LS Power Stakeholder Comments

Submitted by	Company	Date Submitted
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Please use this template to provide your comments on the ESDER Phase 2 stakeholder initiative Revised Straw Proposal posted on July 21 and as supplemented by the presentation and discussion during the stakeholder web conference held on July 28.

Submit comments to InitiativeComments@CAISO.com

Comments are due August 11, 2016 by 5:00pm

The Revised Straw Proposal posted on July 21 and the presentation discussed during the July 28 stakeholder web conference may be found on the ESDER Phase 2 webpage.

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

NGR enhancements

The CAISO has been focused on two areas of potential NGR enhancement: (1) representing use limitations in the NGR model and (2) representing throughput limitations based on a resource's state of charge (SOC).

The CAISO is requesting stakeholders provide comments in each of these two areas.

Comments:

We regard item #2, representing limitations based on a resource's State of Charge, as the single most important part of the NGR model for energy storage projects participating in the CAISO markets. Particularly, the ability to alter the maximum Positive or Negative generation parameters as a function of SOC is important for a variety of battery based storage technologies. These changing power ratings are something that could potentially be dealt with in the resource's master file or with a well-chosen set of bid parameters.

Outside of technical constraints, SOC is also tied to significant variable operating costs that a storage resource owner must accounts for in their bids, which do not apply to traditional generators. The most significant of which is non-linear degradation, although there are others such as lost opportunity costs experienced when the ESS has been drained to empty and can no longer participate in the market.

Non-linear degradation explained: various storage technologies such as batteries degrade with use, in other words they lose energy storage capacity. Many batteries show degradation that is a non-linear function of their use, and most of these batteries will degrade faster with 100% depth of discharge (DOD) cycles than with shallow cycles. For example, a resource owner with a particular battery might expect a battery to last 2000 cycles at 100% DOD, but 6000 cycles at 50% DOD. This resource owner trying to represent their variable operating costs in their CAISO bid would want to account for a VOM that is 50% higher when discharging from 1% SOC to 0% SOC than when discharging from 51% SOC to 50% SOC.

These are important and complicated issues, and we hope that CAISO continues to review options that best capture the marginal cost of energy storage in the NGR market participation model. There are many possible options for how to address these issues, of which the "multiple bid stack" idea discussed previously is only one. The use of existing bid stacks with a couple of new terms in the master file or the bid parameters to make a simple If-This-Then-That calculation modifying the single bid stack is one such possibility, and surely there are many others.

Demand response enhancements

Two stakeholder-led work groups are up and running within ESDER 2 to explore two areas of potential demand response enhancement:

- Baseline Analysis Working Group – Explore additional baselines to assess the performance of PDR when application of the current approved 10-in-10 baseline methodology is sufficiently inaccurate. The Working Group has completed its first phase of analysis on topics including alternative baselines and control groups.

- Load Consumption Working Group – Explore the ability for PDR to consume load based on an ISO dispatch, including the ability for PDR to provide regulation service. The working group has recommended bi-directional PDR modelling.

The CAISO is requesting stakeholders provide comments in each of these two areas.

Comments:

No comments on this topic at this time.

Multiple-use applications

The ISO has not yet identified specific MUA issues or topics that require treatment in ESDER 2. The ISO proposes to continue its collaboration with the CPUC in this topic area through Track 2 of the CPUC's energy storage proceeding (CPUC Rulemaking 15-03-011). If an issue is identified that should be addressed within ESDER 2 the ISO can amend the scope and develop a response.

The ISO is requesting stakeholders provide comments on this topic area as well as this proposed approach.

Comments:

No comments on this topic at this time.

Distinction between charging energy and station power

In this topic area the ISO will continue its collaboration with the CPUC through Track 2 of the CPUC's energy storage proceeding (CPUC Rulemaking 15-03-011) rather than exclusively through ESDER 2. At this time, the ISO proposes the following:

- Revise the ISO tariff definition of station power to exclude explicitly charging energy (and any associated efficiency losses); and
- Revise its tariff later to be consistent with IOU tariffs, as needed, in the event that they revise their station power rates.

The CAISO is requesting stakeholders provide comments on this proposed approach. The CAISO also seeks comments on the following:

- What rules are necessary, if any, to dictate how station power and wholesale charging energy (including efficiency losses) can be separately calculated for settlement purposes? For example, what would be the advantages and disadvantages of using meters compared to predetermined deductions?

