Transmission Planning Issues	SCE	The recommendations made in the Draft Report may be inaccurate once the study is reevaluated with the consideration of most current information and assumptions available. Specifically, • The recommendation (#2 page 8) for wind developers to only utilize Type 3 and Type 4 generators may not be consistent with FERC Order 661A. FERC Order 661-A requires that all new wind plants meet specified under-voltage ride-through requirements; however, Order 661-A does not require a specific turbine type. Additionally, FERC Order 661-A requires the utility to prove that power factor correction (metered at the point of interconnection) is required but does not specify whether such power factor correction should be switched or dynamic in nature. The key is for the CAISO to specify windpark requirements or criteria and not specific turbine requirements. • The recommendation (#3 page 8) for re-evaluation of the optimal location and size for the dynamic reactive support (i.e., SVC) proposed as part of the TRTP project may not be necessary once corresponding study assumptions and technical data used to represent queued	The CAISO will make it clear in the Executive Summary and in its recommendations that the CAISO's role is to ensure all new wind generators meet LVRT and voltage control standards. The generator owner/operator has the responsibility of selecting the appropriate equipment to meet those standards. The report also stated that a portion of the power factor installation must be dynamic. Acknowledged, and will be addressed by future joint studies with the CAISO and SCE.

		wind generation projects are updated. • The recommendation (#4 page 8) to analyze the best solution for improving the nose point of the Q-V analysis may not be necessary once the corresponding study assumptions and technical data used to represent queued wind generation projects are updated.	
Transmission Planning Issues	SCE	The Draft Report discusses additional studies to optimize the voltage support. There is no time line specified to complete these studies. If CAISO needs additional time to perform further studies as mentioned on pages 24 and 25 (i.e. items 7, 8, 11 and 4) it is not clear how this equipment can be installed to meet the 2010 operating date.	The CAISO planning will coordinate additional studies with SCE planning engineers. All reference to 2010 has been removed from the report.

Transmission Planning Issues	SCE	The study also assumes the operation of Helms pumps. The Draft Report identifies that the three pumps were operated for less than 3% of the time. It is not clear for what percentage of time these three pumps need to be operated to integrate the wind resources. Is there a correlation between wind generation and Helms pumps operation? The Draft Report claims that PG&E has proposed a transmission upgrade plan for this area that would enable the operation of these pumps for additional hours. It is our understanding that this project has a proposed operating date in late 2012 and the plans have not yet been reviewed and approved by the CAISO. It is premature to assume that that the Helms pump operation can mitigate the problem until this proposed plan of service is built & energized.	The fact that wind generation is predominately a night time or off peak resource means that there is a significant potential role for energy storage. Storage could provide the added off-peak load needed to absorb excess wind energy and then it could deliver this energy during peak load period. The goal in the report was to make a case for new storage capability to assist with the integration of large amounts of wind generation. The Helms Pump Storage plant is a proven resource that is readily available to partially meet this need. The CAISO intends to work with the plant owner/ operator to determine how many added hours of 3 pump operation can be achieved after completion of the transmission upgrade in the Fresno area.
Transmission Planning Issues	SCE	There appears to be a discrepancy, which needs to be corrected, in the amount of wind resources that can be supported in the Tehachapi area. Under the Conclusion section on page 6, it is stated “The proposed Tehachapi Transmission Project can support up to 4,200 MW of wind generation in the Tehachapi area, …” while under the Summary section on page 11 it is stated	This discrepancy has been corrected in the final report to correctly state 4,200 MW.

		"The planned $1.8 billion of transmission upgrades for the Tehachapi area are sufficient to support up to 5,000 MW of new renewable resources."	
Transmission Planning Issues	SCE	It seems that the changes proposed, on page 39, related to Generation Interconnection Standards is misplaced in this Draft Report. It is not clear how the suggestions identified under this section relate to wind integration.	The discussion of Generator Interconnection Standards was moved to page 47 of the final report. SCE is correct that the discussion pertains to interconnection of all large generation facilities, not just wind generation or other renewables. The management of the interconnection queue is a hot topic and a focus of intense discussion. The CAISO decision was to include this topic as a part of the transmission plan discussion.
Transmission Planning Issues	Nancy Rader California Wind Energy Association (CalWEA)	CalWEA would like to thank the CAISO for drafting a wide-ranging and impartial report, "Integration of Renewable Resources" (CAISO Report). The CAISO took on the responsibility to perform a restudy of the Tehachapi Renewable Transmission Project (TRTP) based on updated and more realistic assumptions about wind generation technologies that are expected to be employed in the Tehachapi Wind Resource Area (TWRA). CalWEA appreciates the conclusion of the CAISO Report that the Tehachapi Transmission Project is	We appreciate CalWEA's feed back and comments. Installation of Type 3 and Type 4 wind generation facilities certainly provide better voltage control and more certainty of meeting the LVRT standard.

		technically sound and can support 4,200 MW of wind generation in this important wind resource area. Given recent trends in the wind industry in California and nationally, the CAISO should assume that most of the new wind turbines to be installed in the Tehachapi wind resource area will be Type 3 and 4 generators, thus providing adequate dynamic reactive support to meet applicable WECC transient stability performance standards.	
Transmission Planning Issues	Larry Chaset & Keith White California Public Utility Commission (CPUC staff)	It would be helpful to have a fuller description of what the WECC 2010 Heavy Summer peak load and 2012 Light Spring load cases represent in terms of generation and transmission changes from today. It would also be helpful to address the following questions: • In what ways (and with what likelihood) could actual conditions during these periods differ from what the WECC cases imply, in a manner that would significantly affect the conclusions? • Do we know what levels of California and west-wide intermittent wind generation these cases reflect, and what are the implications of higher levels of wind generation coming on line?	The WECC basecases are available on the WECC website at: www.wecc.biz/modules.php?op=modload&name=Downloads&file=index&req=viewsdownload&sid=153. Most of the information relating to generation assumptions is confidential. In order to share the data, each recipient of the data would have to obtain NDA with 20 to 30 generation projects in the Tehachapi area. The CAISO believes that the two basecases used for the analysis are fairly representative of expected extreme operating conditions. Also, the Planning and operating engineers were confident that the various sensitivities and contingencies studied were comprehensive enough to uncover potential problems.

		• When large amounts of new wind generation were modeled in the Tehachapi area to test the adequacy of the proposed transmission plan of service, what other generation/power flow was backed down from the WECC case levels, and (how) would this power flow back-down impact the conclusions in the Draft Report? • Where was the 3540 MW of new wind generation assumed to be located within the Tehachapi area, and (how) would a different plausible distribution affect the conclusions in the Draft Report? Finally, can the CAISO identify other geographic areas where the transmission system is likely to be stressed by new renewable generation in the next five years that may deserve similar attention in subsequent studies, or that might impact the conclusions in the Draft Report applicable to the Tehachapi area?	No, the levels of non-CAISO and west-wide wind resources were not the focus of the study and would not have impacted the transmission conclusions in this report. Remote resources were adjusted. The remote units adjusted do not affect the analyses outlined in Chapter 3. This information is confidential. The resources modeled were obtained from the CAISO generation queue and is consistent with the resources modeled in the CAISO South Regional Transmission Plan for 2006 (CSRTP-2006) which was done in full collaboration with SCE and other CSRTP-2006 participants. Other potential geographic area that are likely to be stressed in the next five years were not analyzed in this study.
Transmission Planning Issues	Brendan Kirby, American Wind Energy Association (AWEA)	Advances in wind turbine technology have helped in integrating wind into the power system. In this most recent study CAISO found that with the dynamic reactive capability of Type 3 and 4 modern wind turbines power system transient stability can	The CAISO agrees that advances in wind generator technology have significantly reduced the grid integration issues. New Type 3 and Type 4 units meet LVRT standards and new unit controls even enable the

		be maintained with fewer and smaller SVCs and capacitors than previously planned for when integrating 4,200 MW of wind in the Tehachapi area. It will be important to find ways to encourage the use of advanced wind turbine technology to assure that these power system reliability and cost benefits are realized. This should not be difficult as it aligns with trends within the wind industry.	operator for provide other grid services. The CAISO would certainly like to encourage the installation of Type 3 and Type 4 wind generation technology.
Grid Operations Issues	MWD	Many conclusions are reached without sufficient identification of assumptions or support, e.g., "Needed integration services can be provided by Hydro IF there is enough water, Existing thermal IF it is kept operating at certain levels, New thermal IF it has the right characteristics." [1] More details should be provided on the assumptions for quantity & location of existing thermal or hydro resources that are assumed to provide "integration services."	This is covered in Chapter 5 section 5.8.5. A future quantified study will be needed to provide the specificity MWD suggests
Grid Operations Issues	MWD	Increased Ramping, Regulation & Load Following Requirements: • The ISO should identify increased requirements on an average basis by regions & the amount that is assumed to be provided by existing resources.	The CAISO believes sufficient market based resource will be available to meet the requirements we have identified as essential for the integration of large amounts of renewable resources for the 20% RPS.

[1] See 9/26/2007 ISO presentation "Achieving California's 20% Renewable Portfolio Standard" at slide 7.

		• In addition, the ISO should identify the market participation in Ancillary Services pre-MRTU from existing resources. • If the ISO is experiencing supply deficiencies today, it should explain how or why it believes it will obtain the significant increases in integration services which will be required to accommodate significant increases in intermittent generation?	If substantial amounts energy from renewable resources are imported from other BA's, then the locational requirements for the Ancillary Services may be more of an issue. The future deployment of new storage technology systems may also provide some of the required A/S for integration of renewables.
Grid Operations Issues	MWD	Over generation: • The ISO should identify whether LMP will provide different price signals at nodes where a large amount of wind is injected. • Is the ISO proposing that LMP be negative during over generation conditions and will generators pay that negative LMP - if not, why not? • Additionally, it is unclear how the ISO will curtail over generation if insufficient reductions are made in response to LMP. • A pro-rata reduction among all supplies may exacerbate the problem of over generation or require more "integration	A large amount of wind generation at the grid interconnection point will certainly impact the LMP at that node. In an over-generation condition, the system market clearing price may go negative. The LMP price of any generator may also go negative but the price is also determined by the congestion costs. CAISO Operation Procedure G-202 describes the process for doing pro-rata cuts if there are not sufficient market based resources for mitigating the problem. The Pro-Rata Reduction Tool is used to determine each SCs required reduction.

		services" by curtailing hydro and wind equally. For example: o hydro resources with dependable water and synchronous units can help supply reactive support and ramping whereas wind units don't. o In addition, existing hydro and QFs may be categorized as "Must Take" or needed for local reliability reason, and therefore would not be subject to over-generation curtailments. o Thus, the ISO should examine the extent of such limitations in order to gain a better assessment of curtailment options	Our expectation is that MRTU will produce more accurate day-ahead generation schedules and this will reduce the number of occurrences of an over generation condition. If, however, we have a lot more wind generation show up in real-time than has been forecasted, then there is a potential for an over generation problem. If the market is providing sufficient supplemental energy DEC bids, then the problem is handled with the market redispatch tools. If there is insufficient market resources, then & only then will some generation have to be curtailed on a pro-rata cut basis to insure system reliability. Any pro-rata cut in generation due to over-generation will be consistent with the CAISO's published over-generation procedure.
Grid Operations Issues	MWSF	Adequacy of Existing Resources - The study indicates that existing resources can accommodate the renewables integration needs, but it does not address whether added renewables may speed the retirement of existing units & whether more new fast response capacity such as storage may then be needed for both reliability and economics.	The CAISO agrees that the addition of sufficient new thermal generation resources that have fast start up and shut down capability, fast ramping, and AGC capability could speed the retirement of existing units that are uneconomical or have significant environmental issues. New storage capability could also provide essential

