Comments on CAISO's ESDER Phase 4 Proceeding

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I. INTRODUCTION

According to the CAISO, ESDER is intended to enhance the ability of CAISO connected and distribution connected resources to participate in the CAISO market, as energy storage and distributed energy resources (DERs) are becoming an increasingly important part of the future resource mix needed to lower carbon emissions and provide operational benefits. The details of demand response and storage resources are the focus in the Phase 4 ESDER process. Vote Solar strongly believes, however, that the focus of ESDER needs to evolve beyond the microeconomic issues and the protocol details in market participation. To focus on microeconomic and protocol details seems insufficient as the functioning of the CAISO market is changing in fundamental ways to meet the challenges of a regional low-carbon grid. The CAISO should use ESDER to engage stakeholders in a discussion about how best to enable the market to evolve as we proceed to meet California's ambitious clean energy and climate goals, ultimately reaching the 100% carbon-free clean energy goal.

Vote Solar respectfully asks that CAISO consider how the ESDER stakeholder process can address the larger need and the full context of electric market reform. The need to reform the CAISO market is now evident as more renewables and DERs with zero marginal cost come on line. With zero marginal cost resources increasingly setting market clearing prices, the average price of wholesale energy will fall further, revenue adequacy for generators will continue to decline, and wholesale market failure should be expected, absent major programmatic change.

These comments ask CAISO to take a hard look at the inevitable changes we will see in two to three years in order to meaningfully recalibrate the direction for the ESDER process. CAISO's Resource Adequacy (RA) Enhancements Workshop (First Revised Straw Proposal Stakeholder Meeting), Monday and Tuesday this week, calls for major reform largely to address greater ramping and flexible capacity needs to ensure reliability. Vote Solar respectfully asks CAISO to recognize that with a predominance of renewable generation resources that reflect zero marginal costs, the current bid-based Locational Marginal Cost – *security constrained*

economic dispatch – will require a rework. It seems obvious that the market is moving from a kWh (energy) focus to a kW (capacity) focus.

Energy storage, demand response and behind-the-meter distributed technologies can be expected to have a much larger role in the evolving market as more transactions will occur on the demand side.[1] The ESDER stakeholder process is an appropriate venue to consider how the market can be reformed to one that is based on customer value or marginal value of service (MVOS) rather than generation value or marginal cost of service (MCOS). Customer-based reliability and capacity, based on MVOS, seem to be more important as we move forward.

II. ESDER IN A BROADER CONTEXT

A. Market is Moving Rapidly

The need for ramping capacity is will be increasing rapidly as fossil fuel resources are retired removed and more variable output renewable resources are added. As explained by CAISO's CEO, 20,000 MW of renewable resources have already been added as we move to meet 50-percent and 60-percent renewable energy goals. Progress to date suggests if we proceed apace the 100-percent goal will be met well before 2045.

B. More Zero or Negative Prices and Renewable Curtailment

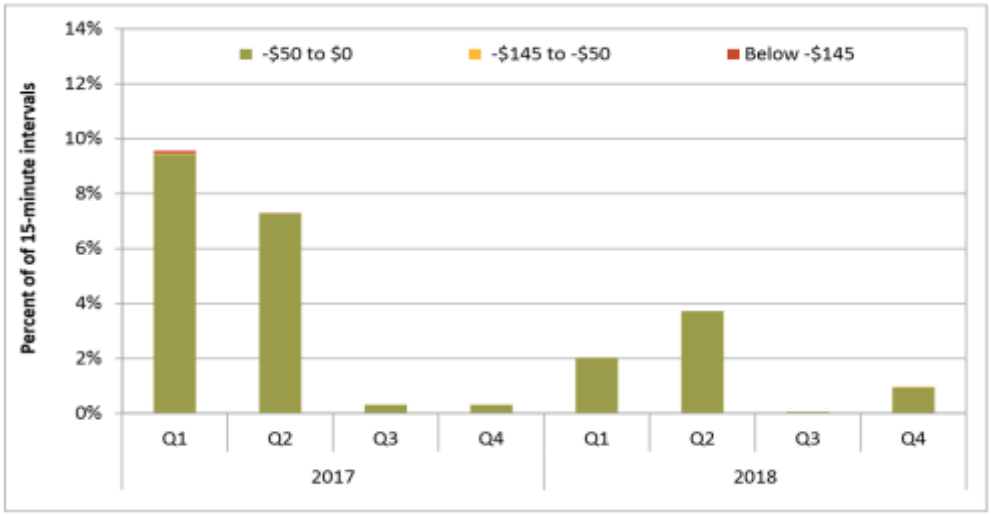
LMPs were designed when the MCOS of thermal or renewable resources determined market clearing prices. We now see a significant number of hours with zero and negative LMPs. As more renewable generation becomes the marginal resource, market prices will be zero or negative more frequently. At the same time, renewable curtailments are being used as a tool to balance the system during an increasing number of hours each year. This approach to system balancing, by curtailment of renewables, is being used to ensure sufficient ramping capacity is available to CAISO. Vote Solar is concerned that overreliance on curtailment to balance the system will keep a significant number of uneconomic thermal resources in the mix, which in turn crowd out the use of more economic clean energy resources. This suggests, overreliance on curtailment of zero marginal cost resources simply to maintain positive LMPs is counterproductive.