- Assuming that station power includes all energy drawn from the grid except to charge the storage device, what specific advantages and disadvantages do storage devices have compared to conventional generators under current netting and self-supply rules?

Detailed examples comparing the generally expected dispatching of storage devices and conventional generators under current netting and self-supply rules are appreciated.

Comments:

We support the ISO's motion to revise the tariff definition of station power to explicitly exclude charging energy and associated efficiency losses. We point out that the "associated efficiency losses" are not necessarily clear cut, and we will return to this theme later in comparing the metering configurations of different types of power plants. We will address each of CAISO's questions in turn below:

- What rules are necessary, if any, to dictate how station power and wholesale charging energy (including efficiency losses) can be separately calculated for settlement purposes? Several items must be clarified regarding settlement of station power vs. charging energy.

  First, metering configurations should be standardized, with storage projects metered to the same standards as conventional generation resources. This means using single-meter configurations which are the norm for metering solar and traditional qualifying facilities (QFs). The 2 meter configuration is not the norm for other generation types and is potentially discriminatory against storage because it pushes additional capital and operating costs onto energy storage projects that are not required for other asset types.

  Second, CAISO and the CPUC should both clarify that energy losses during positive or negative generation (i.e. whether charging or discharging) that occur in the transformers, wires, batteries and inverters are efficiency losses and should not be subject to a static station use charge at retail rates during periods of charge. The related concept of calculating some base charge for energy losses in the asset's equipment is not currently in practice with any other type of generation at any site that we are aware of. To the extent this is or becomes a requirement for energy storage contracts with the IOUs, it is an example of how storage resources are at a disadvantage compared with traditional resources in the current tariff and contract environment on the topic of station power.

  Third, CAISO and the CPUC should modify the tariff definitions of Permitted Netting specifically for energy storage to allow storage devices to net station use from output during wholesale operation regardless of whether output is Positive (discharge) or Negative (charge). This will be discussed with examples below. At its heart, the issue is that Negative Generation provides a valuable wholesale market service, especially in a world with renewable overgeneration, and should still be treated as Generation. The assumptions underpinning the present definition of Permitted Netting pre-date useful resources like NGRs that can continuously vary output from positive to negative, and these rules should be updated to avoid disadvantaging these valuable new resources.

For example, what would be the advantages and disadvantages of using meters compared to predetermined deductions?

Our understanding is that "predetermined deductions" is not the norm for billing the station use of any other class of resources in the CAISO market. Other generation types settle their station use based on meter reads, and allowing utilities to require automatic payments for unmetered quantities of retail energy would therefore be discriminatory against storage. Using meters is the appropriate way to determine station use in our view.

- Assuming that station power includes all energy drawn from the grid except to charge the storage device, what specific advantages and disadvantages do storage devices have compared to conventional generators under current netting and self-supply rules?

Storage devices are at a distinct disadvantage to conventional generators because half of their operational range is Negative Generation, and under current rules they are not permitted to net station power during periods of Negative Generation. All real-world devices have efficiency less than 100%, therefore all storage devices spend more than 50% of their time in the market in Negative Generation, and this is time where station power is not Permitted Netting under current rules.

Given that wholesale energy costs are typically low or even negative during the times storage is charged, serving station loads at retail in California will frequently be an order of magnitude more expensive for the storage system when charging, and this applies more than half of the time a storage system is in the market. These artificially inflated operating costs must then be passed on to the bid price for discharging energy, which will raise costs for the entire market when a "storage peaker" is on the margin.

The only advantages energy storage devices have over conventional generators are fast startup times and minimal pump/motor loads, thus removing the typical start-up "spikes" of station power energy that must be procured to start a thermal generation unit.

Detailed examples comparing the generally expected dispatching of storage devices and conventional generators under current netting and self-supply rules are appreciated.

We would like to thank CAISO for the opportunity to present the following detailed examples of Station Power metering and rate treatment. There is a lot of detail here, and we are happy to discuss further at the ISO's convenience and share source data if necessary.