		More on this under theme: Grid Operations Issues/Storage Technology	grid resources for meeting peak loads and other benefits. The portfolio of required generation resources will be a continuously evolving picture that needs to be annually reassessed.
Grid Operations Issues	MWD	New resources - New wind generators will be required to meet LVRT standard of WECC. The ISO should also require type 3 or 4 for new wind turbines as part of an interconnection standard or require a non-conforming wind generator to pay the resulting increased integration costs.	New wind generation resources will be required to meet the interconnection standards.
Grid Operations Issue	MWSF	New Generation Resources - If most new generation is renewable and there is retirement of existing thermal, how will the mix of fast response and energy producing generation be procured?	This is a major concern that we have pointed out in the report and in the presentations of the findings from this study. There must be a balance between the amount of new renewable resources and the other generation resources that will be required to facilitate the integration of the new renewable resources.
Grid Operations Issues	PG&E	The Operating Characteristics of New and Existing Resources - It appears the CAISO may have over estimated the ability of existing resources to compensate for the effects of increased renewable penetration. If this is the case, then the CAISO will have underestimated the impact and costs of	The CAISO believes we have accurately gauged the ability of the existing resources to accommodate the variability of the renewable resources. If we are wrong, then we may have to impose ramp rate limits on the renewables to limit their impact on the

		renewable integration.	grid and stay within the capability of the other resources to move to accommodate the variability of the renewables.
Grid Operations Issues	PG&E	The CAISO may have Overstated the Flexibility of PG&E's Helms Pumped Storage Hydroelectric Project: • The draft report makes several references to PG&E's Helms Pumped Storage Hydroelectric Project. Specifically, the draft report discusses how Helms may be integrated with new wind generation in Tehachapi. However, Helms operation is integrated with PG&E's existing generation & demand side portfolio to meet PG&E's electric load obligations reliably & at least cost. Using Helms principally as a "sink for the excess off-peak wind energy" is not consistent with least cost dispatch. In addition, Helms pumping typically occurs in the spring. Helms may not be incrementally available to absorb excess wind energy produced in the off-peak hours when future off-peak issues are expected to become most severe. • Also, Helms has several operating constraints including: 1) turbine efficiency	The CAISO appreciates PG&E's clarifying comments on the operation of the Helms Pump Storage plant. As the owner and operator of this facility, no one else knows more than PG&E what this plant is capable of doing and its operating limitations. The CAISO would like to work collaboratively with PG&E to see what changes could be made in its operations to help with the integration of the large amount wind generation expected on the system in the near future. We are also aware that Helms does not provide regulation services when it is operating in pump mode.

		curves that result in units usually generating at more than 200 MW, 2) a 30-minute lag between successive pump starts, 3) a limitation of one start per day in each mode to minimize loss of service life. Further, Helms has a lower efficiency when multiple units are pumping, & the amount of pumping available may be limited by hydro conditions & runoff. • In addition, as the draft report notes, individual Helms pumps can only operate at 300 MW or off-line at 0 MW. Therefore Helms pumping, which typically occurs off-peak, does not contribute to solving the regulation issue.	
Grid Operations Issues	PG&E	Operating Flexibility of PG&E's Existing Conventional Hydro Electric Power Plants may be Overstated, as Well: • The ability to use the existing hydroelectric system to meet future ramping and regulation requirements is limited. Limitations occur for a variety of reasons. FERC requirements limit the daily fluctuations from some plants during various seasons, particularly when fisheries and/or recreation would be adversely impacted. When spill is expected to occur, or is occurring, plants are operated at full output to maximize	The CAISO appreciates PG&E's comments on the operating limitations of the Northern California hydro generation facilities. PG&E has operated these facilities many years and managed the associated water sheds. The CAISO is committed to working with PG&E on ways the hydro resources can be optimally used to provide the least cost energy solutions and assist with the integration of large amount of intermittent resources.

		the value of the output. During these periods ramping and regulation are not available. Optimization of watersheds over a yearly period causes the water to be used when it is most valuable, and hence providing ramping or regulation when wind energy is most variable, may not be consistent with least cost dispatch. Overhaul of units, and outages, also limit the ability of units to provide ramping or regulation. PG&E is concerned that the hydroelectric system may not be able to provide ramping or regulation to accommodate an influx of intermittent resources. Spilling of water past plants for short periods of time, resulting in rapid fluctuations in river flows, may not be allowed per FERC license requirements. • Finally, if additional fossil units must be operated to provide the regulation & load following services needed to effectively integrate additional wind generation into the grid in a reliable manner; this could result in the spilling of hydro.	
Grid Operations Issues	PG&E	Operating Assumptions For Conventional Steam Units From Which PG&E Purchases Power Are Not Fully Analyzed: • Significant ramping and load following is	The CAISO appreciates PG&E's comments that further detailed analysis of existing and planned generation resources may be required.

		currently provided by these units during certain times of the year. While these units have ramping and load following capability and such operation may be used to support intermittent wind generation, it does so at a cost – the cost of burning natural gas, and the added wear and tear on the equipment. Another uncertainty is whether these units will be retired and replaced by newer technology such as combined cycles or combustion turbines, which may not have operating characteristics that fully support integration of intermittent wind generation as noted below. • Further, changes in the operation of gas-fired generation affect the operation of the interstate and California gas transmission system. The operation of gas-fired generation must be in compliance with the FERC-approved tariffs of interstate pipelines, and the CPUC approved tariffs of California's gas utilities. This is especially relevant with respect to nomination and balancing provisions.	
Grid Operations Issues	PG&E	Operating Characteristics of New Resources may not Have the Same Flexibility As Current Resources:	The CAISO shares this concern and it is our hope that new thermal generating facilities will be specified to have faster start up times, more easily

		• New conventional resources, typically combustion turbines and combined cycle facilities, are not expected to have ramping capacities or operating characteristics similar to those of the existing steam units. New combined cycles and combustion turbines are most efficient at full load and may have emissions issues at partial load. • Operation of these newer facilities in conjunction with least cost dispatch is expected to result in operation at or near full energy production capacity, limiting their ability to provide regulation. The economics of these units will drive them toward daily cycling, limiting the opportunity to use them to provide regulation or load following during the off-peak hours. Also, least cost dispatch of combustion turbines is expected to result in their commitment for peak energy needs, not for morning or evening ramps or ancillary services.	accommodate shut downs at night, and have wider operating ranges than some of the CCCT units that were installed in the last 10 years. Future thermal units should be specified to have operating characteristics that can meet environmental constraints while operating over wider production ranges.
Grid Operations Issues	PG&E	The CAISO Should Consider the Changing Character of Resources in Future Years: • The draft report notes the "regulation capacity requirements would increase noticeably during certain hour ranges" and a greater a larger bid stack will be	We share this concern and appreciate PG&E's comment and observation. We need to pursue all sources for additional regulation services including new generation facilities, storage facilities and loads that can respond to

		necessary. Many of the conventional steam units which provide these services are expected to be retired from service just as these needs increase. The economic use of new resources is not expected to allow them to provide significant amounts of these services. • Therefore, the CAISO should carefully evaluate current sources of ancillary service and the bid stacks. Some of these sources maybe retired just as the need for them increases. Sources the CAISO is assuming will be available may in fact not be available in the future to the CAISO because of equipment limitations, various environmental or regulatory limitations, or economic limitations.	an AGC regulation signal.
Grid Operations Issues	SCE	SCE would like the CAISO to perform a scenario with maximum wind generation online, with minimum imports, and minimum thermal generation on-line, to determine how the system will perform if the wind speed drops down to a minimum value where all the wind output is shut-off in a 10 minute window. This might require keeping more units on automatic generation control (AGC) to pick up the lost generation. It is not even clear whether thermal units can pick up all the lost generation, before a potential voltage	In our experience, we have never seen all the wind generation suddenly ramp to zero or a very small number. The wind generation resources are spread over a very large geographic area and it is very unlikely the wind would suddenly stop blowing in all areas at the same time. The wind in an area may die down over a 1 to 2 hour period and we have seen 700 MW ramps in 30 minutes. We have also seen over speed cut outs of wind farms with the

		instability problem drops the load.	wind exceeds the maximum turbine rating. Even with the large wind generation build out over the next several years and a concentration in Tehachapi, the loss of 2000 MW or more seems extremely unlikely and that is still with the acceptable generator contingency range for the CAISO.
Grid Operations Issues	SCE	In general, the study results that identify additional regulation, ramping and load following capability should be clarified to specify the existing capability and the additional capability required for renewable resources integration. For example, if an additional 170 MW to 250 MW of "Up Regulation" and 100 MW to 500 MW of "Down Regulation" is identified, it will be helpful to specify how much regulation capability currently exists on the system.	The current capacity certified to provide regulation is covered in Chapter 5 section 5.8.5 of the report
Grid Operations Issues	SCE	Over-generation – The Draft Report should give a clearer description of the over generation protocol to be implemented in MRTU. In the absence of the ability to curtail wind resources, the CAISO should estimate the cost. The Draft Report should also estimate the amount of additional schedulable off-peak load that would be required to mitigate the increase in over-generation conditions caused by wind	A reference to the CAISO Over-Generation procedure will be added to the report in the Over Generation section. The amount of mismatch between generation and load that we have seen in the past is in the 500 to 600 MW range. The increase in the amount of wind generation will tend to make this

		resources. Will the transmission upgrade at Helms provide enough off-peak load capability to cover that requirement?	mismatch number larger, while the more accurate scheduling of generation to match forecasted loads with MRTU will tend to drive the mismatch number down. So at this point, we believe the over generation mismatch will rarely exceed 800 MW and that it will be a rare occurrence if we have good forecasting of wind generation energy production. 300 more MW of pump load at Helms will certainly help to reduce the magnitude of the problem. A detailed study of the Helms plant operation and the proposed transmission upgrade will have to been done in collaboration with PG&E
Grid Operations Issues	SCE	Regulation – The Draft Report should discuss the locational attributes, if any, of the additional regulation requirements.	Good utility practice is to have regulation resources in Southern California as well as Northern California. There is no specific technical basis for how much regulation will be required in each area.
Grid Operations Issues	SCE	On August 27, 2007, the CAISO made a presentation to the CPUC on the topic of: "Renewable Integration Work Plan." In the presentation (slide #16), the CAISO	In 2006, the CAISO typically procured 700 MW (±350 MW) of regulation at an average cost of approximately $18/MW

		estimates $30 million annually for procuring 170 MW to 500 MW of regulation reserves to ensure reliability of the system. SCE would like to request that the CAISO explain the differences that effected the changes from (170 MW to 500 MW) to (600 MW to 800 MW in the Draft Report). SCE would also like to request that the CAISO update the cost estimate based on the most recent integration study.	which is approximately $110 million annually. Although the amount of additional regulation will increase by the range of 170 to 500 MW in the future, the amount of additional regulation will change by season and vary by hour. When there is little wind forecasted, the additional regulation required will be zero or a small number. So the average amount of additional regulation over the entire year may be closer to 100 MW. The price for this additional regulation is totally unknown and speculation on our part. SCE is welcomed to plug in a price for future regulation services and calculate the cost impact the added regulation. The $30 million number used in the slide for the CPUC presentation was only a crude estimate and should not be taken as definitive forecast on our part.
Grid Operations Issues	SCE	Load Following – While the Draft Report indicates that additional ramping capability is required, a more detailed description of consequences of inadequate ramping should be given.	The consequence of inadequate ramping capability is a potential increase in CPS-2 violations. The CAISO would be required to increase the amount of regulation resources. If the problem still can not be solved, then we may be force to implement

			ramp limits on solar and wind generation resources to ensure their ramps stay within the capability of our system to handle the rapid changes from these renewables.
Grid Operations Issues	SCE	The section identifies (pages 47 and 48) twelve (12) recommendations and it is not clear whether all these or only a part of these recommendations are needed to achieve 20%. This section also does not identify what is the likelihood of implementing these recommendations before 2010. Some of these recommendations have contractual and policy implications and these issues need to be addressed about the feasibility of implementing.	The first ten recommendations can be implemented within the next two years. Commercial forecasting services are available that can provide Day-Ahead and Hour-Ahead wind and solar generation energy production forecasts. These forecasts can be integrated with MRTU and grid operations. Recommendations involving Resource Adequacy policies may take longer to implement.
Grid Operations Issues	SCE	The Draft Report recommends that additional regulation, load following and ramping capability should be procured via modifications to the Resource Adequacy (RA) rules. This is a policy-making recommendation that should not be included in the Draft Report. The study content and conclusions should focus on engineering analysis and conclusions only.	The CAISO agrees that Resource Adequacy rules and regulations are a policy issue and not a technical issue.
Grid Operations Issues	SCE	The Draft Report may not be sufficiently comprehensive with respect to addressing reliability concerns. It is not clear whether	A comprehensive study of the conditions suggested by SCE really requires an interconnection wide model

