



California ISO

Primary Frequency Response

Summary of Stakeholder Comments Appendix

October 20, 2015

1. Introduction

The Frequency Response initiative’s goal is to propose an option that will reduce the risk of the ISO not complying with a new NERC standard requiring a defined amount of primary frequency response (PFR) within 52 seconds of a disturbance. The ISO is issuing this appendix to the Frequency Response Straw Proposal in order to summarize the stakeholder comments on the Issue Paper and provide the ISO’s responses to these comments.

2. Summary of Stakeholder Comments and ISO’s Responses

Section 5 of the ISO’s Straw Proposal discusses the summary of stakeholder comments and the ISO’s responses.

Stakeholder comments on the Issue Paper have been summarized in a matrix organizing comments into the following ten topics.

- Design market tools
- Design market-based solution
- Expand capacity requirements
- Modify spinning reserve procurement
- Primary frequency response certification
- Primary frequency response sharing
- Requirements for participating generators
- Role of load shedding
- Role of non-conventional resources
- Understanding the issue

Topic	Market Participant	Stakeholder Comment	ISO’s Response
Design market tools	Pacific Gas and Electric	CAISO should actively monitor frequency responsive reserves and try to forecast frequency response needs that can be used as inputs in DA and RT markets.	Section 6.2.1 addresses the need for anticipating real-time primary frequency response deficiencies. The ISO’s proposal supports the development of look-ahead assessment tools to forecast frequency response needs and assess frequency response capabilities.
	Union of Concerned Scientists	CAISO should develop a tool to determine adequacy of committed resources and track response in real-time as well as actual and minimum required inertia.	

Design market-based solution	California Large Energy Consumers Association	How does the cost of procuring more spinning reserves compare to a frequency response product where resources will add capability based on expected compensation? What are the long-term trade-offs between a requirement and a market-based approach?	The ISO is committed to evaluating the long-term trade-offs between a requirement and a market-based solution. Section 6 of the ISO's proposal supports a two-phased approach which enables satisfaction of the FRO through various real-time actions including additional modifications of the spinning reserve requirement in the near-term. In Section 6.3, the ISO proposes to continue evaluating the differing costs of modifying spin procurement versus market-based solutions. The second phase may introduce a market product or constraint if necessary.
	California Department of Water Resources	If study process shows there is a need for a market product, CAISO should develop one. Ultimately, it should choose between increased spinning reserves and a market product.	
	San Diego Gas and Electric	When would CAISO be able to develop a product and what would be done in the interim?	Section 6 of the ISO's proposal supports a two-phased approach which enables satisfaction of the FRO implementing 5 near-term approaches to ensure compliance followed by an evaluation of long-term market-based solutions. The ISO proposes using the 2017 compliance period to further evaluate its performance and the impact of the near-term approaches discussed in Section 6.2 on actual performance. Further, the ISO anticipates the implementation of the near-term approaches will lay the foundation for the development of market-based solutions if found necessary.
	California Energy Storage Alliance	There could be a constraint in the optimization that would act similarly to a Frequency Response product or constraint.	

	Union of Concerned Scientists	Make constraints in market optimization that can be turned into products in 2017.	
	Wellhead	CAISO should lean on fast-responding resources.	Section 6.2.1 of the ISO's proposal supports the consideration of system capabilities through the continued development of look-ahead assessment tools. The ISO proposes to consider the frequency response characteristics such as time delay of specific resources when taking real-time actions to ensure sufficient frequency.
	California Department of Water Resources	CAISO should follow its cost allocation guiding principles if additional frequency response capacity is procured. Cost allocation should be similar to that of the flexible ramping product based on deviation of generators, loads, and inertias. Additional frequency response capacity costs should be allocated to resources that caused the disturbance.	Section 6 of the ISO's proposal supports a two-phased approach which enables satisfaction of the FRO through implementing 5 near-term approaches to ensure compliance followed by an evaluation of long-term market-based solutions. Frequency response costs may be priced in the spinning reserve unit's bid to ensure adequate compensation. The second phase may introduce a market product or constraint if necessary.
	Cities of Anaheim, Azusa, Banning, Colton, Pasadena, and Riverside	No market product unless it is the only feasible compliance tool.	Section 6 of the ISO's proposal supports a two-phased approach which enables satisfaction of the FRO through implementing 5 near-term approaches to ensure compliance followed by an evaluation of long-term