Below we compare three different hypothetical resources with respect to their daily wholesale output and station power requirements. The resources are a 100 MW gas peaker, a 100 MW battery energy storage system, and a 190 MW solar PV facility (which is an example borrowed from Mr. Robert Thomas of SCE's presentation at the CPUC/CAISO Station Power Workshop which took place on May 2 2016).

Solar PV Example

This example shows operation on a sunny day. As the slide in Figure 1 indicates, the idle load of the facility is approximately 0.7 MW, or roughly 0.4% of the generation capacity. In a PV facility, the idle loads come principally from the power conversion system's control electronics, the no-load losses of the transformers and cables, any lighting or security cameras at the project substation, and any SCADA and protective equipment used for operating the plant. It is worth noting that the PCS, transformers, and computerized control equipment which contribute the bulk of the idle load are essentially identical to those used in most battery energy storage facilities.

Solar facilities are typically connected to the grid using a Single Meter Arrangement where the utility has one meter for their billing and telemetry, and CAISO uses a separate meter which measures the same electrical point for their own telemetry and settlement data. This configuration is depicted in Figure 2. Between Figures 1 and 2 it can be seen that the status of station power for Solar PV can be described as:

- Station Use is paid for at a retail rate when the plant is not generating (Blue line)
- Station Use is netted from output when the plant is generating (Red line)

Also worth noting is that the electronics and transformer energization losses (~0.7 MW in this example) do not stop during generation. That load is still integral to the power plant. All power plant loads are rightfully netted from the wholesale output of the facility during operation. The graphical interpretation of this is that when the blue line is at 0, that blue line load plus any additional loads required for operation (solar tracking hardware for example) are reducing the magnitude of the red line showing generation output. There is no calculated minimum cost of idle energy added to the retail station power bill every month.

