# Stakeholder Comments Template

| Submitted by | Company | Date Submitted |
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Please use this template to provide your comments on the FRACMOO Phase 2 stakeholder initiative Second Revised Draft Framework Proposal posted on April 27, 2018.

Submit comments to InitiativeComments@CAISO.com

**Comments are due May 17, 2018 by 5:00pm**

The Second Revised Draft Framework Proposal posted on April 27, 2018 and the presentation discussed during the May 3, 2018 stakeholder meeting may be found on the FRACMOO webpage.

Please provide your comments on the Second Revised Draft Framework Proposal topics listed below and any additional comments you wish to provide using this template.

First Solar appreciates CAISO's efforts to update its FRACMOO requirements to facilitate the effective use of new technologies, but even more importantly to proactively address constraints that might otherwise affect grid reliability.

**Identification of ramping and uncertainty needs**

The ISO has identified two drivers of flexible capacity needs: General ramping needs and uncertainty. The ISO also demonstrated how these drivers were related to operational needs.

**Comments:**

First Solar has no comments on this topic at this time.

**Definition of products**

The ISO has outlined the need for three different flexible RA products: Day-ahead load shaping, a 15-minute product, and a 5-minute product.

**Comments:**

First Solar has no comments on this topic at this time.

**Quantification of the flexible capacity needs**

The ISO has provided data regarding observed levels of imbalances, in addition to previous discussion of net load ramps.

**Comments:**

First Solar has no comments on this topic at this time.

**Eligibility criteria, counting rules, and must offer obligations**

The ISO has identified a preliminary list of resource characteristics and attributes that could be considered for resource eligibility to provide each product. Additionally, the ISO has proposed new EFC counting rules for VERs and storage resources that are willing to provide flexible RA capacity.

**Comments:**

First Solar strongly supports the ability of VERs to participate as a flexible ramping product. Additionally, First Solar collaborated with E3 on the most appropriate calculation method for EFC. E3's analysis is attached at Appendix A. Related to the selection and dispatch of flexible capacity, First Solar recommends that prioritization be given to curtailed VERs. For example, downward ramping capabilities – which appear to be the most pressing need – can effectively be met with wind and solar via targeted curtailment. Moreover, VERs that have already been curtailed can provide additional services, such as frequency regulation and spinning reserves, much more efficiently than conventional fossil-fueled resources. It should be noted that over-reliance on curtailment of VERs as a flexible ramping product can have consequences on the subsequent delivery of RECs as part of compliance with the RPS. These issues warrant further discussion and dialogue with all impacted parties.

**Equitable allocation of flexible capacity needs**

The ISO has proposed a methodology for equitable allocation of flexible capacity requirements. The ISO seeks comments on this proposed methodology as well as any alternative methodologies.

**Comments:**

First Solar recognizes that utility-scale solar resources cannot account for 100% of the CAISO's flexible capacity needs. Photovoltaic solar combined with storage (PVS), however, should not be subject to such a restriction. Stand-alone storage assets are not currently capped in the CAISO proposal, nor should they be. To that end, First Solar recommends that for PVS deployments, the storage component's full capabilities are counted for flexible capacity rather than being restricted by an EFC, and it is not subject to the 25% cap.

**Next Steps**

The ISO is currently planning to issue a draft final framework on June 6, 2018. However, given the schedule change in the CPUC's RA proceeding, the ISO will not release a draft final framework until July 10, 2018. The ISO seeks stakeholder input regarding next steps that should be taken to further enhance the ISO's framework. Options include, but are not limited to, another full iteration or working groups.

**Comments:**

First Solar strongly supports the concept of a joint workshop or stakeholder meeting between FRACMOO and the Day Ahead Market Enhancements Initiative. The overlap that exists between these two initiatives, coupled with the complexities involved, warrants a more deliberate and thoughtful conversation between the various parties that are tracking either or both processes. Moreover, to effectively take advantage of ancillary services that can be provided by new technologies, it will be important to continue coordinating the implementation of revised FRACMOO requirements with Resource Adequacy requirements that will be implemented by CPUC.

**Other**

Please provide and comments not addressed above, including any comments on process or scope of the FRACMOO2 initiative, here.

**Comments:**

First Solar has no comments on this topic at this time.