	San Diego Gas and Electric	A market product would not be implemented in time and may not be needed in the medium to long term.	market-based solutions. The ISO agrees the idea of a market-based solution has merit under this initiative but since such mechanisms could not be designed, approved and implemented by December 1, 2016, the ISO will need to consider them in a second phase of this initiative. In Section 6.3, the ISO proposes to continue evaluating potential market efficiency improvements from implementing market-based solutions such as a market product or constraint if found necessary.
	California Large Energy Consumers Association	The idea of a frequency response product has merit. There should be proper compensation to insure that resources do not limit governor response. Also, resources should be compensated for investing in smart inverters or reducing load to help with frequency response.	
	California Energy Storage Alliance	CAISO should review regulation product designs. Eventually, there should be a Frequency Response product for both DA and RT markets.	
	Jack Ellis	There should be a market product.	
	Large Scale Solar Association	A market would incent asynchronous resources to provide frequency response and pay for added costs.	

	NRG Energy	There should be a market product.	
	Wellhead	Supports long term market that is pay-as-you go, only requires procurement of amount needed, has transparency and accountability, and encourages products that are fast-responding and GHG-free.	
	Wellhead	CAISO should procure in DA market.	
	Western Power Trading Forum	There should be a full FR product.	
	California Energy Storage Alliance	Resources should be incentivized to participate in markets, not forced to provide capabilities.	

	California Energy Storage Alliance	Market solutions are better than imposing a standard for all generators.	
	Union of Concerned Scientists	A requirement should only be considered when there is not a significant cost. Or just have a PFR market.	
	NRG Energy	CAISO would need to establish market signals to commit more units in order to obtain frequency response.	
	California Energy Storage Alliance	Resources could be selected in DA and RT optimization and scheduling runs to preserve enough headroom for frequency response. They could be compensated through capacity payments, opportunity cost payments, avoided cost of non-compliance, or other options. There should also be cost (like fuel cost) recovery).	
	NRG Energy	If there is not a market product, there should be	

		uniform non-discriminatory compensation.	
	Large-scale Solar Association	A market would incent asynchronous resources to provide frequency response and pay for added costs.	
	NRG Energy	There needs to be proper market structure to compensate resources for providing headroom and for actual response.	
	Pacific Gas and Electric	CAISO should work on developing a permanent solution and needs to provide analysis justifying any interim measures.	
Expand capacity requirements	Wellhead	CAISO should consider expanded flexi-ramp.	The ISO is not proposing adjustments to flexible ramping and other capacity requirements at this time but will continue to evaluate if potential benefits might exist. These issues are beyond the scope of this initiative.
	California Energy Storage Alliance	CAISO could require frequency response capability as part of RA.	
	California Energy Storage Alliance	In the long term, CAISO could work with CPUC and other LRAs to come up with longer-term capacity contract solutions.	
Modify spinning reserve procurement	Cities of Anaheim, Azusa, Banning, Colton, Pasadena, and Riverside	The ISO should examine whether current spinning reserve procurement would be sufficient.	The ISO is evaluating whether additional procurement of spinning reserves would be sufficient to ensure frequency responsive headroom. Additionally, the ISO is

Bay Area Municipal Transmission Group	CAISO should consider the effect on the amount of spinning reserve procured and the spinning reserve provided for a single unit.	considering the cost and magnitude of spinning reserve modification in Phase 1. Section 6.2.1 of the ISO's proposal supports the use of various real-time market actions to procure frequency responsive headroom including but not limited to the spinning reserve market.
California Department of Water Resources	CAISO should examine whether primary frequency response should be provided by spinning reserves.	
San Diego Gas and Electric	How much supply and procurement of spinning reserve is the CAISO currently seeing in the DA and RT markets? How liquid is the market or what does the Page 2 of 4 supply price (cost) curve look like? How large is the spinning reserve market now and how much would the estimated need increase if looking at procuring to meet frequency response needs in the future? How costly may this method be, particularly in periods of over generation?	
California Energy Storage Alliance	If Spinning Reserve is used, resources should be able to include Frequency Response in addition to Spinning Reserve costs.	Frequency response costs may be priced in spinning reserve unit bid cap to ensure adequate compensation.
Union of Concerned Scientists	Increasing spinning reserve requirement could lead to new capacity costs.	Section 6.2.1 of the ISO's proposal supports implementing 5 near-term approaches to ensure compliance including the consideration of spinning reserve capabilities through the continued development of look-ahead assessment tools. The ISO proposes to continue evaluating changes to costs such as increased capacity costs throughout 2017 compliance period and to use these lessons-learned in Phase 2.
California Large Energy Consumers Association	Concerned about using spinning reserve in lieu of a frequency response product. CAISO may have to procure more spinning reserve at additional costs.	
Pacific Gas and Electric	Supports expanding spinning reserve requirement, but CAISO should examine cost implications of this.	