[11] See for example. Utility Dive, *Los Angeles solicits record solar + storage deal at 1.997/1.3-cents kWh*, https://www.utilitydive.com/news/los-angeles-solicits-record-solar-storage-deal-at-199713-cents-kwh/558018/

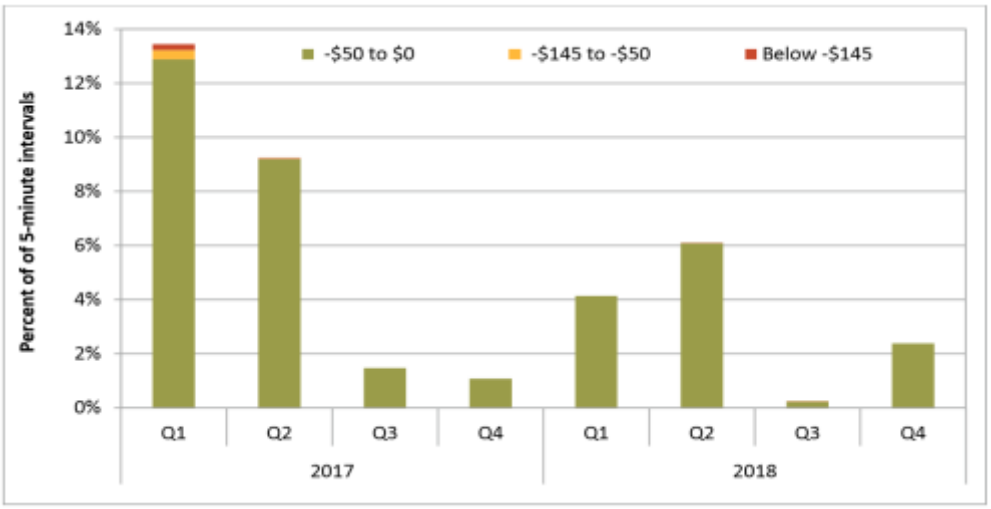
Unfortunately, the metaphorical "duck-curve" has sometimes been interpreted to mean that low priced times are a problem that require a set of "cures." Instead, low or negative prices should be seen as opportunities to charge storage batteries, to create virtual storage (pre-heat and pre-cool) and to charge electric vehicles.

The frequency of negative CAISO prices in 2017 and 2018 are shown in CAISO's 2018 markets report[2], respectively for the 15 minute and 5 minute markets in the two figures below:

Frequency of Negative CAISO 15 Minute Prices in 2017 and 2018



Frequency of Negative CAISO 5-Minute Prices in 2017 and 2018



[2] CAISO, Annual Report on Market Issues and Performance, Department of Market Monitoring, April 2019.

In addition, as CAISO explains a power balance constraint is being used when sufficient ramping capacity is unavailable:

> *The ISO and energy imbalance market areas can run out of ramping capability in either the upward or downward direction to solve the real-time market solution. This condition is known as a power balance constraint relaxation. When this occurs, prices can be set at the $1,000/MWh penalty parameter while relaxing the constraint for shortages (under-supply infeasibility), or the -$155/MWh penalty parameter while relaxing the constraint for excess energy (over-supply infeasibility). If the operator load adjustment exceeds the size of the power balance constraint relaxation and in the same direction, the size of the load adjustment is automatically reduced and the price is set by the last dispatched economic bid rather than the penalty parameter for the relaxation.*

It is not clear whether this market structure element (power balance constraint) should be retained, especially in light of the MVOS focus for the market explained below. Many of CAISO market rules are complicated and can reduce market entry as transaction costs are simply too high. It is also unclear how ramping market valuation squares with CAISO use of renewable curtailments. Vote Solar prefers a market solution to an administrative rule on order to resolve these matters.