# Appendix A

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# Calculating Effective Flexible Capacity for Dispatchable Variable Energy Resources within the California ISO's Flexible Capacity Procurement Framework

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**Jimmy Nelson, *Senior Consultant***
**John Stevens, *Senior Associate***

April 6, 2018

## 1. Introduction

First Solar retained Energy and Environmental Economics, Inc. (E3) in January 2018 to prepare draft comments to California Independent System Operator (ISO) in response to the ISO's November 20, 2017 Draft Flexible Capacity Framework. E3's comments proposed a method for incorporating dispatchable variable energy resources (DVERs) into the ISO's flexible capacity framework. On January 31, 2018, the ISO released a Revised Flexible Capacity Framework that recognized the potential role of DVERs in meeting the ISO's flexible capacity needs. Specifically, the Revised Framework:

1. Recognized that Flexible Capacity is distinct from Resource Adequacy capacity, and that a DVER resource's Effective Flexible Capacity (EFC) could be either higher or lower than its Effective Load Carrying Capability (ELCC); and
2. Asked for additional stakeholder comment on how to calculate EFC for DVERs.

First Solar has asked E3 to prepare these additional comments summarizing a proposed methodology for calculating DVER EFC. The methodology consists of sequentially estimating needs in each category proposed by the CAISO; first assuming all DVERs are must-take, and second assuming that all DVERs can be operated flexibly. The resulting reduction in ramping need is the EFC of the entire DVER fleet, denominated in MW. Dividing by the nameplate MW yields EFC%. The methodology is demonstrated for solar generation meeting 3-hour upward ramping needs. We find that the monthly EFC% for dispatchable solar is between 46% and 63% in 2017, except July and August where EFC% is 1% and 11%, respectively. In a future year with 20 GW of solar capacity online, the monthly EFC% is between 60% and 71%, except during July and August where EFC% is 36% and 46%, respectively.

## 2. Overview of DVER flexible capacity provision

Flexibility is defined as the ability to meet "net load" (NL), or load minus must-run generation, at any two points A and B, separated by a time interval *T* (see Figure 1). Assuming perfect foresight, the size of the Flexibility need *F* is determined by $NL_B - NL_A$. For upward Flexibility need, point A represents a "trough" and point B represents a "peak"; for downward Flexibility need, the roles are reversed. The time period *T* can range from milliseconds to multiple hours, e.g., the three-hour ramping period considered in the ISO's original FRAC-MOO initiative.

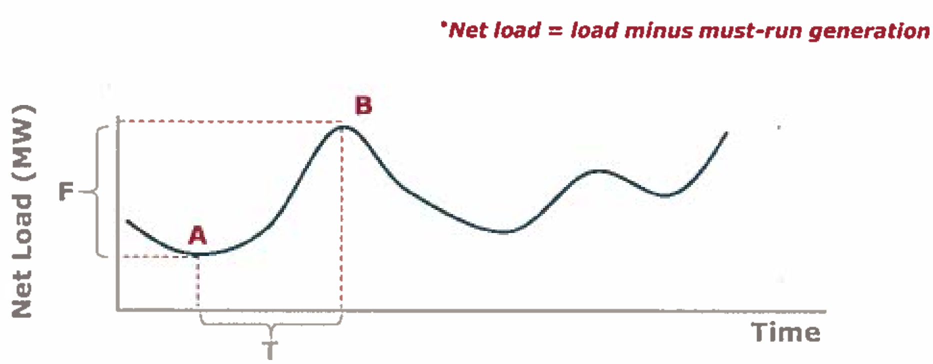


**Figure 1. Under perfect foresight, the Flexibility Need *F* is defined as net load at Point B minus net load at Point A**

Flexibility need can be satisfied with either Inc bids at B ("Inc B") or Dec bids at A ("Dec A"). DVERs can help meet the Flexibility need by providing either Inc B or Dec A bids.

1. Dec A bids. A DVER can provide Flexibility by offering to reduce production at Point A, i.e., by providing a Dec A bid. Deploying a Dec A bid requires the ISO to downwardly dispatch DVER production at Point A to a given quantity below the maximum potential

production over the time period *T*. The size of the potential Dec A bid is bounded by the scheduled production at Point A, including a margin of error.