	Jack Ellis	Spinning reserves are a source of secondary frequency response, not fast enough for primary.	Section 6 ISO's proposal supports a two-phased approach which enables satisfaction of the FRO through implementing 5 near-term approaches to ensure compliance. One of these approaches described in Section 3.2 supports procurement of spinning reserves to provide automatic primary frequency response. Spinning reserves insure available unit headroom and necessary governor control system performance requirements which enable primary frequency response. The ISO considered these factors during its evaluation of the effectiveness of sole reliance on spinning reserves to ensure sufficient frequency responsive headroom. The ISO proposal under Section 6.2.1 includes exceptional dispatches under potential real-time actions in addition to reliance on spinning reserves. Section 6.3 of the ISO's proposal supports further evaluation of the development of a phase two product or constraint which would create market signals to commit units to meet the FRO.
	NRG Energy	Procuring additional spinning reserves might work as an interim measure, but buying more spinning reserve on same synchronous machines may not increase response.	
	Union of Concerned Scientists	Increased spinning reserve requirement would probably raise commitment in many hours. Also, more generators would be running at low output and thus generating more GHG emissions. When there is low net demand, increased committed generation (especially at min load) would lead to increased curtailment of renewables and increased cost.	
	Western Power Trading Forum	Spinning reserve will be at least as complicated as a new product.	
	Western Power Trading Forum	Regulation up counts towards spinning reserve; this would have to be restricted.	Section 6.2.1 of the ISO's proposal supports modifications to spinning reserves that will help the ISO meet this new obligation. The impacts on regulation and other ancillary services is being considered at this time.
	Western Power Trading Forum	Ancillary services are constrained regionally.	

	Large Scale Solar Association	The ISO should always have the option of using spinning reserves.	Section 6.2.1 of the ISO's proposal supports the consideration for spinning reserves capability in helping to meet the FRO and the consideration of spinning reserve capabilities through the continued development of look-ahead assessment tools.
	Western Power Trading Forum	Could initially use spinning reserve offer slack to meet 2016 deadline.	
	California Energy Storage Alliance	If there's no explicit frequency response requirement for spinning reserve, there could be potential reliability risks (noncompliance with NERC rules).	
			Section 3.2 of the Straw Proposal describes the current frequency response requirements for spinning reserve units. The ISO is proposing applying minimum frequency response performance requirements on participating generators having governors under Section 6.2.4 of its Straw Proposal.
Primary frequency response certification	California Department of Water Resources	A "frequency response certification process" for resources that are already certified to provide ancillary services should be examined. Generators with outer-loop KWh control would not be certified.	The ISO is not proposing a certification process for resources with primary frequency response capabilities at this time but will consider its merits as the initiative progresses.
	California Department of Water Resources	Maybe more spinning reserves could be procured from "certified frequency response" resources as an interim solution.	
	California Department of Water Resources	CAISO should examine whether a new "frequency response certification" is necessary.	
Primary frequency response sharing	San Diego Gas and Electric	There should be a Frequency Response Sharing Group where CAISO can partner with other BAs to meet obligation.	The ISO is not proposing to establish a frequency response sharing group at this time as other efforts are in place considering the establishment of frequency response sharing in WECC. This issue is outside the scope of this initiative.
	Jack Ellis	The only other solution than a market product is procuring primary frequency response from neighboring BAAs.	