C. Issues with Ramping Value

A key question is how to effectively value ramping capacity? How many MW and MWH are needed, when, under what conditions, to address which specific uncertainties? Related to these questions is how should renewable curtailment be valued and when should it be used vis-à-vis ramping capacity. The grid requires both capacity and capacity over a specified duration, which means energy (MWHs).

A Flexible Ramping Product has been put in place by CAISO. The flexible ramping product is designed to enhance reliability and market performance by procuring flexible ramping capacity in the real-time market to help manage volatility and uncertainty of real-time imbalance demand. The amount of flexible capacity the market procures is derived from a demand curve which reflects a calculation of the willingness-to-pay for that flexible capacity. The demand curves allow the market optimization to consider the trade-off between the cost of procuring additional flexible ramping capacity and the resulting reduction in power balance violation costs.

The flexible ramping product provides both upward and downward flexible capacity, in both the 15-minute and 5-minute markets. Procurement in the 15-minute market is intended to ensure that enough ramping capacity is available to meet the needs of both the upcoming 15-minute market runs and the three 5-minute market runs within that 15-minute interval. Procurement in the 5-minute market is aimed at ensuring that enough ramping capacity is available to manage differences between consecutive 5-minute market intervals.

III. THE ESDER PROCESS SHOULD HELP PREPARE FOR A NEW ELECTRICITY MARKET STRUCTURE where the majority of energy resources have near-zero marginal costs

A. ESDER Focuses on Implementation Details Instead of New Market Direction

The recent ESDER Workshop focused on understanding battery costs, based on these four categories:

- *Energy – Energy likely procured through the energy market*
- *Losses – Round trip efficiency losses – Parasitic losses*
- *Cycling costs – Battery cells degrade with each "cycle" they run – Cells may degrade more with "deeper" cycles…*
- *Opportunity costs*[3]

Under the traditional MCOS framework, and current CAISO market metrics, this seems like a logical approach. Quite differently, from the MVOS perspective, where MVOS is the basis to determine market prices, the four cost categories are less relevant. Absent under the MCOS approach is the customer value, and less emphasized is the customer cost. Under the MVOS framework customer non-discretionary and discretionary loads would be differentiated, based on (customer-based) priority service pricing. The battery technology then is just one way to achieve customer-focused MVOS benefits.

This departure, to move to MVOS, allows us to recalibrate market value with greater focus on the tradeoffs between the customer and new smart grid technology. In general, *to maximize the net economic benefits of supplying electricity to society, the reliability level should be increased as long as the corresponding decrease in outage costs exceeds the increase in supply*

[3] CAISO, Energy Storage and Distributed Energy Resources Phase 4: Stakeholder Workshop, June 27, 2019, slide 13.

costs, and vice versa.[4] This remains entirely consistent with MCOS as this *golden rule* of resource planning is to pursue electricity system expansion until one equates MVOS to MCOS (or MVOS = MCOS).[5]

B. Flexible Response to Grid Needs Will be Paramount

The ESDER initiative has explained that it intends to support the electricity market needs for resource flexibility, which is an expanding market in California. As explained in its recent RA enhancements workshop, *CAISO requires several different types of flexibility, but not all need to be procured through resource adequacy mechanisms*. Specifically, CAISO needs the following three kinds of flexibility:

- *Primary – Frequency Response…CAISO needs to ensure resources are able to and incentivized to meet their obligations…*
- *Secondary – Regulation…Market product that provides sufficient incentives through the market to ensure adequacy*
- *Tertiary – Market flexibility needs… sufficient economic bid range…to dispatch around load and resource variability (or inflexibility)*[6]

These are services that ESDER should focus on, not just at the RA or tertiary level but as well at the primary and secondary market levels.

New markets for ESDER resources should incentivize capabilities to allow those flexibility resources to dispatch around resource and load variability, address net load ramps, respond to uncertainty, and respond to different market time frames. This market design should include incentives to encourage rational plant retirements.

