California ISO

Stakeholder Comments Template

Energy Storage and Distributed Energy Resources (ESDER) Phase 4

This template has been created for submission of stakeholder comments on the Straw Proposal Working Group Meeting for ESDER Phase 4 that was held on August 21, 2019. The paper, stakeholder meeting presentation, and all information related to this initiative is located on the initiative webpage.

Upon completion of this template, please submit it to initiativecomments@caiso.com. Submissions are requested by close of business **September 4, 2019.**

Submitted by	Organization	Date Submitted
Bora Akyol, Luke Hansen, Gautham Ramesh	*8minute Solar Energy*	*8/30/2019*

Please provide your organization's general comments on the following issues and answers to specific requests.

1. **Discussion on non-24x7 settlement of BTM Resources**

   Which areas will require the local regulatory authority to change its rules or provide clarification to load serving entities?

2. **Market Power Mitigation for energy storage resources**

   1. On slide 21, CAISO recognizes that the existing battery fleet in the region is limited to 150MW and is mainly used for ancillary services and not energy shift. With only ~150 MW of BESS operating in CAISO those systems clear first in frequency regulation because it is the most profitable service, but this will soon change. 8Minute expects the size of the battery fleet to significantly increase to 5,000-10,000 MW by 2025. The result will be that ancillary services will be provided mostly by battery systems that depress the value of frequency regulation and most battery storage systems will transition to delivering energy shift services. The majority of the incoming battery systems will be PV+S hybrid resources which will also have a difficult time providing frequency regulation services while managing Federal ITC grid charging restrictions and the limitation of shared POI with the solar PV. Additionally, many of the incoming PV+S resources will be DC coupled which will make it even more difficult to perform frequency regulation.

   a. Analysis on expected future BESS use cases should look forward to the expected incoming resources providing energy shift not the existing pilot systems.

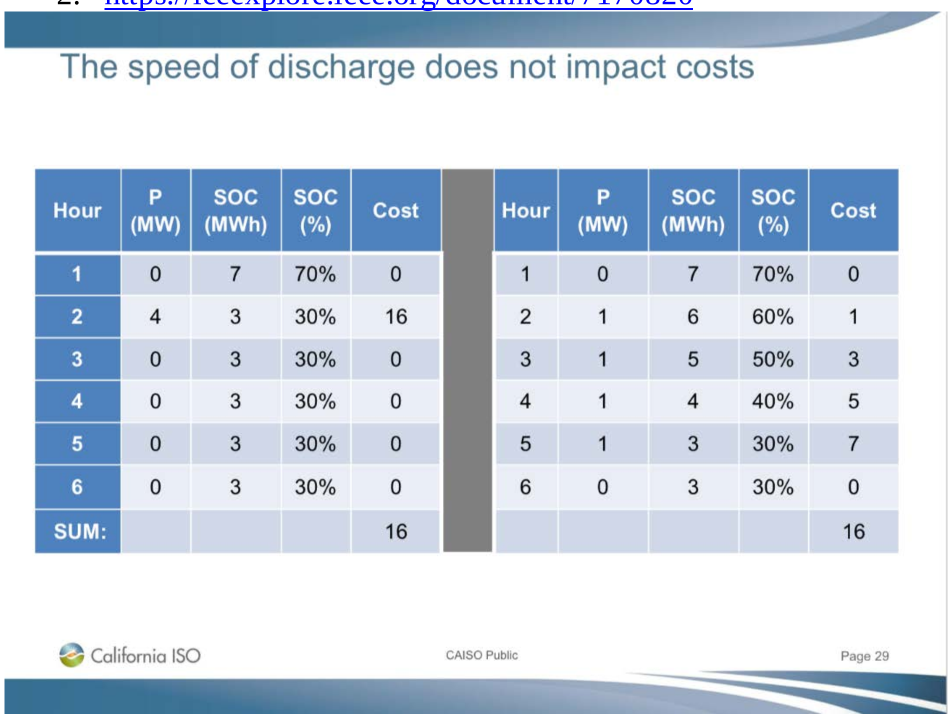
2. CAISO should in clearly indicate that the following marginal cost components are always recognized when Clarity on calculating the total marginal cost of a BESS.
   The presentation should more clearly show the cycle marginal cost as equal to the summation of efficiency costs plus degradation costs plus opportunity costs. These costs will be significantly different for each battery technology.
   a. Cycle Marginal Cost = Charge Energy Price + RTE Losses + Degrade + Opportunity
   b. **Round Trip Efficiency (RTE):** The typical marginal costs shown on slide #27 appears to underestimate or ignore the marginal costs of efficiency losses. If the average energy cost is $30/MWh and a typical li-ion battery system has about 85% round trip efficiency, then the RTE losses results in minimum $5.29/MWh marginal costs. Typical li-ion battery efficiency losses include (HV xfmr * AC cables * MV xfmr * inverter * DC cables * battery * HVAC)^2 =
   BESS RTE = (0.992 * 0.995 * 0.992 * 0.982 * 0.995 * 0.984 * 0.984)^2 = 85.8%