	Pacific Gas and Electric	CAISO should consider procuring frequency responses from other WECC BAAs, at least in the interim.	
	Union of Concerned Scientists	It would be helpful to trade frequency response with other BAs.	
Requirements for participating generators	Union of Concerned Scientists	Will the ISO be in compliance with the PFR standard (NERC standard BAL- 003-1) if all synchronous resources that should have governor response were to enable their response?	Section 6 of the ISO's proposal supports a two-phased approach which enables satisfaction of the FRO through implementing 5 near-term approaches to ensure compliance. The ISO anticipates if all resources having governors enable their response and the proposed real-time actions are available to ensure sufficient frequency responsive headroom then it will be in compliance.
	Bay Area Municipal Transmission Group	WECC's Governor Droop Setting Regional Criterion allows for generators to have governor droop settings ranging from 3% to 5%. Perhaps CAISO could change its response settings recommendations to improve performance (such as 5% for hydro, 4% for other synchronous generation, and 3% for batteries).	Section 6.2.2 of the ISO's proposal supports tariff revisions that require specified droop settings and deadbands for all participating generators with governor controls.
	NRG Energy	CAISO would need to discuss changes in governor droop settings with participants if spinning reserves were used.	
	Large-scale Solar Association	Consider temporary changes to droop settings.	
	Jack Ellis	Penalties for failing to provide frequency response should be severe enough so there is no need for additional testing or certification. Also, the cost of a NERC compliance violation should first be allocated to providers who failed to perform during the disturbance based on the amount short.	Section 6.2.4 and 6.2.5 of the ISO's proposal supports consideration for performance requirements and penalty allocation procedures.

	Cities of Anaheim, Azusa, Banning, Colton, Pasadena, and Riverside	The ISO should consider a requirement, at least for new resources	Section 6 of the ISO's proposal supports a two-phased approach which enables satisfaction of the FRO through implementing 5 near-term approaches to ensure compliance followed by an evaluation of long-term market-based solutions. The ISO proposes requirements for participating generators having governor control in Section 6.2.2 of its Straw Proposal. The ISO is proposing applying minimum frequency response performance requirements on participating generators having governors under Section 6.2.4 of its Straw Proposal. Finally, the ISO will consider requirements for inverter-based resources in Phase 2.
	Jack Ellis	There should be performance obligations for primary frequency response providers, including (1) amount of committed response capacity, (2) expected duration of response (should be 5-15 minutes), (3) Maximum allowable response latency (starts when response is triggered, ends when response provide stops responding), and (4) rise time (amount to time to ramp from 0 to committed response level).	
	Jack Ellis	Response could be provided by synchronous resources but amount is unknown and hard to estimate. Response can also be provided by load or wind, solar, and other intermittent resources, but it is hard to predict. There should be a requirement to demonstrate that obligations can be met.	
	Union of Concerned Scientists	Droop settings specify response as MW/Hz, but UCS is unaware of a response time in which the resource must provide this response. Is there a standard for this?	
	Wellhead	CAISO should include resource inertial constant and FR ramp rate in GRDTs.	
	California Energy Storage Alliance	There would need to be a flag in the master file for resources	In Section 6.2.2, the ISO proposes to include requirements for participating generators to provide governor control system data for inclusion in the Masterfile. The ISO continues to evaluate the feasibility of adding a requirement to submit these additional pieces of information to the proposed

		willing to provide frequency response.	tariff revisions in section 6.2.2. of its proposal.
Role of load shedding	California Large Energy Consumers Association	CAISO should consider a provision for frequency-based load shedding. PG&E tariff allows for monthly payments for load-shedding triggered by frequency at or below 59.65 Hz for 20 seconds.	The ISO is evaluating the role of under frequency load shedding. This issue is outside the scope of Phase 1 of this initiative but will be further evaluated under Phase 2.
	Union of Concerned Scientists	There should be a role for increased under-frequency load shedding.	
Role of non-conventional resources	San Diego Gas and Electric	Renewables will push more synchronous resources offline. There would need to be contract changes to permit renewables to reserve extra headroom for frequency response	Section 6 of the ISO's proposal supports a two-phased approach which enables satisfaction of the FRO through implementing 5 near-term approaches to ensure compliance followed by an evaluation of long-term market-based solutions. The effect of implementing near-term solutions on renewables will be evaluated throughout the 2017 compliance period and considered in Phase 2. The second phase may introduce a market product or constraint if necessary and will take into consideration the effect of renewable resources contracts on the liquidity of such market-based solutions.
	Bay Area Municipal Transmission Group	Any requirement for frequency response from asynchronous generators will have to consider lost opportunity costs for resources that maximize energy output.	Section 6 of the ISO's proposal supports a two-phased approach which enables satisfaction of the FRO through implementing 5 near-term approaches to ensure compliance followed by an evaluation of long-term market-based solutions. In Phase 1 and Phase 2, the ISO continues to consider and address the impact of opportunity costs when resources are providing frequency responsive headroom. Section 6.2.1 discusses the ways in which