Vote Solar further agrees with CAISO that two categories of resource flexibility will be important as we proceed into new energy markets:

1. Predictable: known and/or reasonably forecastable ramping needs…

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[4] M. Monasinghe, Electric Power Economics, Butterworths, 1990, pg. 237.
[5] *Economic Criteria for Optimizing Power System Reliability Levels*, in M. Monasinghe, Electric Power Economics, Butterworths, 1990, pp. 230-38; M. Munasinghe and A. Sangvi, Reliability of Electricity Supply, Outage Costs and Value of Service: An Overview, Energy Journal, Volume 9, 1988; E. Woychik, Regulatory View of Capacity Valuation in California, Energy Journal, Volume 9, 1988; Electricity Outage Cost Study", http://www.eppo.go.th/power/ERI-study-E/ERI-ExeSummary-E.html, 19 November 2005. See also, M. Sullivan, M. Collins, J. Schellenberg, P. Larsen, Estimating Power System Interruption Costs: A Guidebook for Electric Utilities, Lawrence Berkeley National Laboratory, LBNL Report No. DE-AC02-05CH11231, July 2018, page 10.
[6] CAISO, Resource Adequacy Enhancements: First Revised Straw Proposal Stakeholder Meeting, July 8-9, 2019, slide 95.

2. Unpredictable: ramping needs caused by load following and forecast error…[7]

Vote Solar does not agree with CAISO that the real-time market will be sufficient in many cases to respond to uncertain conditions. Moreover, in the future it is unclear that a suitably granular market can be maintained that will provide real-time market dispatch which can sufficiently respond to unpredictable ramping needs caused by uncertainty, such as weather.

CAISO seems to confirm this conclusion, stating that a much deeper pool of flexible resources will be needed:

- *CAISO expects net load ramps to grow and minimum net load to decrease over time*
- *Could lead to ramp constraints within the RA fleet and require additional exceptional dispatches*
- *CAISO proposes to maintain a requirement so there is sufficient bid range to cover the forecasted maximum three-hour net load ramps*
    - *Provide the resources needed to shape day-ahead market awards and commitments based on market solutions and should mitigate the need for exceptional dispatches*[8]

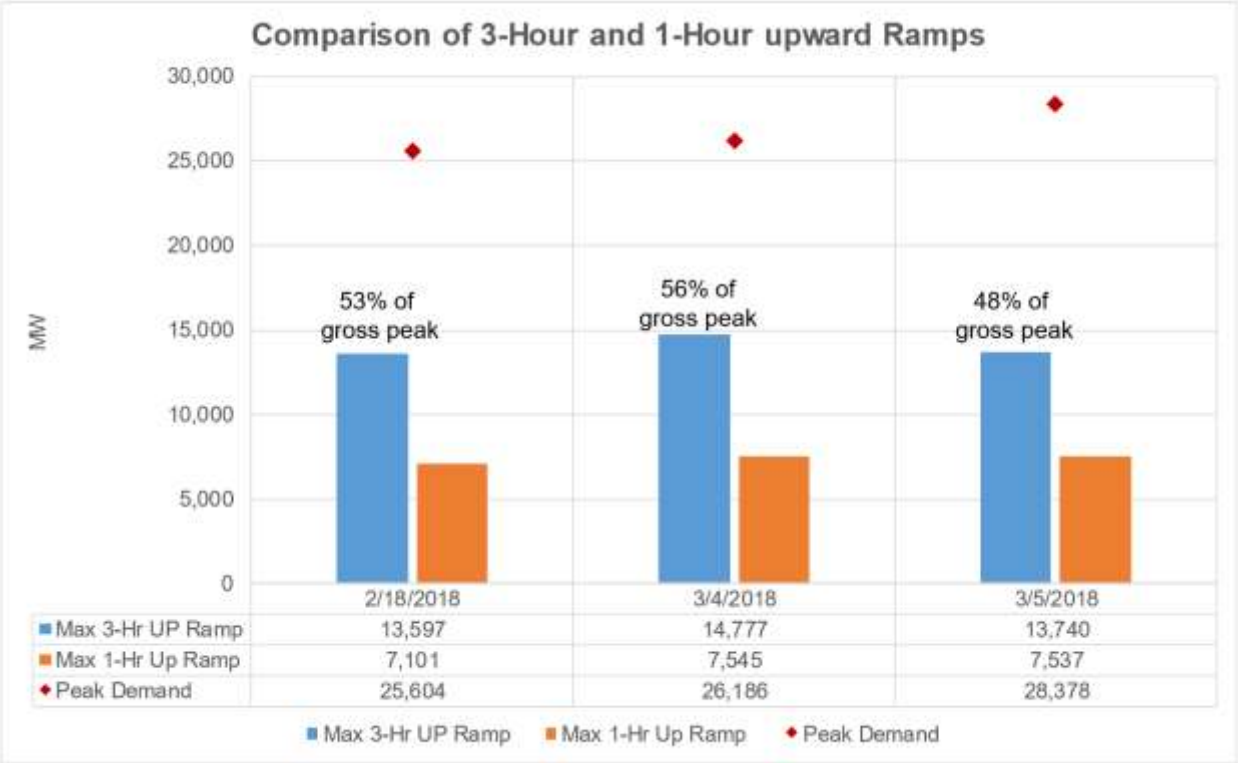
The ESDER initiative should be refocused to address these flexibility issues, rather than focusing solely on narrow issues such as understanding storage (battery) costs and developing methods for assigning capacity credit for demand response products.