2. Inc B bids. A DVER can also provide Flexibility by offering to increase production at Point B. In practice this will likely occur when the resource has been economically dispatched to lower than maximum potential production levels. The size of the Inc B bid is bounded by the potential production, based on resource availability, minus scheduled production at Point B.

In both cases, the quantity of DVER available to provide Flexibility is a function of the potential and scheduled production during a given time period *T*. Therefore, the Flexibility counting rules must consider DVERs' time-varying production capability. We assume here that all VERs are must-run to determine the starting point from which to calculate flexibility need. DVERs are then considered a source of Flexibility to meet system needs.

# 3. Methodology

## 3.1. Simulating the Effects of Dispatchable Solar on 3 Hour Upward Ramping Needs

**Input Data:**

E3 gathered hourly load and resource data from CAISO's Daily Renewables Watch dataset for the year 2017[1]. E3 also collected 5-minute CAISO renewables curtailment data for 2017[2], and averaged the 5-minute data to hourly MW curtailed. These two datasets were combined to calculate hourly annual profiles of system load and power production potential (pre-curtailment production) for solar and wind resources. E3 estimated the installed capacity of CAISO utility-

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[1] California Independent System Operator (CAISO), "Daily Renewables Output Data", http://www.caiso.com/market/Pages/ReportsBulletins/RenewablesReporting.aspx (Accessed Feb 7, 2018.)

[2] CAISO, "Managing Oversupply", http://www.caiso.com/informed/Pages/ManagingOversupply.aspx (Accessed Feb 7, 2018).

scale solar photovoltaic (PV) in 2017 as the maximum hourly power production potential observed in the 2017 dataset, resulting in 9.7 GW of solar capacity.

**Net Load Ramp Calculation:**

To create a business-as-usual net load profile, E3 calculated hourly net load by subtracting wind, solar thermal, and solar PV production potential profiles from the load profile. The result of this calculation is a net load profile that other system resources would need to follow if downward dispatch of solar resources was not feasible.

To simulate the effect of dispatchable solar on three-hour net load ramps, E3 removed part or all of utility scale solar production potential from the net load calculation, representing the ability to curtail solar as a supply-side resource if necessary. E3 varied the amount of dispatchable solar from 0 GW to 9.7 GW in 2 GW increments (Figure 2) because the marginal contribution of solar to maximum net load ramps can change at different levels of solar penetration.

To construct net load profiles for each dispatchable solar penetration level, the annual hourly PV output profile was multiplied by the ratio of assumed dispatchable solar capacity to maximum solar capacity, and the resulting dispatchable solar profile was added to business-as-usual net load profile. An example of the resulting net load profiles for varying penetrations of dispatchable solar is shown for a day in February 2017 in Figure 2. To explore scenarios in which greater deployment of PV is required by CAISO to reduce greenhouse gas emissions and meet renewable portfolio standard targets, a second "future" set of net load profiles were created using the same methodology, but with a maximum solar capacity of 20 GW.

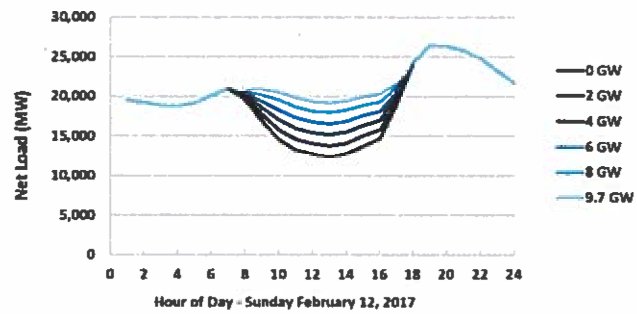


**Figure 2: Net load as a function of dispatchable PV penetration for an example February day**

Using these sets of net load data, E3 then calculated the maximum upwards 3-hour ramp for each month. The total reduction in monthly maximum 3-hour upwards ramp as a function of dispatchable solar is shown in Figure 3 (2017 Case) and Figure 5 (Future Case).