			the ISO proposes to address opportunity costs.
	Union of Concerned Scientists	UCS studies showed that regional generation requirements could cause 11-39% of renewable curtailment.	Section 6 of the ISO's proposal supports a two-phased approach which enables satisfaction of the FRO through implementing 5 near-term approaches to ensure compliance followed by an evaluation of long-term market-based solutions. The effect of implementing these near-term solutions on renewables will be evaluated throughout the 2017 compliance period and considered in Phase 2. This evaluation will include renewable curtailments, if any occur.
	Bay Area Municipal Transmission Group	CAISO should study a greater role for batteries in providing faster frequency response.	Section 6.3 of the ISO's proposal supports the development of a product or constraint which may create a greater role for batteries in providing frequency response.
	Jack Ellis	Batteries and storage can provide full primary frequency response if SOC allows it. Wind and solar capabilities are more uncertain.	Section 6 of the ISO's proposal supports a two-phased approach which enables satisfaction of the FRO through implementing 5 near-term approaches to ensure compliance followed by an evaluation of long-term market-based solutions. The effect of implementing these near-term solutions on renewables will be evaluated throughout the 2017 compliance period and considered in Phase 2. Discussed in Section 6.3, the ISO will evaluate the role of non-conventional resources
	Bay Area Municipal Transmission Group	CAISO should work with the CEC and IEEE to include frequency response requirement for EV charging equipment before there are many charging stations without it.	

	San Diego Gas and Electric	What is timeline for shift towards asynchronous resources? Will storage come quickly enough to add FR?	to provide primary frequency response. These considerations are outside the scope of Phase 1 but will be evaluated under Phase 2.
	Jack Ellis	CAISO shouldn't explore a requirement for non-synchronous generation to have FR capability. There would be no compensation to generators, which are mostly operating under fixed-price purchased power agreements. It's not clear that it would be cost-effective to equip most non-synchronous generators to provide primary frequency response.	
	Large Scale Solar Association	There should only be a requirement for asynchronous resources to have FR capability as a last resort, and it should only apply to new generators if implemented.	
	NRG Energy	Doesn't object to a requirement but asynchronous sources should not be default source of frequency response.	
	Pacific Gas and Electric	Supports examining using asynchronous generators to provide primary frequency response.	
	California Department of Water Resources	CAISO should require frequency response from non-synchronous generators and determine total capability for such resources	
	California Department of Water Resources	The ISO should explore a requirement that nonsynchronous generators have primary FR capability	

Understanding the issue	Union of Concerned Scientists	If the ISO could enable governor response on all resources that should be responding today, in what year would the ISO expect to be out of compliance with BAL-003-1?	Section 6 of the ISO's proposal supports a two-phased approach which enables satisfaction of the FRO through implementing 5 near-term approaches to ensure compliance followed by an evaluation of long-term market-based solutions. The second phase may introduce a market product or constraint if necessary.
	California Department of Water Resources	CAISO should analyze procurement of frequency response product. Choose between increased use of spinning reserves and a new product.	Section 6 of the ISO's proposal supports a two-phased approach which enables satisfaction of the FRO through implementing 5 near-term approaches to ensure compliance followed by an evaluation of long-term market-based solutions. Frequency response costs may be priced in the spinning reserve unit's bid to ensure adequate compensation. The second phase may introduce a market product or constraint if necessary.
	Union of Concerned Scientists	Consider marginal cost of requiring wind and solar to have PFR capability (pre-curtailment), cost of storage and DR to have PFR capability, what technologies should be excluded, and would existing resources be required to have PFR capability too.	Section 6 of the ISO's proposal supports a two-phased approach which enables satisfaction of the FRO through implementing 5 near-term approaches to ensure compliance followed by an evaluation of long-term market-based solutions. Frequency response costs may be priced in the spinning reserve unit's bid to ensure adequate compensation. The second phase may introduce a market product or constraint if necessary.
	NRG Energy	CAISO should examine why it was not able to meet frequency response obligations for some events and what it will need to do to comply with BAL-003.	In Section 4 of the proposal, the ISO discusses its analysis of its performance and why the actual response falls short of its expectation for some events. The proposal in Section 6.2.1 of