		this study has considered the worst case scenario: minimum load conditions during early spring or late winter months, hydro runoff conditions, "Must take" generation (i.e. QF contracts), maximum nuclear generation, and local area generation to meet reliability requirements based on contracts. The Draft Report did not address in detail how the low load time periods reliability can be maintained with high wind generation.	study. The key question in the next 5 years is how much wind and solar generation is not only going to be built in California but also the adjacent states. Load serving entities in adjacent states may find it very attractive to buy the excess renewable energy available on California during light load condition. A detailed production costing study for the California and regional resources was beyond the scope of this study.
Grid Operations Issues	SCE	On page 9, item 3 the Draft Report states "…this increase in regulation requirements is ten times larger than in previous studies due to a new and improved model…". Do we know why and do we agree? If this is true then how will this equate to higher levels of renewables. And lastly how much will operating costs and system marginal prices change with this type of analysis?	The additional regulation and load following requirements is based on the CAISO's operating practice and timelines. The results are only valid for the level of integration studied. The requirement is not linear and any higher level of integration would have to be studied in detail.
Grid Operations Issues	SCE	The Draft Report continually notes that there will be minimum load issues on the grid and that the grid can only absorb a maximum of 2912 MW of new wind by 2010. (page 73 line 2). To solve these minimum load problems the Draft Report notes that wind will need to be curtailed. Without a good program for such curtailment, communication and turning	CAISO agrees that we must have good communications with the wind generation operators and they must be ready to execute dispatch commands from the grid operators. A comprehensive assessment of the thermal generation fleet and the risk of

		off generators, the system will have significant operating problems. Another issue regarding operating problems is the need for more ramping and ancillary services. The Draft Report notes that these services are now provided by hydro and thermal resources. However, there will most likely be a push for retirement of existing larger older thermal plants. Therefore this study needs to be redone with more assumptions about retirements and new replacement thermal generation.	potential retirements of existing units were beyond the scope of this study. A separate project that assessed the potential impact of generator requirements is currently underway.
Grid Operations Issues	SCE	The effects of cycling operations on most of the older and other existing plants have not been analyzed. Not only is this a cost issue but this may be a serious operating issue. It is difficult to determine from the data presented just how many over-generation hours might occur in the near future but it might easily be hundreds of hours with the amount of wind penetration suggested in this Draft Report for 20% renewable penetration. If this were increased to 33% renewables and the wind were to double then the minimum load effects might increase exponentially to over a thousand hours. This seems to indicate that until appropriate off peak load can be built and/or more storage devices can be developed the increase of renewables must proceed with only on-peak	The CAISO agrees that deep curtailments and frequent cycling of thermal generating plants is a serious concern. More use of Peaking plants will probably be required. An increase in storage facilities and demand response programs will all help. SCE is correct that moving from 20% to 33% renewables target will be a significant challenge and it is our recommendation that we need to implement many of the recommendations for accommodating 20% renewables before we commit to a higher RPS target.

		types of resources as building more off peak generation will just exacerbate this problem. As stated by the Draft Report (page 14, item 1.1.4), moving from 20% to 33% renewables could more than double the integration problems and costs.	
Grid Operations Issues	SCE	It is not clear from the Draft Report, whether achieving the 20% renewable resources goal requires the addition of storage technologies. Given the current status of development of these technologies, it may be too optimistic to assume that these technologies will be commercially available, even leaving the cost aside, to meet the 2010 operating date. CAISO needs to identify the use of these storage technologies by year, at what cost, and what is the market mechanism for the merchant storage facility to bid into the CAISO market?	As described earlier in these comments, the primary barrier to storage facilities is not really the technology as it is the lack of a market of financial mechanism to compensate the storage owner/operator for the services they can provide. The market constructs today do not provide enough incentives to encourage the construction new storage facilities. The report is based on engineering analysis and does not address cost or policy decisions.
Grid Operations Issues	SDG&E	REGULATION. • The Operations Issues section of the Draft Report identifies a need for additional regulation beyond the average 350 MW of upward and downward regulation normally procured in today's market. The Draft Report concludes that while the integration of renewable	The CAISO shares SDG&E's concern that there may be insufficient regulation resources in the future to match the increased regulation requirements due to a large amount of intermittent resources. This need could be filled by fast ramping storage technology and by new generating units that are specifically designed to provide

		resources will increase regulation requirements, the increased regulation will resolve the problem. However the Draft Report fails to take into account market and other external issues within California that may dramatically impact the availability and cost of additional regulation beyond current MW levels. • In the current market, a unit's regulation capacity rating is based on its certified regulation ramp rate in MW/min time a 30 minute duration. Under MRTU, the duration for establishing a unit's regulation capacity rating is reduced to 10 minutes. As a result, the CAISO's available regulating capacity will be reduced by a factor of 3 under MRTU. In addition, a substantial portion of the CAISO's regulation capacity is provided by old thermal steam units. Not only is this fleet of units aging, there is regulatory pressure through the "Old Generation Retirement and Replacement of Once-Thru Cooling Systems" initiative that may further reduce the availability of these units. These plants are being replaced by CCGT units with smaller regulating ranges. The Draft Report fails to address the future availability of regulation capacity to manage the growth in	regulation services. The CAISO needs to work with our stakeholders and policy makers to make sure there are mechanisms in place to provide the needed regulation resources.

		renewable resources or its cost in light of the shrinking capacity quantity.	
Grid Operations Issues	SDG&E	Optimal Dispatch - The ISO study points to the need to make changes to the manner in which plants that are conventional units are dispatched, including additional commitment of units, in order to allow integration of intermittent resources. However, no quantification of the effects of these changes in dispatch is made. The technical ability to allow integration of intermittent resources needs to be balanced with a policy decision on the cost of doing so. The ISO should undertaking modeling to examine the extent of changes to optimal dispatch and quantify the costs in a 20% RPS scenario vs low wind integration scenarios. Additional costs will also be incurred through the ISO's anticipated requirement of a significantly larger supplemental energy stack.	This was an engineering study and a cost impact analysis was beyond the scope of this study.
Grid Operations Issues	SDG&E	Resource Adequacy - The ISO report raises issues with changes that may be required to the RA program currently in place. Specifically, the ISO suggests a requirement for certain (to be determined) levels of quickstart units on the system. The additional costs of these RA enhancements need to be quantified. Intermittent resources already create additional RA costs due to large	The report was trying to give a "heads up" to the LSE that have an RA obligation that they need to think about the additional features or functions the generating resources must provide to reliably operate the grid with the amount of renewable resources required to meet the 20% RPS target. The CAISO is not in a position to

		discount to nameplate capacity of these resources that can be counted toward a LSE's RA obligation.	assess the cost impact of these RA resources.
Grid Operations Issues	SDG&E	Scheduling of Intermittent Resources Across the Interties - Finally, the ISO report raises important questions regarding the scheduling of intermittent resources across the interties. SDG&E encourages the ISO to work with stakeholders (including WECC and neighboring control areas) to resolve issues and create procedures to allow for inter-control area scheduling of intermittent energy as this will likely be an important tool to be used by the California LSE's in meeting the states ambitious RPS goals.	The CAISO agrees that scheduling of imports and exports of intermittent resources is an important issue and it should be addressed in the next study.
Grid Operations Issues	CalWEA	**The Importance of Forecasting and Flexible Generation.** Many of the CAISO Report's recommendations parallel those made by the final report of the CEC's Intermittency Analysis Project (IAP), which was released in July 2007. Importantly, both reports highlight that the successful integration of wind generation into the CAISO's scheduling and dispatching activities will require: • Continued improvements in the ability to forecast wind generation on a day-ahead, hour-ahead, and real-time basis, and	The CEC study, NY State Study, XCEL Energy studies and the CAISO studies all conclude that Day Ahead wind generation forecasting is very important for optimum scheduling and use of renewable resources. The forecasts do not have to be perfect to achieve substantial benefits.

		• Increasing the flexibility and quantity of generation that can follow load. CalWEA agrees that these will be central elements in the successful integration of 20% renewable generation in California.	
Grid Operations Issues	CalWEA	**The CAISO's Approach to Determining Regulation Needs.** CalWEA offers the following comments on the CAISO's overall approach to determining regulation capacity requirements in 2010: • The Report does not present the details of the actual methodology that CAISO used to estimate the added regulation requirement for the planned Tehachapi wind generation. Understanding the details of the approach is particularly critical in distinguishing between the regulation and the ramping needs of the planned Tehachapi wind generation as what may be considered as regulation need may simply be ramping need. We believe that ramping needs can be more readily addressed by less costly and more effective measures. This is especially true considering the significant sophistication of the CAISO's various market and scheduling procedures under the MRTU which will be in place by 2010.	• We think we have fully disclosed the new methodology for calculating the amount of regulation and load following/supplemental energy dispatches in Appendix B. The MRTU scheduling and redispatch process with modeled in detail to calculate the regulation, load following and ramping requirements. The variability of loads and of wind generation was major inputs to the calculations. • The methodology used in the report is a new method that has been developed in the past few months. The development of this model was started by PNNL under contract with BPA and then it was adopted and modified to model the CAISO market based processes. We believe the validity of the new

		• The Report neither indicates if the approach used for determining the regulation capacity needs for the planned Tehachapi wind generation is the same one that is used today for determining the regulation reserve needs for the CAISO system nor if used the same methodology to estimate the future regulation needs for the CAISO system without the planned Tehachapi wind generation for the 2010 studies. • The Report does not indicate as to whether it has fully accounted for the vast geography where the planned Tehachapi wind turbines will be located when forecasting rapid variations in wind generation output in the area. It is well documented in the literature that spreading wind turbines over a large geography, such as that of Tehachapi, have a significant smoothing effect on the fast variations of the output of individual wind turbines. • The Report does not clearly indicate whether it has modeled planned Tehachapi wind generation simply as an "uncontrollable negative load" or as a generating plant whose output, especially	model will be clearly demonstrated over the next several years as the system responds to the variability of both loads and intermittent resources. • We agree that Tehachapi is a large geographic area and the wind generation in the area will not all act as one highly correlated wind generation facility. We therefore modeled the wind generation facilities as four separate areas with the Tehachapi area. We had input from AWS Truewind on how these different areas should be modeled. • We did not find the compelling need to require ramp rate limits on the wind generation facilities at this time. This may change in the future if we lose some of ramping capability of the existing generation facilities due to low water for the hydro systems and due to the retirement of existing thermal generating units. • We do not have an estimate of the number of hours we will have to increase reg up and reg down at

		when using Type-3 and Type-4 generators as expected in the Tehachapi area, can be readily controlled. We believe that accounting for even limited controllability of the wind generator output can have a significant impact on mitigating its regulation (as well as ramping) capacity needs, and particularly downward regulation capacity needs. • The Report does not indicate for how many hours in a year the extreme level of upward and downward regulation capacity (at or around +250MW and -500MW) will be needed. Understanding the number of hours will help the industry to determine whether the need for such extreme values of regulation capacity can be completely mitigated by simply controlling more carefully Tehachapi wind generation output for those hours. While the need for more frequent telemetry of meteorological and production data is understandable, we do not understand the need for 4-second telemetry of such data, particularly given that the report has developed its findings and recommendations based on modeling wind generation as an "uncontrollable negative load" anyway.	this time. The amount required will be continuously assessed as the installed capacity of wind generation facilities increases on the system. • The Participating Generator Agreement (PGA) requires all generators to supply the CAISO with real time operating data – 4 second energy production data, voltages, breaker status, etc. We do not need to see this data from every wind generation but only from the point where the wind farm is interconnected to the transmission grid.

Grid Operations Issues	CalWEA	**Solar and Wind Are Complementary.** CalWEA also is concerned that the draft CAISO Report may overstate the need for additional load following and regulation resources by focusing solely on the impacts of additional wind generation. The state also plans to add significant new solar resources, both to meet the 20% by 2010 goal and continuing into the next decade. The California Solar Initiative (CSI) aims to add 3,000 MW of solar photovoltaic (PV) capacity over the next ten years (2007 - 2016), and the investor-owned utilities have contracted for significant capacity from central station plants using a variety of concentrating solar thermal (CS) technologies.[2] The IAP projected that the state will have 630 MW of PV and 1,200 MW of CS on-line in 2010 in its 20% renewables case (Scenario 2010T). The CEC forecast of renewables additions in Table 1 of the CAISO Report are consistent with the IAP's numbers, including about 1,900 MW of solar generation in 2010. CalWEA believes that this projection is generally reasonable. As a	The 3000 MW of PV capacity will be spread throughout the distribution system and will appear like negative load or simply a net load reduction to the bulk power system. The net effect may be to lower the ramping requirements for the morning load pickup but it may also increase the uncertainty in the load forecast as it will now be subject to the amount of cloud cover in an area. We share you enthusiasm that concentrated solar may reduce the morning load ramp impact and it will be a major complement to wind generation energy production. Our data for concentrated solar energy production is still quite limited and more data and more modeling is really required to a make definitive impact report on solar. The results from the IAP report are encouraging on the role that solar could play in the states energy future. We hope that the construction of the

[2] CalWEA is aware that PG&E has signed three solar thermal RPS contracts totaling 560 MW, and SCE and SDG&E have contracts for 500-850 MW and 500-900 MW, respectively, with Sterling Energy Systems. Other major solar thermal projects in California have been announced, some have filed for siting permits at the CEC (see http://www.energy.ca.gov/siting/solar/index.html), and there are more than 18,000 MW of solar projects in the CAISO's interconnection queue.