C. The Explosion of Fast Ramping Needs Suggest More Focus to Integrate ESDER

The huge growth in DERs and grid level storage should be the focus point for ESDER, particularly to integrate and deliver these resources. As CAISO explains, ramping needs are distinctively nonlinear, increasingly require much faster ramping, and can constitute over 50 percent of daily peak demand. In short, more and faster ramping are essential in the emerging electricity market.

As CAISO's recent RA forum pointed out, storage batteries offer almost instantaneous ramping, as compared to the use of thermal plants to achieve most of our past ramping needs. The comparison between one hour and three hour ramps illustrates these extraordinary market changes, as shown by CAISO:[9]

[7] Ibid, slide 98.
[8] Ibid, slide 99.
[9] Ibid, slide 101.



As CAISO and others have aptly explained, the confluence of load and generation uncertainty can create further divergence between day-ahead and real-time markets. Forecast error contributes significantly to this. The ESDER process should focus on remedies to these needs.

D. Vote Solar Supports CAISO Initiatives to Advance Flexible and Ramping Market Services

We support CAISO's extensive efforts to define locational transmission and generation constraints. Vote Solar strongly recommends that bottom-up distribution planning be directly integrated into CAISO's changes to market structure, ESDER vision, flexibility needs assessment and transmission modeling, including TPP. CAISO has done a substantial amount of work on ramping and flexibility needs assessment, particularly with utilities at the transmission level.

Vote Solar appreciates the CAISO focus on developing rules to enable market forces to provide flexible services, including upward and downward ramping and imbalance reserves. It seems critical to both justify and quantify flexible capacity needs so that stakeholders can deliver these services.

Linkages between customers, market operations, and utility distribution systems are critical to deliver on resource optionality. CAISO is to be applauded for its support of economic methods including bidding to avoid the use of penalties.

CAISO's previous push to leave ramping and flexible resources as energy-based resources, with variable compensation, seems to have changed. Flexible and other ramping resources must be justly compensated, as capacity value, in exchange for the time-based attributes offered with certainty. Unbundled ramping capacity – with uncertainty, fast ramp, and long ramp components – as proposed by CAISO seems long overdue. Vote Solar further supports the use of bilateral contracts for these services with clearly defined requirements as a way to mitigate regulatory risks. Existing flexible capacity requirements need to be streamlined, with clear rules of play, to address renewable ramping through market mechanisms as much as possible.

E. Additional Considerations

Two related points deserve mention in the context of ESDER. First is the need to recognize the benefits with optional use of localized portfolios of DERs through bilateral contracts and option pricing, which can enable these resources to be used to balance the system both regionally and in load pockets to lower overall costs.

Second, bottoms-up planning is needed based on MVOS to integrate new technologies that provide customer-based and distribution system benefits. Integration of new wholesale market operations will be critical to optimize all resources including storage, demand response and other resource in the ESDER process. MVOS will enable us to restructure how we address transmission constraints, distribution constraints, electric transportation, and the DERs. Bottoms-up planning can integrate the 100% clean energy portfolio that will require networked smart inverters and electronic inertia (from synchronous condensers) to replace mechanical inertia. MVOS is nothing short of a reinvention of capacity to enable DERs and renewable resources to displace combustion turbines and fossil fuel ramping.

IV. CONCLUSION

The need for a new market paradigm has been recognized by key experts in the industry for some time. Some believe we need fundamental market reform very soon. The assumptions about the production and delivery of electric power have changed rapidly. Fossil and nuclear units are rapidly being retired. Solar photo-voltaic and wind are low cost

even when coupled with large increments of storage batteries. In a 100% clean energy scenario power supply must come from clean energy sources. In this light it seems appropriate to consider a set of key questions:

- How to run the power system in which the resources are inflexible and unpredictable?
- How to run the market [when] short-run marginal cost is zero?
- How to attract new investments to meet the growing demand?
- Can electricity markets work [in these circumstances]? How?[10]

Vote Solar appreciates the opportunity to provide comments to CAISO and the ESDER stakeholders on these critically important topics.

[10] Hung Po Chao, Demand Management for Clean Power Under Uncertainty, CRRI-Rutgers 38th Annual Conference, 31 May 2019.