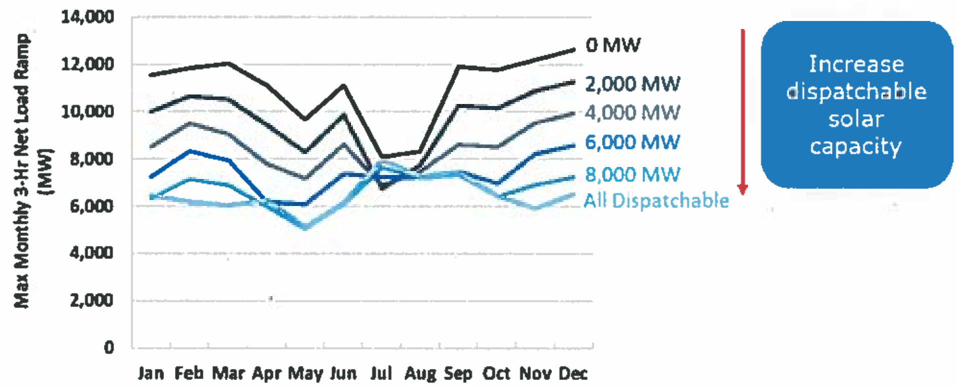


**Figure 3: Peak 3-hour ramp by month vs dispatchable PV penetration for 2017 case**

Figure 3 demonstrates that in all but the summer months (July and August) the effect of increasing dispatchable solar penetration is to reduce the peak 3-hour ramping requirement significantly. The result indicates that solar PV is causing a significant portion of the maximum net load ramp in most months. The net load ramp during summer months (i.e. July and August) is not greatly reduced by increasing dispatchable solar penetration. This is because the maximum ramp during these months is primarily driven by the demand profile, at least at 2017 solar penetration levels.

Figure 4 shows that for March 2017, increasing the amount dispatchable solar reduces the maximum net load ramp, even if 100% of CAISO utility scale solar PV is dispatchable (the right-hand side of Figure 4). The marginal dispatchable PV contribution to reducing the net load ramp is calculated as the incremental reduction in three-hour net load ramp (MW) divided by the incremental dispatchable solar capacity (MW). Figure 4 shows that there are decreasing marginal returns on dispatchable solar PV deployment, but that for many months (March as an example in the figure), any level of dispatchable PV helps to reduce the maximum ramp.

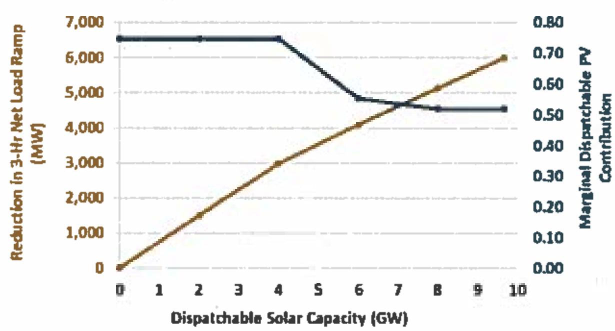


**Figure 4: Reduction in three-hour net load ramps as a function of dispatchable PV penetration for March 2017.**

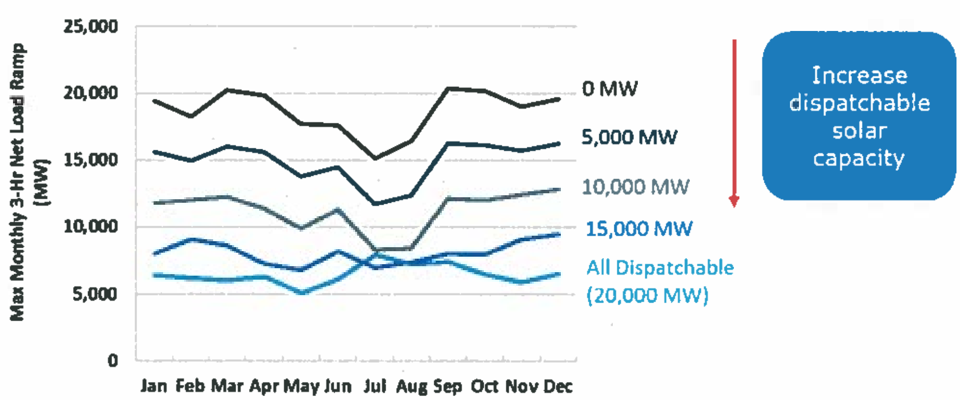


**Figure 5: Peak 3-hour ramp by month vs dispatchable PV penetration for future case**

In the future case (Figure 5), this same trend generally exists as is seen in the 2017 case, though the maximum net load ramp in the summer months also becomes driven by solar production. Comparing the All Dispatchable curve to the 0 MW curve in Figure 5 demonstrates that future maximum net load ramps will have a large contribution from solar PV in all months unless dispatchable solar PV is included as a supply-side resource in the net load calculation. Stated differently, solar curtailment is likely to be an increasingly attractive strategy to meet steep net load ramps in the future.