[3] See the CPUC's recent CSI update, at http://www.cpuc.ca.gov/static/energy/solar/california_solar_initiative_staff_progress_report_september_2007.pdf.

		result, the IAP report looked at the integration impacts in 2010 of the combined profile of solar and wind generation. Wind and solar output often are complementary – wind generation decreases in the morning as solar output is rising, and wind output rises in the late afternoon as solar generation is waning. The IAP study found that the impacts of the combination of intermittent wind and solar generation in 2010 on load following and regulation requirements generally were modest. For example, the impact of wind and solar resources on load following were less than the impact due to load growth. Regulation requirements in 2010 would increase by just 3% to 7% as a result of new intermittent generation, according to the IAP results. CalWEA strongly disagrees with the CAISO Report's assumption, at page 44, that no significant solar additions are expected by the 2010 time frame. From 1981 through 2006, California installed about 200 MW of solar PV. Based on data through mid-September 2007, applications for solar incentives under the new CSI program are expected easily to exceed 200 MW in 2007 alone, and the pace of new applications is accelerating.[3] The IOUs have signed more than 1,500 MWs of contracts with CS plants.	solar units specified in the IAP report and in the IOU contracts are completed and come on-line on schedule. We disagree with the IAP results that show the amount of regulation increase required is only 3% as our studies find it is closer to 10% or larger increase, depending on the season.

		CalWEA is concerned that the CAISO's focus on the operational impacts of wind generation alone fails to present an accurate picture of the true impacts of integrating the complete portfolio of new renewables that are expected to be operational in 2010. Due to its focus on wind generation alone, CalWEA believes that the CAISO Report overstates the impacts of intermittent renewables on morning and evening ramps, on intra-hour load following, and on regulation requirements. Commenting on the IAP study, the CAISO Report says, at page 20, that "it is very encouraging to see how the combination of wind and solar together can reduce the variability of the entire fleet of intermittent resources." The CAISO Report later concedes that "solar…could be beneficial in alleviating some of the expected ramping concerns" (page 54; this point is also repeated on page 91). Yet rather than studying the impacts of expected solar generation, the CAISO Report simply urges additional research to drive down the costs of solar (page 20), and lists the intermittency impacts of solar as an action item (page 48, Recommendation No. 7) . The best way to drive down the cost of any technology is to bring it to the market, in quantity, which appears to be happening with solar	

		technologies. The state's ambitious CSI program and the substantial amount of CS capacity now subscribed in contracts should be enough to convince the CAISO that solar is no longer a technology still in R&D.	
Grid Operations Issues	CalWEA	**Minimizing Wind Curtailments.** Both the IAP and the CAISO Report highlight the potential for the growth in wind generation to increase the potential for over-generation conditions during periods of low loads and high wind output. Curtailment of wind generation is one means to respond to an over-generation condition. However, curtailment will result in the loss of renewable energy, which is contrary to the state's policy goals, and may result in undue discrimination against wind generators. Both the IAP and the CAISO Report make a number of constructive recommendations for minimizing the potential need for wind curtailments: • Increase the ability of pumped-storage units to use excess off-peak generation, • Explore the deployment of new storage technologies and off-peak loads (such as flywheels, compressed-air storage, plug-in hybrid vehicles, & off-peak cooling), &	• As mentioned in earlier comments, we need to aggressively pursue new storage options to complement the energy production from intermittent renewable resources. • We believe the potential over generation problem can be handled by implementing the series of recommendations in our report. • We would be glad to work with CalWEA to explore all creative solutions that help to match load and generation including variable loads that respond to the availability of excess wind generation availability. • The CAISO intends to review its operating procedure for dealing with over generation issues and ensure the process is clear and all Participating Generators, including

		• Improve wind forecasting to allow over-generation problems to be resolved in the day-ahead market. CalWEA urges the CAISO to consider additional measures that the IAP study recommends to minimize over-generation conditions: • Encourage new thermal generation with lower minimum turndown points & a greater ability to start-up and shut-down every day, • Allow more frequent & flexible changes in import/export schedules on the interties, • Replace the artificially inflexible Dept of Water Resources (DWR) contracts with more responsive generation as the DWR contracts expire in the coming years, • Increase the ability of DWR pumping loads to respond to system conditions, & • Enhance the flexibility of hydro resources. More specifically, the CAISO needs to consider whether the current "minimum loads" of all types of generation are	wind generators, fully understand the procedure and their obligations.

		appropriate: whether the minimum turndown points of gas-fired generators really are minimums, whether "minimum" levels of imports can be lowered, and even whether nuclear generation can be reduced during critical periods. Finally, CalWEA is aware that some QF contracts have provisions that allow for a limited number of hours of curtailments by the utilities each year. CalWEA appreciates the recognition in both the IAP and the CAISO Report that, if wind curtailment is to be considered as a means to deal with over-generation before the CAISO's own over-generation protocol is used, the number of hours of annual curtailment should be limited to no more than 100 hours. CalWEA strongly supports the IAP's recommendations that the limits on wind curtailments should be clearly defined, and that wind generators should be appropriately compensated when curtailment of wind generation alone is used to provide decremental generation. Beyond a strictly limited number of hours of curtailments for which wind generators are compensated, the CAISO must look to its own over-generation protocol to reduce generation when the market for decremental generation has been exhausted. The key	

		feature of the over-generation protocol – which the CAISO must be vigilant to enforce – is non-discrimination. The protocol does not single out any particular generation source. So, for example: • Curtailment of generators operating above schedule, whatever their fuel source, should precede any other non-market curtailment. • Curtailment of wind generation should not be placed ahead of curtailment of any other generation operating at or below schedule. • The ISO should ensure that all generators with PGAs, which are obligated to comply with this and other ISO protocols, are able to reduce generation when needed, not just wind generators. This includes both utility-owned and merchant generation. For example, utility-owned hydro plants can curtail their generation, even during high-runoff conditions, by spilling water rather than running it through the turbines. In addition, some wind QFs may have "must-take" status under the ISO tariff, which the	

		CAISO must consider as well. That status will not change if those contracts are repowered to produce more energy.	
Grid Operations Issues	AWEA	**Calculated Regulation Requirements:** While AWEA congratulates CAISO on the high quality of the majority of the September 2007 draft of the Integration of Renewable Resources Report AWEA has strong reservations concerning the calculation of regulation requirements. As CAISO notes, the calculated regulation requirement is ten times higher than that calculated by previous studies. The calculation methodology is not described in sufficient detail to allow either full understanding or duplication, however. It appears that the methodology mixes ramping requirements and forecasting error penalties with regulation requirements. It is important to accurately identify modeled operational impacts of increased wind generation to determine if 1) the impacts are real, 2) the impacts can be mitigated by market response or operational methods.	We have included the equations and a description of the methodology used to calculate the added regulation requirements. We believe our methodology more accurately represents the time lags associated with supplemental energy dispatches and these time lags drive up the amount automatically control that is supplied by units on regulation. The variability of load, wind generation and solar generation all contribute to the regulation requirements. The final validation of the methodology and models we are using will be proven out with the addition of large amount on wind and solar generation in the 2010 to 2012 time frame. The CAISO's CPS2 scores will be affected if there is insufficient regulating resources and bids in the supplemental energy stack.
Grid Operations Issues	AWEA	Wind variability is fairly well understood, especially for large aggregations over short intervals. Any calculated increased reserve requirement must be reconciled with the CEC study findings that wind variability	We agree that aggregation of wind generation different geographic area can reduce the net variability. However, some of that advantage will be lost due to the major increase of

		netted with load variability result in only a modest increase in regulation reserves. It is unlikely that the wind variability itself accounts for the increased regulation requirements calculated by CAISO.	wind generation one specific area – namely Tehachapi. The regulation requirement is drive by the variability of load, wind and solar, plus deviations by other generators and imports.
Grid Operations Issues	AWEA	CAISO states that the new regulation assessment methodology "more accurately reflects the operation characteristics of the Automatic Generation Control (AGC) and automatic Supplemental Energy dispatches" that are currently in use. CAISO also states that "In order to model the scheduling process, the probability distributions of total CAISO load forecast errors and total CAISO wind generation forecast errors are necessary inputs to the models." But CAISO acknowledges that "This means that real time wind forecast is not available." CAISO further states "The Real Time wind generation curves were modeled by applying the persistence model. This model assumes that the wind generation within each five-minute dispatch interval would be the same as it was eight minutes before the beginning of this interval." While persistence is a reasonable wind energy forecasting technique over short time steps (if nothing better is available) it is inherently a poor variability forecast. By definition persistence forecasts *zero* variability; not a good	The CAISO agrees with your concern that the regulation requirement not be overstated as it will be an added cost to the market. Additional work is certainly required to determine the optimum amount of added regulation that will be required on a day to day basis and to provide transparency on how the amount of regulation per hour is determined. It is not clear to us what "mitigation methods" could be used unless the wind generators are providing some of the shaping and firming of their energy delivery.

		variability estimate for wind. If the introduced error compounds from interval to interval then the calculated regulation requirement could easily be greatly overestimated. Before concluding that such a large increase in regulating reserves is required it is wise to both verify the modeling and determine what mitigation methods are available.	
Grid Operations Issues	CPUC staff	In Chapter 5, it would be helpful to have a more clearly structured verbal presentation (apart from and complementing the equations), in outline form (e.g., 5.1, 5.1.2, etc.) organized around the different kinds of system response, such as DA, multi-hour ramp, load following, regulation and minimum load conditions. In this structured verbal presentation there should be a clear explanation of how • each quantitative or qualitative finding of operational impacts, such as those applicable to DA scheduling/RUC, multi-hour ramps, supplemental energy, regulation, or required curtailability arises specifically from • a particular aspect of wind intermittency, such as very short-term (i.e., not	This is a very valid comment and the CAISO attempted to follow a more structured format in the final report.

		forecasted) variation vs. HA uncertainty vs. DA uncertainty vs. sustained (deterministic?) ramping combined with the • specific system response(s) from generation (or, potentially, load) able to address that aspect of intermittency, and also indicating • what market products (regulation, other ancillary services, etc.) & physical types of generators can provide that response. This analysis could be performed using textual explanation supported by summary tables. The tables would clarify the above relationships & complement the report's existing tables that summarize operational requirements in terms of MW & MW/minute. The textual explanation & supporting tables should be comprehensible if standing alone, while underlying equations should be clearly linked to the textual explanation and be (for the most part) included in appendices.	
Grid Operations Issues	CPUC staff	While the desired information is generally already incorporated in the Draft Report, additional structuring (as discussed above)	The CAISO believes the Final Report will be easier to read and it will meet this objective.