			addresses these factors through the continued development of look-ahead assessment tools.
	Large-scale Solar Association	There should be an assessment of CAISO's needs for frequency response.	The ISO proposes the development of a real-time look ahead tool to assess its needs for frequency response in Section 6.2.1.
	Bay Area Municipal Transmission Group	CAISO should examine existing frequency response capabilities of its resource fleet and how to best utilize them before developing a new market product.	Section 6 of the ISO's proposal supports a two-phased approach which enables satisfaction of the FRO through implementing 5 near-term approaches to ensure compliance followed by an evaluation of long-term market-based solutions. Section 6.2.1 of the ISO's proposal supports the consideration of frequency response capabilities through the continued development of look-ahead assessment tools. The ISO's performance will be evaluated throughout the 2017 compliance period. The ISO discusses its assumptions underlying expectations of generators providing frequency response in Section 4 of the proposal. The second phase may introduce a market product or constraint if found necessary.
	Large Scale Solar Association	There should be an assessment of CAISO's needs for frequency response to meet the compliance. CAISO should analyze current and potential frequency response capability for existing and planned generation resources, potential to provide frequency response from headroom in Spinning Reserves, load-based frequency response programs, and CAISO's projected WECC compliance.	
	California Department of Water Resources	CAISO should determine whether existing synchronous and non-synchronous generators can meet BAL-003-1 obligations and study possible deficiencies.	
	Union of Concerned Scientists	What percent of the total expected response from governors is the ISO receiving today?	
	San Diego Gas and Electric	CAISO should provide details on assumptions of the future resource mix and corresponding frequency response available each hour. How much FR will be available from synchronous resources during different seasons?	

	Bay Area Municipal Transmission Group	Frequency response chart should also include discussion of how Frequency Response Obligation relates to Frequency Response Measure and Single Event Frequency Response Data values, how performance shown relates to FRM, inclusion of more years would illustrate impact of low hydro conditions and more inverter-based generation.	Section 4.1 of the ISO's proposal expands discussion around the requirements of the BAL-003-1 standard in greater depth than the Issue Paper. The relation between performance and FRM is shown in Figure 2.
	Bay Area Municipal Transmission Group	CAISO should survey generators to determine the prevalence of outer loop controls and the reasons for having them engaged, the response time of controls, and whether generators will slow the response time voluntarily.	The ISO is committed to engaging with stakeholders to expand industry knowledge. Input that would add value to the understanding of stakeholder challenges is welcomed in the form of comments.
	Pacific Gas and Electric	Why is ISO obligation based on 24% share of WECC generation/load, not 24-30%? Also, why does ISO need to reserve for category C event at all times when NERC wants median response of 218 MW/0.1 Hz?	Section 3 of the ISO's proposal provides more information on the compliance measurement. The ISO explains the NERC standard and the requirements placed on the ISO by this standard in which NERC specifies the size of the loss event as well as the methodology for determining the ISO's share. The 24-30% share of WECC annual generation and load is an estimate and will be updated to the actual share in October 2016.
	San Diego Gas and Electric	How might CAISO FR needs change over time? Will it always be based on Palo Verde?	Section 6.2.1 of the ISO's proposal supports the consideration of frequency response capabilities through the continued development of look-ahead assessment tools. The ISO proposes forecasting the expected frequency deviation given the loss of 2 Palo Verde units with current system conditions as a part of this look-ahead tool. The estimate will be based on this loss for the foreseeable future.

	<p>California Large Energy Consumers Association</p>	<p>CAISO needs to be clearer about what needs to be demonstrated to NERC and WECC to meet its compliance obligation. Is it MW of synchronous generation, MW of frequency-responsive resource (how much they can actually provide)? Or what else?</p>	<p>Section 3 and the technical appendix of the ISO's proposal provides more information on the compliance measurement.</p>
	<p>Cities of Anaheim, Azusa, Banning, Colton, Pasadena, and Riverside</p>	<p>CAISO should provide more information on compliance measurement.</p>	