We define dispatchable solar Effective Flexible Capacity EFC as the fraction of the monthly 3-hour upwards net load ramping requirement that would be satisfied by dispatchable solar if all utility-solar were to be dispatchable. The calculated EFC is shown in Figure 6 for the 2017 case and Figure 7 for the future case. While we recognize that the marginal solar EFC value will be greater at lower solar penetrations (see in Figure 4 for an example of how the marginal contribution decreases as more solar is dispatchable), our calculation methodology represents a balance between precision and simplicity because it would be administratively challenging to apply resource-specific EFC values. Also, while marginal EFC is somewhat sensitive to penetration, the relationship is much weaker than for ELCC where some parties have proposed a "vintaged" approach for applying marginal values to future resources.

As before, the role that dispatchable solar can play is greatest outside of the summer months for the 2017 case. For the future case, the higher penetration of solar PV increases the role that dispatchable solar can play in reducing 3-hour net load ramps in all months.

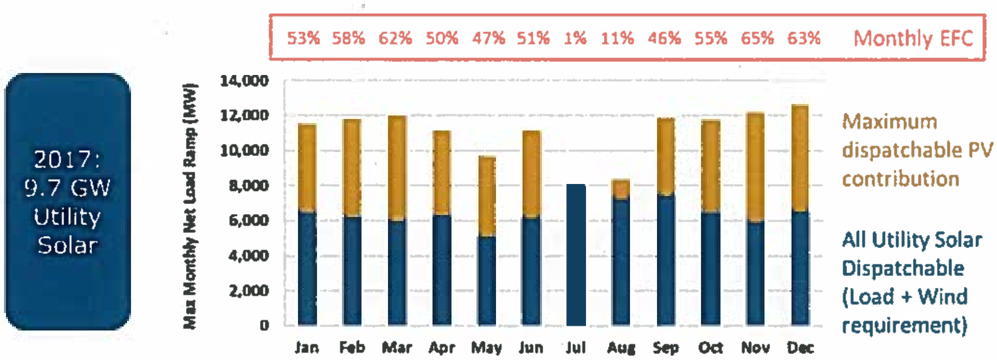


**Figure 6: Contribution of utility-scale PV to maximum net load ramp, and monthly effective flexible capacity for 2017 Case.**

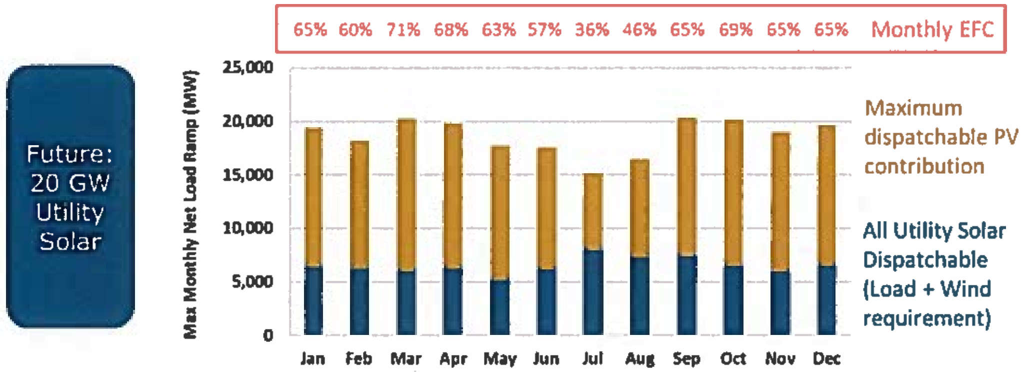


**Figure 7: Contribution of utility-scale PV to maximum net load ramp, and monthly effective flexible capacity for future case.**