		plus some reduction in redundancy would help make the report more accessible. For example, a complex issue should be fully described at a single point in the Report rather than being dealt with in a dispersed fashion throughout the Report.	
Grid Operations Issues	CPUC staff	This Report and/or future work should address the interdependence and substitutability of different kinds of system response to intermittency. As examples: up to a point, regulation and load following are interchangeable; wind curtailment could in certain cases substitute for downward load following or residual unit de-commitment; and day-ahead or hour-ahead commitment changes could affect the ease and cost of meeting intra-hour requirements.	Good comment and we agree there are tradeoffs between the amount of regulation required and the amount of supplemental energy dispatch required. They are not perfect substitutes, however, and the CAISO must meet NERC operating standards such as CPS-2. The CPS-2 standard requires corrective action to return system ACE to control area limits within10 minutes so the time lags associated with the generator responses to supplemental energy dispatches may be too long to meet CPS-2 standards. Therefore it is important to have the right amount of regulation resources to meet the standard.
Grid Operations Issues	CPUC staff	In addition, the Report should incorporate a preliminary discussion of the localization of system flexibility requirements (*e.g.*, the potential mandatory use of specific, identified geographic locations for unit commitment, load following, etc.) as a means to address	Good comment and we agree that geographic location of resources is important. Good operating practice requires having regulating resources geographically dispersed. So regulating units in Southern California

		transmission constraints or reactive power consumption, and this concept should be explicitly targeted for future study. One important question that such future study should address is how such localization could be affected by changing hydro conditions, or reliance on larger quantities of imported vs. in-state wind.	are important & the whole area should not depend on having all the regulation in the north. In the unlikely event of a system separation – north to south - there would be no way of controlling the system in the south. Regulation in the south will also lower the impact on the transmission network and Path 15.
Forecasting Issues	MWSF	Forecasting lead times and hence forecasting error could also be reduced by the use of fast responding storage to fully increment or decrement 5-min dispatches immediately after a forecast is published and the dispatch computed, with no ramping necessary. How would storage be compensated for this faster response and reduced forecast error?	The fast response storage systems would probably have to be installed at the wind farms to provide maximum benefit for this shaping and firming service – or electronically coupled with the wind farm. It is a good question on the financial/economic model for compensating them for this service. An issue that we should work on with potential providers of storage facilities.
Forecasting Issues	SCE	The integration of significant amounts of intermittent resources has the potential to dramatically impact the operations of and competitiveness of the CAISO's energy, congestion, and ancillary services markets. According to the Draft Report, the CAISO's need for real-time energy bids, Regulation Up, Regulation Down and overall ramping capability will increase significantly – in some cases by more than 140% of current demands. Given that these same markets	The classic supply and demand model will certainly apply. If the amount of regulation services needed increases, the price will certainly increase unless there is an increase in the supply of regulation resources.

		have a history of problems in liquidity and competitiveness, such increases in demand post a considerable risk of having dramatic price impacts in these markets. As the CAISO has been ordered by FERC to develop “scarcity pricing” for these markets, prices will likely have the potential to rise to levels heretofore unseen.	
Forecasting Issues	SCE	How was wind forecast in the day-ahead market (that is, did the model assume current PIPR rules that require wind to schedule in the HASP or was forecasted wind included in the day-ahead process)?	A Day -Ahead forecast of total wind generation is important to make the most optimum decisions on A/S procurement and RUC decisions day-ahead. The wind generation is not required to schedule in the day-ahead market but they find it advantageous to do some energy scheduling day-ahead. The assumption is that wind generation in the PIRP program will use the forecast to lock their schedules in HASP fro the real-time operating day.
Forecasting Issues	SCE	If wind was included in day-ahead, how did the CAISO model wind-forecast errors in determining their actual real-time generation requirements?	Good question on how accurate is the day-ahead wind generation forecast. We are doing a separate project on day-ahead wind generation forecasting and publish the results when they are available.

Forecasting Issues	SCE	How did the CAISO model their Ancillary Service needs in the day-ahead market? That is, did they purchase extra Spin and Regulation in hours where wind was most uncertain? What were the resulting prices? What did the study do if the markets did not clear?	The CAISO methodology for assessing Ancillary Services is covered in detail in Appendix B. Also, an analysis of cost impacts was out side of the scope of this study.
Forecasting Issues	SCE	Has the DMM and/or the MSC reviewed the results of the study? If so, have they raised any concerns over the resulting ability for parties to exercise market power either the day ahead or real-time energy or ancillary services markets? Has the DMM or the MSC performed any studies related to market costs of energy and ancillary service as part of the integration study?	DMM and MSC were not specifically asked to review and comment on this engineering study.
Forecasting Issues	SCE	Market impacts on energy prices: Given that hydro resources will play a much more important role in ramping and load following, and less of a role in providing energy, has the CAISO, DMM or MSC looked at the impact to energy price and the resulting increase in cost to the market as a result of diminished or constrained participation of hydro in the energy markets?	An analysis of cost impacts was outside of the scope of this study.
Forecasting Issues	SCE	Market impacts for load following: The CAISO claims that they will require between 700-800 MW of additional real-time	An analysis of cost impacts was outside of the scope of this study.

		generation for upward dispatch and 500-900MW of downward dispatch in the real-time market. (Page 47, item 5). However, according to Figures 2.39 and Figure 2.41 of the CAISO's "Annual Report Market Issues and Performance 2006", the real-time market exceeded the CAISO Residual Supply Index (their benchmark for competitiveness) for both INCs and DEC in about 10% of the total hours. This increase demand for real-time bids raises concerns over the resulting competitiveness of the CAISO's real-time energy market. Has the CAISO/DMM/MSC done any analysis to see what the impacts are on prices and the ability to exercise market power?	
Forecasting Issues	SCE	If, in fact real-time energy prices are inflated due to market power, has the CAISO/DMM /MSC attempted to calculate the impact this will have on day-ahead energy prices, particularly in the presence of Virtual Bidding, and the cost this may have to the market?	An analysis of cost impacts was outside of the scope of this study.
Forecasting Issues	SCE	Market impacts for Regulation: The CAISO claims that by 2010 they will have to increase their current 350MW regulation purchase - "up regulation" purchases will increase by 170-250MW (totaling 520-600 MW) per hour, and their "down regulation" by 100-500MW (totaling 350-850 MW). (Exec Sum, page 8).	An analysis of cost impacts and depth of various markets was outside of the scope of this study.

		• Concerning Reg Down, Fig 4.19 of the CAISO's "Annual Report Market Issues & Performance 2006" show that in some months during 2005-06, average bids were below 600MW – indicating that the market may not clear under the study assumptions. In many months, bids were well below 1,000MW indicating sellers may have the ability to exercise market power. Has the CAISO/DMM/MSC looked at the study to see what impact on Reg Up prices, competitiveness, and finally total costs to customers, will be? • Concerning Reg Up, Fig 4.20 of the CAISO's "Annual Report Market Issues & Performance 2006" show that in about half of the months in 2005-06, average bids were below 850MW – indicating that the market may not clear using the study assumptions. In no months did bids exceed 1,500MW indicating that sellers may have the ability to exercise market power in many hours. Has the DMM looked at the study to see what impact on Reg Up prices, competitiveness, and finally total costs to customers, will be?	
Forecasting Issues	SCE	The CAISO recommends that Resource Adequacy standards should be changed to require more quick start, faster ramps, &	The CAISO goal was to identify transmission and operating issues related to the integration of large

		more durable ramps. This issue is currently under discussion at both the CPUC & CAISO as part of CPUC docket D.05-12-013. Other alternatives may be preferable, such as the CAISO enhancing their current Ancillary Services, developing new products, or simply proving additional information to the market, to get the necessary resources. In any event, this issue is complex and should be addressed in the CPUC process, not as part of an interconnection/integration study.	amounts of intermittent renewable resources. We welcome SCE suggestions on how these issues can be most effectively resolved.
Forecasting Issues	SCE	The CAISO has been ordered by FERC to implement Blackstart and Reactive Power markets. Given the CAISO has concluded that Reactive Power infrastructure is "inadequate", what role will markets play in attracting more reactive power?	This is a policy issue and it is queued up for future consideration
Forecasting Issues	SCE	The CAISO has been ordered by FERC, & is in the process of introducing Administratively set high prices (i.e. "scarcity pricing") in the event they are unable to satisfy ancillary service or energy needs in either the day-ahead or real-time markets. Per FERC's mandate, these rules must be in place within 1-year after the start of MRTU, and thus they will be active during the study period. Given the serious concerns of market performance raised above, has the CAISO/DMM/MSC considered the cost impact to customers	The CAISO held a stakeholder meeting in November to discuss this issue. A straw proposal can be found on the CAISO web site at: http://www.caiso.com/1c9b/1c9bd08c63920.pdf This is a policy issue that will be discussed at a CAISO Board meeting in 2008 and SCE is welcomed to provide comments to the Board.

		resulting from possible “scarcity pricing”?	
Forecasting Issues	CPUC staff	There appears to be considerable overlap among Chapter 4, Chapter 5 and Appendices C-E, all of which contain some information regarding forecasting and associated error. Chapter 4 nominally addresses forecasting, but is incomplete. A more complete, self-contained description of forecasting in one chapter would be preferable. Verbal descriptions of forecasting and operational matters should be more structured and self-explanatory (*i.e.*, comprehensible without the equations) and more fully segregated into forecasting versus operations chapters, although the operations chapter will necessarily refer to forecasts.	In the final report chapters 4 and 5 were significantly restructured to address these issues.
Forecasting Issues	CPUC staff	For forecasting, as for operations, equations implementing logical steps should be more clearly linked to complete verbal descriptions of those steps, and could, by and large, be incorporated into Appendices. In several instances, equations and their notation could be more clearly explained.	This is a very good comment and attempts would be made in the final report to clearly explain equations.
Forecasting Issues	CPUC staff	The role that day-ahead wind forecasting and forecasting error plays in this study should be clarified. How the “7-9 percent” hour-ahead (two hour ahead?) wind forecasting error was applied, in combination with shorter term	Chapter 4 of the final report covers the impact of Day-Ahead forecasting errors. Revisions to sections 5.8 through section 5.10.4 were made to clarify the difference between load

		wind fluctuations (which, apparently, are assumed to be incapable of being usefully forecasted) to determine regulation versus load following requirements should be better explained verbally. The extent to which the analysis assumes application of wind forecasts beyond the current use or availability of such forecasts for grid operations should be clarified.	following and regulation requirements. Appendix B of the final report is also a detail reference on the methodology used explain the regulation versus load following requirements.
Forecasting Issues	CPUC staff	The derivation and application of temporal and spatial correlation of wind fluctuations and wind forecast error is discussed in the Draft Report, but needs to be explained more fully and clearly, and in one place. This includes correlations between and within individual wind areas, such as the three new "wind parks" assumed for Tehachapi. Going further, the robustness of the conclusions set forth in the Report would be improved by at least semi-quantitative consideration of how wind generation patterns, correlations (time and space) and forecasting error could differ from what was used as a basis for the Report's conclusions. Moreover, the Report should at least comment on how, qualitatively, significant wind development outside of Tehachapi and Solano (*e.g.*, in the San Bernardino corridor) might impact the Report's conclusions.	This is a good comment and the workgroup believes that Appendix D of the report address the correlation within the different parks in Tehachapi. A separate study would have to be done to determine the impact of significant wind development outside the Tehachapi or Solano areas. Sensitivity with a 5% wind forecast error was studied and covered in section 5.9 of the final report.

Forecasting Issues	CPUC staff	Finally, the recommendations in Chapter 10 discuss need for day-ahead and 5-hour wind forecasting tools, yet the operations analysis appears to assume hour-ahead or 2-hour forecasts. The Report needs to explain the linkage between 5-hour and 1- or 2-hour wind forecasts.	The Day-Ahead forecast is used with MRTU to make decisions on Ancillary Services procurements (regulation, spinning reserves, non-spinning reserves), and RUC decisions. The 5 hour ahead decision in the real-time operating day is to send dispatch notices to quick start units to tell them what hour(s) they need to be on-line. The 2 hour ahead forecast is to lock in wind generation forecasts into PIRP schedules and T-75 minutes is the HASP final schedules.
Implementation Issues	MWSF	Ramp Mitigation Strategies – Storage can be charging at the start of a ramp and discharging at the end of a ramp, subject to its storage and operating limits – dispatch of the storage for ramping mitigation may require improved signals and coordination.	The CAISO agrees that storage could play a key role in the helping with the integration of intermittent resources. Additional work is needed to fully develop the concepts on use of stage technology and compensation of storage systems for the benefits they could provide.
Implementation Issues	MWSF	Over Generation Issues – Storage can respond effectively to over generation if the state of charge of the storage devices is properly managed in response to forward prices and other operating signals. Improvements in such signals for storage may be helpful.	Agree. See note above.