3. CAISO's approach to modeling the marginal cost for energy storage did not put sufficient emphasis on legitimate opportunity cost. Opportunity costs should be considered a legitimate component of marginal cost, not market manipulation, for the following reasons:
   a. **End of Life:** Opportunity costs are not market manipulation and should be considered a legitimate cost because more cycling will result in early failure of the battery. This early end-of-life condition for the battery is not represented in the typical degrade vs. depth of discharge curves presented in these slides. For example, a battery with a $10/MWh marginal cost may do 500 cycles per year and fail after 10 years. However, that same battery represented with $50/MWh marginal cost may do 150 cycles per year and fail after 25 years. The total revenue earned per year is only about 10-15% larger for the $10/MWh marginal cost vs the $50/MWh marginal cost. Therefore, a project would legitimately be planned to operate with the higher opportunity cost.
   b. **Owner Opportunity Cost:** If a battery system is operating with a very small marginal cost then it is more likely to discharge energy when prices are relatively low and then not be available for unforeseen high price spikes. The system owner or operator should be allowed to bid a high opportunity cost depending on their forecasted future price because bidding a low discharge price will result in the system earning less revenue and at the same time increase ISO operating costs because stored energy may not be available during the future system energy shortage. The same paradigm existing for the charging opportunity cost. If the energy storage system is fully charged from $20/MWh, then it will not be available to charge during negative price spikes.
   c. **ISO Opportunity Cost:** If a battery system is operating with a very small marginal cost then it is more likely to discharge energy when prices are relatively low and then not be available for unforeseen high price spikes. The ISO should model a non-zero opportunity cost for flexible spinning reserve that can ramp up or down if some state of charge is preserved away from top or bottom of charge.

4. 8Minute sees two changes that should be made to CAISO's initial approach to battery physics modeling presented in this working group:

a. **State of Charge (SOC):** The information required to tailor the physics-based model to fit each energy storage system is often confidential and highly dependent on the different devices in a plant. 8Minute thinks that CAISO would find it arduous to model the losses for every energy storage market participant. If CAISO views physics-based modeling to be a critical activity then it should have a standard form that is submitted by the market participant which gives the degradation factors for (1) battery throughput, and (2) time at state of charge. The model on page 29 of this presentation claims that “speed of discharge does not impact costs”. This is not accurate. SOC is sometimes ignored from battery degrade models if the modeler has insufficient access to data or cannot computationally handle the complexity. However, time at SOC typically ranges from 25-50% of the degrade factors and especially time at high SOC for li-ion batteries. If CAISO is going to make a physics-based model that will impact market participation and attempt to detect and prevent market manipulation, then CAISO must consider this factor or it will not be able to anticipate the bids of legitimate market participants.

1. https://www.nrel.gov/docs/fy17osti/67102.pdf
2. https://ieeexplore.ieee.org/document/7170820



Hour	P (MW)	SOC (MWh)	SOC (%)	Cost		Hour	P (MW)	SOC (MWh)	SOC (%)	Cost
1	0	7	70%	0		1	0	7	70%	0
2	4	3	30%	16		2	1	6	60%	1
3	0	3	30%	0		3	1	5	50%	3
4	0	3	30%	0		4	1	4	40%	5
5	0	3	30%	0		5	1	3	30%	7
6	0	3	30%	0		6	0	3	30%	0
SUM:				16						16

In the above slide, CAISO argues that both cases are equivalent when taking the cost into consideration since the speed of discharge does not impact costs. In case 1 (left) the average SOC is 36.67% and in case 2 (right) the average SOC is 46.67%. Case 2 has a higher degradation because of the higher average SOC and according to our models would result in 2-4 years shorter usable life than case 1 depending on battery manufacturer and model.

b. **Capacitance:** The general shape should ramp up much more quickly. Further data from lithium battery manufacturers will show that the DOD <1% is often delivered by "capacitive" energy stored in the battery's electric field. This energy has very low effect on degradation. Energy delivered above approximately 1% DOD begins to be delivered by energy storage in the battery's chemical reactions. Therefore, some detail is missed in slide #31 by not capturing the biggest transition in marginal cost near 1% DOD.

Slide #31		Suggested shape of "degrade" costs component	
DOD	Marginal Cost	DOD	Cycling Degrade Cost
1	$0.20	1	$0.20
20	4	5	8
40	8	20	10
60	12	60	12
70	14	100	14

3. **Variable Output Demand Response resources**

4. **Additional comments**

Please offer any other feedback your organization would like to provide from the topics discussed during the working group meeting.