Implementation Issues	MWSF	Improvements in Forecasting - The report also focuses on improvements in forecasting systems, especially for renewables. Will such forecasting be provided to operators of fast response resources such as storage to assist in mitigation of over generation?	Good question. Certainly the wind generation and solar plant operators will want the forecast information for their facilities. How transparent or public we should make the forecasted energy production is open for discussion. If making the information available gives some SC market power, the forecasted energy production can not be made public.
Implementation Issues	MWSF	Impact on Resource Adequacy – What will be the counting rules for storage resources – will fast response needs and contributions be counted as well?	To be determined in future studies and workshops.
Implementation Issues	SCE	The CAISO identified curtailing wind generation as a mitigation option under certain conditions. LSEs have been signing the contracts with the developers and these need to be modified to allow the curtailments as proposed by CAISO. The question that needs to be answered is who has the responsibility, is it CAISO or the counterparty to the contract? Can the wind developers obtain financing if there are curtailment provisions of wind energy? What is the cost of curtailing this wind generation?	Obviously the goal is to deliver every MW-Hr possible from renewable resources to meet the RPS target. The only reason to curtail wind generation would be for a transmission overload or an over generation condition that can not be mitigated through the normal market mechanisms. When it is a reliability issue and the CAISO is at risk for violation of NERC and WECC operating standards, then we must take action and send dispatch notices to units to curtail energy production. Based on our studies, we believe this will be a relatively rare occurrence.

			Even when such action is required, the number of hours is projected to be less than 1% of the time and the amount of MWs that need to be curtailed will be small. We can't forecast the impact on financing wind generation projects and we did not do a cost impact study.
Implementation Issues	SDG&E	If curtailing wind generation as a mitigation option under certain conditions is acceptable, the CAISO needs to be specific on when this acceptable and who make the decision to curtail. Has the CAISO thought about the cost to curtain wind generation?	The criteria and the actions to be taken to curtail wind generation will be described in a CAISO Operating Procedure.
Implementation Issues	SDG&E	SDG&E notes that any policy decision associated with wind generation must ensure that all applicable NERC mandatory standards are met.	The CAISO agrees
Implementation Issues	MWD	Under Tariff Section 42.1.7, the ISO is required to rely to the maximum extent possible on market forces to ensure applicable Generation planning reserve criteria are satisfied. It's unclear whether the ISO is relying on market forces or dictating requirements to mitigate the integration issues with renewables. For example, the report proposes to change Resource Adequacy standards to require	The CAISO is committed to using market systems to help with the integration of all renewable resources including intermittent resources. The objective in our report was to identify changes that will be necessary to reliably operate the grid of the future. The fact that decisions are being made today for the type of power plants that will be built in the next 5 to 8 years means that LSE must think ahead and

		that new thermal units be quick-start and have better ramping characteristics. However, changing an RA standard is not using markets and will shift the cost burden to LSEs, not to those that cause the problem.	procure not just the cheapest MW-Hr of energy production but they must procure resources that help with the integration of large amounts of intermittent resources. There are may options for how this can be accomplished and the RA process on only one option. Linear extrapolation of today's generating fleet to the future is probable not a recipe for success and system reliability.
Implementation Issues	MWD	The recommendation to "change ISO generator interconnection standards to require compliance of all intermittent resources with the interconnections rules established for the PIRP" needs to be reviewed. Under PIRP, the term "intermittent resources" includes wind, solar, and small-conduit hydro. If units choose not to be part of the PIRP and the PIRP rules are unique, the "one size fits all" approach does not appear appropriate. For example, hydro units may be synchronous machines that do not have reactive or ramping issues such as wind units. Perhaps the recommendation should be limited to wind and solar that creates	Good point. All intermittent renewable resources are not required to join the PIRP program. Our major concern is with wind generation and grid connected solar systems. We still need real-time energy production data from all resources including small hydro, biomass and geothermal units. The change was added to Page 10 of the report.

		operational issues.	
Implementation Issues	CalWEA	CalWEA commends the CAISO for this study and encourages it to recalibrate its results based on an assumption that California will see the development of significant solar generation in addition to wind. The CAISO also should re-visit this work after the results from the operation of the first projects from the planned Tehachapi wind generation are in. Only then should the CAISO consider setting actual requirements for added regulation capacity to integrate Tehachapi wind generation and the significant other renewable resources that will be developed in California in the coming years.	The methodology for calculating the A/S requirements should be fully developed and test and used before the significant increase in renewables occurs. This will allow us to fully test the methodology and to provide transparency on how the decision for additional A/S procurement is made. If we over procure, then the market participants will certainly provide feedback and help to correct the process.
Implementation Issues	CPUC staff	Tasks and associated discussion in Conclusions and Recommendations, Chapter 10, have an unclear relationship to topics and conclusions in the other chapters, and some "recommendations" in other chapters don't appear in Chapter 10. If Chapter 10 is intended to be a preliminary action plan or a set of "next steps," it should be more clearly identified and presented as such. In contrast, perhaps "conclusions" should be set forth in the other chapters and the Executive Summary.	Thank you for your comment and we will try to implement this suggestion in the rewrite of the report.
Implementation Issues	CPUC staff	There should also be some discussion of significant transmission planning issues for supporting renewable resource integration	Although transmission planning issues are not envisioned for areas outside the Tehachapi area, additional studies

		beyond the Tehachapi area, possibly for a 20% RPS and certainly for a higher RPS. In this regard, certain transmission facilities, constraints or proposed transmission additions should be identified as critical to wind integration. Moreover, the Report should explain, in a summary fashion at least, how the different issues surrounding wind integration and transmission planning will be addressed in a coordinated manner.	would have to be done for other wind parks to determine if there are any impending problems. Chapter 3 outlines the required wind turbine types, reactive requirement and LVRT requirements that are specified by the FERC and the WECC. The final report section 3.16 outlines some of the recommended changes to the Large Generation Interconnection Process that need to be done in order to address the transmission planning issues
Implementation Issues	CPUC staff	Task 8 in Chapter 10 very briefly addresses resource adequacy, referring to the need to develop "new models and scenarios." This same chapter contains a fuller description of needs or priorities regarding changes in system operations, which in some instances might require tariff changes. Both of these kinds of implementation issues, operations/market design and especially RA/procurement, should be more fully discussed as action needs going forward. Both would be clarified and supported by specific modeling and projection of the retirements, additions and operations of supply assets and transmission, by detailed assessment of existing generating assets	Thank you for your comment and suggestions. RA policy issues are clearly beyond the scope of this study but the CAISO will be glad to work with the CPUC on how some of the report's recommendations could be included in the RA program.

		and their likelihood of retirement, by assessing likely operating characteristics of new generation, and by analyzing the use of and changes to various market/operational "tools" (such as scheduling, ancillary services and residual unit commitment) in a more detailed fashion. While these kinds of analyses are outside of the targeted scope of the present study, their role going forward might be discussed in Chapter 10, and their relationship to the present study might also be discussed, perhaps in the Executive Summary, Background (Chapter 1) and/or Chapter 10.	
Implementation Issues	CPUC staff	More explicit modeling and analysis of the types summarized in the preceding paragraph would provide a basis for assessing the *economic costs* of integrating renewable resources. It would be helpful if the Report were to discuss and anticipate such economic assessments and what they require, if for no other reason than that such considerations are becoming relevant to procurement of both renewable and responsive/flexible generation.	An economic impact analysis was beyond the scope of this specific study but it is an issue that should be queued up for future consideration. Certainly there is more work to be done to implement the many tasks outlined in Chapter 10 of the report. Whether the CAISO should undertake an economic modeling and impact analysis study is an issue for a future project plan.
Implementation Issues	CPUC staff	We note that storage technology is identified as a promising tool for addressing renewable resource integration, and the Report devotes an entire chapter to storage. Yet, storage is	As mentioned in other parts of this document, the CAISO should initiate a workshop and stakeholder process for development of options for storage

		very difficult to value as a commercial investment. Perhaps, the "new models and scenarios to determine the 'best fit' generation portfolio for integration of large amounts of renewables" called for under Task 8 in Chapter 10 could include serious consideration of an operational and economic assessment of storage integrated with large amounts of renewable generation.	facilities.
Implementation Issues	CPUC staff	Finally, it would be useful for this Report, or a subsequent white paper to be issued in the near future, for the CAISO to begin to consider the role of stakeholders in addressing the complex & broad challenges posed by renewable resource integration.	Additional work is clearly needed on the identified issues and the action plans for implement the recommendations. Stakeholder involvement in this process is essential.
Grid Operation Issues/Storage Technology	MWSF	Role of Battery Storage. A well designed multi-MW battery storage system can address the increased needs for (1) regulation, (2) ramping & load following, and (3) over generation, while also providing time shifting of wind and solar generation to higher load periods. Such batteries may be the only technology that can provide all these capabilities from a single resource. Most thermal and other storage cannot respond as fast as batteries and flywheels. Flywheels address regulation only, and have limited storage duration.	Very good points and we are aware that a battery storage project has been announced on the east coast in connection with wind generation. More material is being added to the Storage section of the report concerning new battery technology and the Executive Summary of the report will be modified to include some of the storage recommendations.

		• The study correctly highlights storage as a major potential contributor to integration of intermittent resources; however it appears to not fully recognize the capability of batteries to provide very fast regulation and supplemental energy services along with other services. o For example, some of the conclusions regarding storage in Section 7, could be repeated in the Executive Summary of the report to emphasize the role that storage can play in efficiently integrating wind & solar into the grid & facilitating even more wind & solar on the grid. • The report states that battery storage is relatively costly and has limited storage duration. However, cost needs to be evaluated in the context of alternatives such as new generation & transmission projects that can also be costly & much more difficult to site & build quickly. And while battery storage capacity is limited, many of the uses of storage for fast response, regulation, ramping, over generation and shifting of solar energy a few hours do not require large MWh of storage per MW of storage capacity.	

		• The cycle efficiency of some battery systems is 75% or higher, which is better than most pumped storage & compares favorably with flywheel storage efficiencies. • Battery storage is a readily available solution (RAS) that can be deployed incrementally and moved if necessary. Lead times for battery storage are short in comparison to most generation and transmission alternatives. • Battery storage is a clean technology partner enabling the introduction of more intermittent renewables on the grid.	
Grid Operation Issues/Storage Technology	MWSF	Markets • Volatile prices for hourly and 5–min supplemental energy, regulation and other services will provide the primary economic drivers for revenues to support the operation and of existing and new resources including storage to respond to the renewables intermittency. However, such prices are often capped and RUC, out of market purchases, and other operating procedures may distort and dampen such signals.	MWSF raises many good points and questions on the effective use of storage technology and the market mechanisms needed to compensate storage facilities for the benefits they could provide. We obviously have much more work to do to define the role of storage technology, how it can be most effectively used with large amounts of intermittent resources and how it will be financially compensated for the services it can provide.

		• During over generation periods the CAISO report suggests that the CAISO may go out of market, use HASP to export over generation energy, or require the wind plants to curtail output. Similarly, the report states that the CAISO will use decremental regulation to the maximum extent in the event of over generation. However, all such actions will reduce the price volatility that is necessary for the efficient dispatch of storage and other fast responding resources and for recovering investment costs in these resources. • An alternative would be to change the lower price cap from -$30 per MWh to the same limit as the upper price cap which is now $400 per MWh and to change the lower price cap in the same steps as the upper price cap as MRTU is implemented. And if over generation is declared, the 5-min supplemental price could be set at the lower cap (a reverse version of scarcity pricing). Still other revenue streams may need to be provided to storage to compensate for depressed price volatility. • Fast responding storage such as batteries and flywheels can provide instant energy to adjust frequency, as	

		opposed to regulation from generators, which can take minutes to respond. • As suggested in the report, existing regulation markets need to be modified to take advantage of fast responding storage as well as to compensate such resources for their fast response. Use of fast responding resources will reduce the total MW of regulation purchases & costs, and provide more precise grid regulation. • Storage resources are energy limited and MRTU market rules & software may not be fully tuned to efficient dispatch of storage resources for wind and solar integration. • Battery storage is a resource adequacy technology than can contribute to an LSE capacity requirements. Counting rules for storage need to be addressed. • Batteries and flywheels can provide voltage support but there appears to be no clear compensation mechanism to incent the installation of such capability and its effective operation within wind parks or close to load.	

		• Studies have shown that the use of storage for regulation not only reduces the costs of operation of thermal units and saves fuel, but it also reduces carbon emissions from these services about 70%. However, such benefits may not accrue to the storage plants. • Forecasting, Scheduling & RUC – Does the use of RUC reduce the price volatility necessary to compensate storage? Will the installation of storage reduce RUC costs? How can storage be compensated for the effects of RUC? Can storage be eligible for RUC payments? • Hour-Ahead Dispatch and HASP - How will storage be integrated into HASP and at what prices? • Incentives for Storage – The report states that “New storage technologies should also be encouraged and tested within the state”. Presumably this statement would also apply to commercially proven storage technologies that are not yet deployed in the state. The report further states “Market incentives may be required to secure the flexibility needed to operate the system with large amounts of renewables.” What specific policy	

		directions are recommended by the CAISO in this regard? • Load Following Ancillary Service - Load following defined as an ancillary service with market based capacity payments as other ancillary services would help incent storage? No harm would be done by this, because if the capacity payments are unnecessary to attract the necessary response the capacity payments would be low or zero. • Special Tariff for Storage – The report asks whether there should be a special tariff for storage. Would this be a wholesale, CAISO tariff or a retail tariff? • Grid Services Performance Contract – The report suggests "The first commercial deployments of new storage technology will probably need some type of a grid services performance contract to share the financial risk. This will help the owner/operator get financial backing for the new venture and a chance to validate the business economics of the system. Part of the services they provide could still be market based and part could be contract performance based similar to RMR contracts."	

		• A storage project will provide a portfolio of transmission, distribution, generation and reliability benefits. Separate, independent operation of storage from transmission owners and operators is important to the integrity and proper functioning of CAISO energy, ancillary service and transmission rights markets. As a result, shouldn't ownership and operation of storage projects be independent of transmission and distribution ownership? Transmission and distribution entities can enter into contracts with independent storage operator/owners for services. This will provide an incentive for such independent storage services to develop.	
Grid Operation Issues/Storage Technology	MWSF	Incentives for Storage • The report states that "New storage technologies should also be encouraged and tested within the state". Presumably this statement would also apply to commercially proven storage technologies that are not yet deployed in the state. The report further states "Market incentives may be required to secure the flexibility needed to operate the system with large amounts of renewables." What specific policy directions are recommended by the	The author of these comments on storage raises many good points and questions. Obviously additional in-depth work is needed to answer the market questions, and whether there should be a special tariff for storage. Certainly storage can play a most valuable role in shaping and firming the energy production from intermittent resources and it can provide some the additional ancillary services that will be required.

		CAISO in this regard? • Load Following Ancillary Service - Load following defined as an ancillary service with market based capacity payments as other ancillary services would help incent storage? No harm would be done by this, because if the capacity payments are unnecessary to attract the necessary response the capacity payments would be low or zero. • Special Tariff for Storage – The report asks whether there should be a special tariff for storage. Would this be a wholesale, CAISO tariff or a retail tariff? • Grid Services Performance Contract – The report suggests "The first commercial deployments of new storage technology will probably need some type of a grid services performance contract to share the financial risk. This will help the owner/operator get financial backing for the new venture and a chance to validate the business economics of the system. Part of the services they provide could still be market based and part could be contract performance based similar to RMR contracts."	

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Grid Operation Issues/Storage Technology	Charles Toca, Utility Savings & Rapid Refund, LLC, sales affiliate for VRB Power Systems, Inc. (US&R)	We appreciate the work of David Hawkins and CAISO in evaluating the various energy storage technologies and their potential for integrating renewable energy. I would like to further clarify the attributes of the VRB flow battery energy storage system for such a task. • First, it's important to note that the main application of the VRB technology around the globe has been to integrate wind energy. From the 6 MW capacity installation in 2005 at Hokkaido Island in Japan, to the 200 kW capacity installation	Thank you for your comments on the attributes of flow based battery storage systems and the types of benefits they can provide for integration of intermittent resources. Certainly more work is required to develop the value equation to financially compensate storage faculties for the services they can provide.

		at King Island in 2003 in Australia, to the planned 2 MW capacity (12 MWHr) plant in Ireland; the VRB technology has proven its ability to integrate wind energy • Second, we feel it important to note that most advanced energy storage devices can provide the quick response outlined in the flywheel technology discussions. We suggest that the CAISO remain open to any technology that can meet the technical requirements needed to integrate wind. Each technology has its own applications and advantages in the "toolbox" available to the CAISO. For example, the VRB ESS can respond as quickly as the flywheel technologies and cycle rapidly. Plus, the VRB ESS, with its extended storage, can ramp up to full capacity and hold that level of production for hours, not seconds. We agree that one of the major obstacles to implementation is cost, although we have determined that the value of the CAISO ancillary services market would justify a VRB installation. The issues are more in the financing, as it's difficult to persuade investors to commit to a market based merchant plant. We agree that subsidies or other financing guarantees would help. With	

		the proper financial structure, a VRB plant can be built quickly, and many plants could be built at the source of the integration problem - the wind farm itself. This has been the practice in the past.	
Grid Operation Issues/Storage Technology	Harold Gotschall, Technology Insights, on behalf of NGK Insulators, Ltd's sodium-sulfur (NAS) battery	Disagrees with the California ISO statement that the efficiency of new storage technologies appears to be about 70% stating that the amount is closer to 75%.	The efficiency of different storage technologies certainly varies over a wide range. Generalization about the efficiency of all storage technology is probably misleading.
Grid Operation Issues/Storage Technology	NAS battery	Takes exception to the California ISO statement that the amount of energy storage capability of batteries and flywheels is 10 to 15 minutes and from flow batteries, hydrogen storage, and compressed air systems is one to two hours by stating that NAS batteries can deliver 7 to 8 hours of stored energy at installations having up to a 12 MW capacity.	We stand corrected.
Grid Operation Issues/Storage Technology	NAS battery	Notes that in addition to flywheels, NAS batteries are ideally suited to provide added regulation and can provide up to 40 MW of regulation services.	We would like to do a field test to verify the performance of NAS batteries to provide regulation services.

Grid Operation Issues/Storage Technology	NAS battery	**Sodium Sulfur (NAS) Batteries for Energy Time-Shifting and Renewable Generation Support.** NAS batteries are recently commercial in Japan (2002) and in the early stages of introduction to U.S. and global markets. Over 200 MW of NAS capacity have been deployed in Japan at installations up to 12 MW, each with nominal energy storage of 7 hours at rated power. American Electric Power (AEP) started operation of the first 1 MW unit in the U.S. in June 2006, and recently announced plans to acquire an additional 6 MW. Several other projects are under development in the U.S., including at California utilities. To date, the most frequent application in Japan has been off-peak to on-peak energy delivery (also known as time-shifting or peak-shaving). However, recent emphasis on wind generation deployment to meet the Kyoto protocol has stimulated development of large systems for combined time-shifting and wind stabilization, brought on by a combination of Japanese geography and the usual diurnal mismatch between peak wind generation and peak load. Because premium wind resources are remote from load centers & separated by complex terrain in Japan, wind patterns are turbulent, and wind developers are required to stabilize	Thank you for the update on NAS batteries. We certainly would like to see the commercial deployment of these and other types of storage devices.

		output before connecting to the grid. Also, Japan has a large fraction of base-load nuclear power with few generation resources to provide off-peak load-following. NAS installations will suppress short-term wind power fluctuations (similar to those associated with regulation control on U.S. grids), plus time-shift off-peak generation to on-peak loads. Accordingly, the NAS installation appears to the grid as dispatchable load during off-peak intervals & as dispatchable generation during on-peak intervals. A 34 MW NAS installation rated at 245 MWh storage is under construction at Rokkasho Village in Northern Japan. Operation is scheduled for April 2008. NAS battery applications attractive in U.S. markets include combinations of regulation control, load-following, T&D upgrade deferral, time-shift renewables generation and reliability enhancement. NAS batteries are sold by NGK Insulators, Ltd.	
Other Issues	PG&E	The CAISO correctly recommends additional transmission planning studies as well as studies to review the operational issues. PG&E concurs that such studies are necessary & is committed to working with CAISO & other stakeholders in this process.	The CAISO agrees that additional studies are warranted and this report is primarily focused on the interconnection of a large amount of wind generation in the Tehachapi area.

		• In fact, the CAISO's conclusion that "integrating 20% renewables in the CAISO Control Area is operationally feasible" may be premature. The CAISO's analysis evaluates the addition of 4,000 MW of new wind generation. This may not be the same as 20 percent renewables. • To address this, the CAISO should expand its integration analysis to include the impact of solar power intermittency and a higher level of new wind generation such as 5,000 MW and 6,000 MW. Studying a higher level of new wind generation should provide additional insight into the capability of the CAISO grid. This is especially important in testing the CAISO's finding that the existing grid is adequate to support the additional renewable resources if there is enough water for hydro generation, if new thermal units have the right operating characteristics, and if existing thermal units continue to operate at certain level. • Specifically, the CAISO should look carefully at how wind generation would be integrated during each season in each year, over the period from 2010 through at least 2014. In each year the CAISO	Some of the wind generation energy production diversity from geographically dispersed areas will be reduced due to the proposed increase of wind generation resources in the Tehachapi area. This interconnection of a variety of renewable resources in many areas will require more transmission studies while some of the operational impacts from a large amount of wind generation in one area may be mitigated. The CAISO Renewables Integration report is an engineering report on what it will take to operate the system with 20% renewable energy. A cost impact analysis was not a part of this study. We share PG&E's concerns that the retirement of some existing fossil fueled generation may seriously reduce the type of resources that will be needed to complement the intermittent energy production from large amounts wind and solar generation. New fossil fueled generators should be designed for fast starts; frequent start ups and shuts downs, lower minimum operating points, faster ramping capability and the ability to provide AGC regulation

		should recognize generation additions, generation retirements, and transmission improvements that are expected to occur. The CAISO should also consider the impacts of both dry and wet year hydro availability. The CAISO should identify 1) potential additional sources of ancillary services, 2) potential sources for the bid stack, and 3) potential out of CAISO generation that can be displaced or pumping that can occur. The CAISO should then discuss with operators of the sources or displacement of power production if in fact they expect the CAISO assumptions to be realistic.	services. Units with these characteristics can be built and provide the serves needed. It is important that this need be recognized and action taken now to specify the construction of units with these capabilities so when some of the existing fleet of generators are retired, we have replacement units that are capable of supplying the services that will be required to match the energy production characteristics of large amounts on renewable resources.
Other Issues	MWD	Scope: clarify that the report only assessed the impact of certain wind development and future studies need to also incorporate solar along with more wind developments.	The CAISO agrees that more should be done to analyze the impact of grid connect solar systems. At the present time, we have a very limited amount of operating data from such facilities.
Other Issues	MWD	Costs: The report does not address cost impacts for the increased integration services. However, in the California Energy Markets weekly, dated 10/5/07, on pg. 9, an ISO operator is quoted as saying: "Hundreds of millions of dollars is spent on regulation & where we're going – with increased amounts of	We were misquoted in the California Energy Markets report and these statements do not represent the true facts. In 2006, regulation services cost an estimated $110 million. The average amount of regulation services required for the 20% RPS target will increase by an estimated 10%. For

		intermittent renewables – the amount of regulation is going to increase. We're looking at billions in trying to make this happen". If true, the issue of cost impacts & who will pay for it cannot be deferred. • Either MSC or another ISO group needs to perform a study on how increased regulation and ramping requirements due to increased intermittent renewables will affect the market. • Cost causation principles should require that those who are responsible for increased costs without commensurate benefits should be responsible for bearing such costs.	some hours it will be more and some hours it will be less. The impact on the regulation market and the change is the price and cost for regulation services was beyond the scope of this project.
Other Issues	PG&E	Analysis of the Cost of Integration - The CAISO should include a quantitative analysis of the cost of integrating renewable resources. In addition to acknowledging the increase in ramping and regulation requirements associated with increased intermittency generation, the CAISO report concluded that the integration of additional new wind generation could increase market prices. PG&E recommends the CAISO quantify these integration costs. It is important for the CAISO and stakeholders to understand the impacts of intermittency	An analysis of the cost of integration of renewables to meet the 20% RPS target was beyond the scope of this study.

		generation on both an economic as well as an operational basis. This will help inform state initiatives to assess future renewable penetration goals. This will also help those responsible for procurement to plan for the costs of renewable integration.	
Other Issues	PG&E	The CAISO's study is an excellent first step in assessing the impacts of integrating large quantities of intermittent renewable resources into the electric grid. PG&E recommends that the CAISO continue its work, in coordination with the CEC, CPUC, and market participants, to complete a broader and deeper investigation of the impacts and costs of intermittency generation, and the operational changes, facilities and infrastructure needed to achieve such integration.	The CAISO agrees that there is more work to be done to implement the changes recommended in the report and to continue the coordination efforts in the state. We agree that it is critical to coordinate the construction and interconnection of new wind and concentrated generation with the construction of transmission facilities. Without adequate transmission capability, the new wind and solar generation resources will be stranded. The developers of the new generation facilities are very aware of the transmission construction schedule and it is our understanding they are timing their construction plans accordingly.
Other Issues	California Department of Water Resources – State Water	As owner and operator of a number of large hydroelectric generating facilities and pumped-storage facilities, SWP has long supported the development of Renewable resources . . . [and] SWP is committed to	The CAISO appreciates CDWR comments that the state water project has many constraints and obligations. We look forward to working with CDWR

	Project (SWP)	working independently, and with other State agencies, to develop and help implement strategies to increase the cost-effective use of renewable energy in California SWP has concerns related to the possible expanded or altered use of it's hydroelectric generation and/or pumped-storage facilities to assist in the integration of renewable resources. Since, water management & delivery are the primary purpose of these facilities, generation and pumped-storage operations by these facilities are only available to the electric grid to the extent water management responsibilities permit. Further, SWP's facilities operate under a wide-range of unique operational and environmental constraints. Most of the SWP storage facilities serve multiple functions for storing water for prudent carryover reserves, controlling flood flows, providing recreation facilities, & regulating water deliveries to its water contractors, & some of these functions can conflict with the short term requirements of the electrical grid. In addition, there may be severe environmental restrictions in place during parts of the year which control the allowable flows through its facilities. In some years, water may be unavailable for pumped-storage operations. Consequently, any	in exploring ways that we can work together to collaboratively help the state achieve the 20% RPS target. Whatever new technology and new ideas that can be use to solve some of the integration issues will be most welcomed. We recognize that the state's pumps represent a substantial electric load and we believe that demand response is an important element in mitigating rapid changes in the energy production of intermittent resources.

		increased or altered use of SWP's facilities for integration of renewable resources may be extremely difficult. SWP also confronts significant unknown constraints relating to recent environmental rulings. Recent court orders that restrict pumping from the delta to protect endangered fish have put both Federal and State operations in the delta into question. The SWP does not know how its operations could be affected, but it is clear that its previous assumptions and plans are going to have to change, and this will likely force it to modify its power operations in order to ensure the reliability of its water supply. SWP believes its direct participation with CAISO is needed to meet the Storage and Integration goals for renewables. In general, SWP requests that the CAISO will need to talk directly to the hydroelectric operators & owners to assure that their needs & concerns are being addressed and met. This need for direct consultation with SWP is critically important given the unique & essential nature of SWP operations. Please contact Charles Kearney, Chief of Resource Acquisition at (916) 574-0670 if you have any questions.	

Other Issues	SCE	This Draft Report focused on wind generation, & in particular Tehachapi wind, and assumed that there would be limited operational issues associated with the performance of other renewable resources. Given the Draft Report's exclusive focus on wind resources, the Draft Report's title should be changed to "Integration of Wind Resources."	The point is accurate but is probably too late in the process to change the title of the report.
Other Issues	SDG&E	Based on the report, only wind generation was added in the Tehachapi region & subsequently analyzed for integration issues. The report did not analyze other renewable resources & how they interact and perform with this wind generation. Thus any integration issues associated with solar or geothermal were not studied. As such the title of the report is misleading and a more appropriate title would be "Integration of Wind Resources in the Tehachapi region".	The impacts of other renewables such as biomass, geothermal, small hydro and solar were quite extensive covered in the CEC IAP report. The CAISO was a major participant in that study and we did not find these other renewable resources presented any significant integration issues for the 20% RPS target.
Other Issues	SCE	SCE urges the CAISO to perform its study at the 33% renewable resource level. It is expected that the results at the 33% renewable resource level will not be linear so it is important for the CAISO & stakeholders to understand the implications of grid integration at the 33% level in order to make informed policy decisions. For example, at a presentation given to the CPUC on August	The CAISO agrees an additional study for the 33% RPS target is needed.

		27, 2007 (which can be found at http://www.cpuc.ca.gov/static/hottopics/1energy/caiso+renewables+and+demand+response.pdf) on page 25 of that presentation the CAISO states "The amount of wind generation and solar generation will have to more than double to achieve the 33% goal." The CAISO should be clear in the study that significant additional challenges will arise in the operation of the grid to progress towards a 33% RPS goal.	
Other Issues	SCE	Although the focus of the Draft Report should be on technical issues, the Draft Report should also address the additional cost of integrating these resources based on the proposed operational changes to maintain system reliability. At least the following issues should be considered: sub-optimal operation of resources, pro-rata generation reduction from wind resources, addition of quick start capability units, and other factors.	SCE has identified some important issues; however, they are beyond the scope of this study and report.
Other Issues	SCE	On pages 91-96, CAISO proposes future work by Task. The question under Task1, as pointed by CAISO, has major implication in meeting NERC/WECC Reliability Performance Standards. SCE believes that this issue needs to be addressed with highest priority. If SCE/CAISO can not meet the new Reliability Performance Standards,	The CAISO agrees and a separate project to address the ramp forecasting issue is currently planned.

		due to lack of the proposed tools and systems, then there are monetary penalties of the order of $1 million per day per event.	
Other Issues	PG&E	The CAISO Study Should be Expanded to Include WECC and NERC Reliability Requirements: • The WECC and NERC are considering revising reliability requirements. They have begun a process to develop frequency response requirements. Additional wind power may make meeting these developing requirements more difficult. The CAISO should investigate the potential for a frequency response requirement and how it would meet this requirement. • The CAISO covers a number of contingencies in the Post-Transient Voltage Stability Analysis in its draft report. However, it is not clear from the draft report whether compliance with NERC/WECC Planning Standard[4] I.D, which addresses voltage support and reactive power, has been established.	The CAISO is addressing the proposed FRR standard as a separate project. We agree it is critical to have a strategy for meeting such a requirement. This issue, however, is beyond the scope of this study on integration of renewables. The CAISO conclusions in the post transient voltage stability analysis were done in accordance with the NERC/WECC planning standards. Also, the CAISO conclusions in the Q-V analysis were done in accordance with the NERC/WECC planning standards.

[4] http://www.wecc.biz/documents/library/procedures/planning/WECC-NERC_Planning%20Standards_4-10-03.pdf
[5] http://www.wecc.biz/documents/library/procedures/VoltageStabilityGuideMar-30-2006.pdf

		• Specifically, for a "Q-V" analysis, the WECC methodology outlined in several publications, including the guide to WECC/NERC planning standards I.D relating to voltage support and reactive power[5] calls for first establishing a reactive power margin requirement at a bus to form the basis against which the system performance can be assessed. Then, compliance can be demonstrated by comparing the reactive power margin (RPM) at that bus against the established RPM requirement. • The draft report documents the RPM at various buses for various contingencies. However, it is not clear what the RPM requirements would be. RPMs by themselves do not demonstrate compliance without comparing against the respective requirements. • In addition, NERC/WECC Planning Standards I.D.WECC-S1 and I.D.WECC-2 require that either the transfer path flow or the load in a load area be modeled at 105 percent of the path rating or the load for Category A system conditions and Category B contingencies, and at 102 percent of the path rating or load for Category C contingencies.	

		• These RPM requirements may have been established, but if so they need to be included in the report for completeness. If not, they should be addressed.	
Other Issues	SCE	While the Report's discussion on issues related to wind integration at national and international level may help inform the discussion, it is SCE's opinion that the challenges that California will face will be unique due to the market structure, type and mix of generation (current and future), and location of renewable resources relative to the location of major load centers, percentage of RPS targets, etc.	The CAISO agrees that California has unique renewable integration issues. We do believe studies and reports from other areas with large amounts of renewables can provide some insights and potential solutions we should consider in California. We can learn from others and not have to repeat their mistakes. Applicability of proposed rules and methods should be subject to rigorous analysis and testing before they are adopted.
Other Issues	SCE	Given the impact the final report will have on shaping future California energy policy, a more extensive review and comment process is needed. Too many key issues were unaddressed in this iteration. After taking into consideration this initial round of comments, the CAISO should release the data and assumptions requested above. Then, after a sufficient review period, stakeholders should be allowed a second round of comments before the CAISO releases a final report. With more developed and informed feedback, the stakeholders can then fully	The CAISO believes we have used a process that involves stakeholder feedback on the DRAFT report and we have modified the original report to reflect the many valuable comments we received from many reviewers. There is obviously more work to be done to implement many of the recommendations in the final report. A formal renewables project for 2008-9 is planned and it will provide for lots of stakeholder input and prioritization of tasks.

		assist the CAISO in its goal of identifying issues and solutions for the integration of renewable resources.	
Other Issues	AWEA	**Conventional Generation Flexibility** AWEA agrees with CAISO that it is important to include changes in the Resource Adequacy standard to require more generation with faster and more durable ramping capability as well as additional quick start resources. Conventional generators with increased flexibility will be better positioned to profit under future market conditions. CAISO should assure that sufficient information is available to allow conventional generators to make enlightened decisions as they evaluate future investment. Regulators should also monitor the flexibility of the projected generation fleet and take actions to assure fleet flexibility if it appears that market forces alone will not result in adequate flexibility.	Thank you for your comments and constructive suggestions.
Other Issues	CPUC Staff	The CPUC Staff's most important, overarching concern is that the study's implications could be better appreciated if its approach and scope were more explicitly placed within the broader context of overall renewable integration issues and studies. This concern is elaborated below.	Thank you for your constructive comments and identification of issues that need to be addressed. The Final Report has been extensively rewritten to be more readable and clearer on the results of the investigative work and recommendations. The CAISO intends to continue work

		The CAISO's Integration of Renewable Resources Report focuses on two major concerns, adequacy of the Tehachapi transmission plan to accommodate 4164 MW of total wind generation, and statistical assessment of increased demands on system operating flexibility due to the temporal patterns and forecasting uncertainty for 6688 MW of wind generation system-wide. These high priority issues have been addressed in a relatively short period of time using considerable detail and realism regarding electrical flows, system operations and wind generation patterns. As a result, the CAISO's Draft Report provides valuable insights as well as some reassurance that we can realistically and physically accomplish the system integration that our renewable energy goals will necessitate. In pursuing such a detailed assessment of selected high priority issues in a short time, the Draft Report necessarily focuses on certain matters but not others. Assessing the wider range of renewable resource integration issues would necessarily take more time and resources. However, in order to facilitate a broad understanding of the context and significance of the study process that is reflected in the Report, and to help anticipate what is required going forward, it	on the integration of renewable resources and we will try to address some of the CPUC's suggestions and concerns in the next phase of the work.

		would be very helpful if the final Report more clearly identifies the *broader range* of renewable resources integration challenges and analyses, beyond those that are addressed in the Draft Report. This perspective would be enhanced by a summary of wind integration studies conducted elsewhere. • For example, regarding the study of transmission plan adequacy (Chapter 3), it would be helpful for the Report to describe what the WECC power flow cases represent and how they were used (as noted in comments under subject area 1). • Furthermore, it would be useful to describe the possibility that actual future conditions regarding generation, transmission and operations might differ, and how such differences could affect the Report's conclusions and the identification of future challenges to the integration of wind resources. • Also, the final Report should prominently state that the static, statistical-plus-qualitative assessment of system operating response requirements due to wind and load fluctuations and	

		unpredictability on which the Draft Report's operations-related conclusions are based does not include dynamic modeling of system operations and composition, and does not address the roles of individual generators and transmission facilities. • The implications of the Report's reliance on the statistical/static methodology should be discussed. For example, certain operational and wind generation details may actually be best explored by NOT modeling the system. On the other hand, some insights and identification of key constraints might require explicit modeling of system operations, including utilization, additions and retirements of assets. • Further, it is important to recognize that analysis of the economic costs of integration requires an explicit consideration of system assets and operations as they may exist in the future.	
Other Issues	CPUC staff	In some instances, the Draft Report does not clearly distinguish specific analytic results of the present study versus generalizations, results, or info from other sources. This distinction should be made more explicit.	The final report was extensively rewritten and distinctions should be clearer.

Other Issues	CPUC staff	Near the front of the Draft Report, it was indicated that the approach for assessing the 33% RPS target would be addressed in Chapter 10. It is unclear if this approach will be included in the final Report.	Reference to a 33% RPS study were in error and have been corrected
Other Issues	CPUC staff	Finally, for the sake of clarity, Appendices A, B, *etc*., should be internally structured as A.1, B.1, *etc*. The use of 1.1, 2.1, etc. in the appendices tends to confuse appendix contents with main body contents.	The Appendix material was extensively rewritten and we hope it is less confusing for the readers.