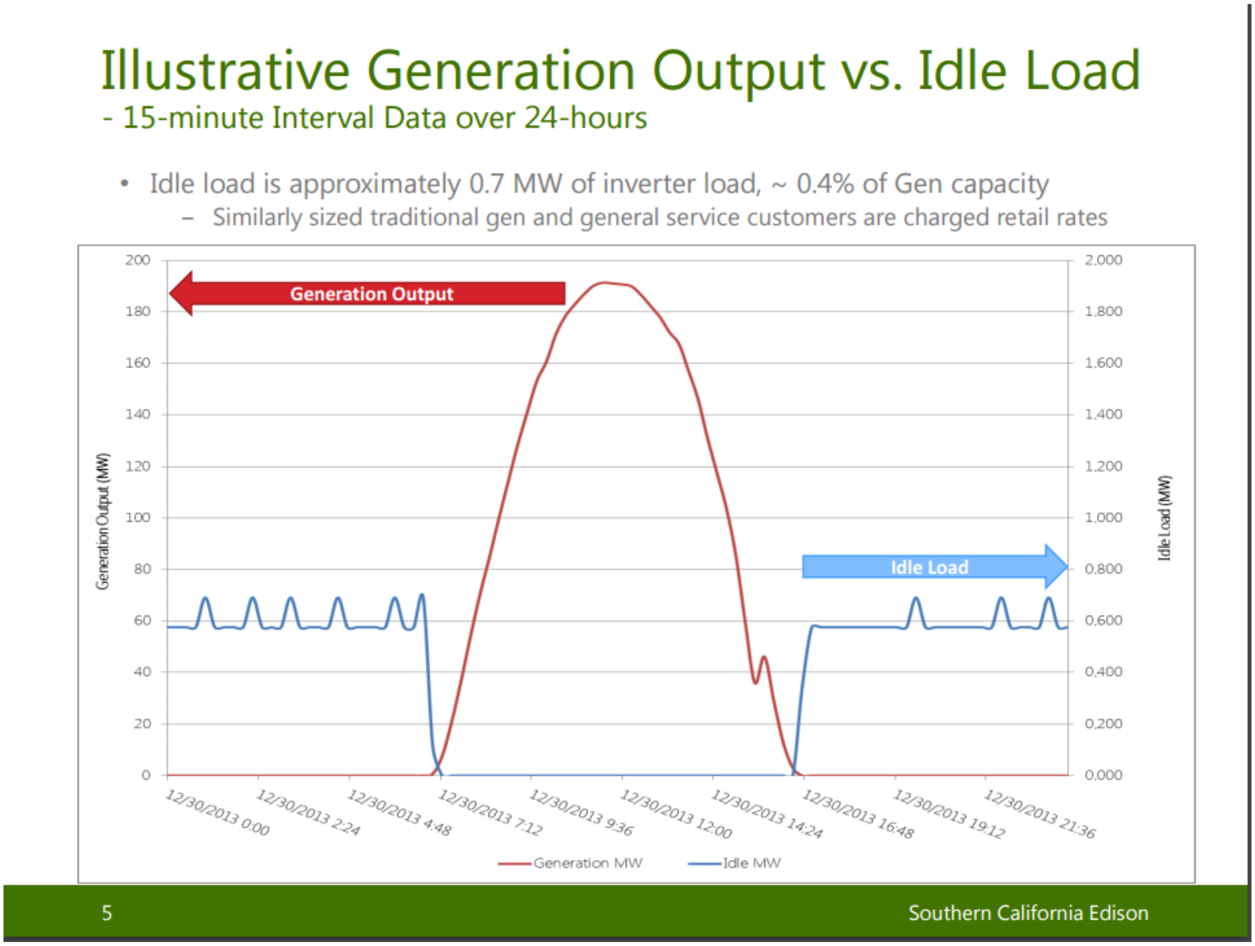

Figure 1: Full day output of 190 MW PV facility. Source: SCE at May 2 workshop, posted at http://www.cpuc.ca.gov/General.aspx?id=3462

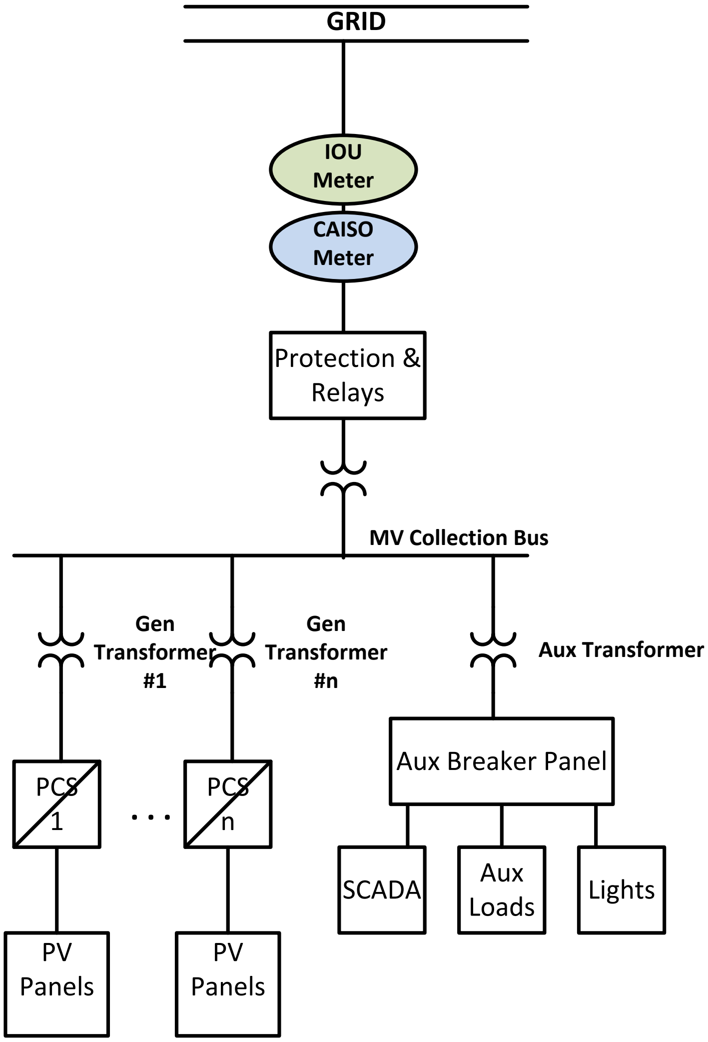

Figure 2: PV Facility with Single Meter Configuration

Gas Peaker vs Battery Energy Storage System Examples – Station Power Metering

This example compares the configurations and station power treatment of two theoretical resources in CAISO: a 100 MW Gas Peaker and a 100 MW Battery Energy Storage System or BESS. The two resources are compared at a very high level in Figure 3.

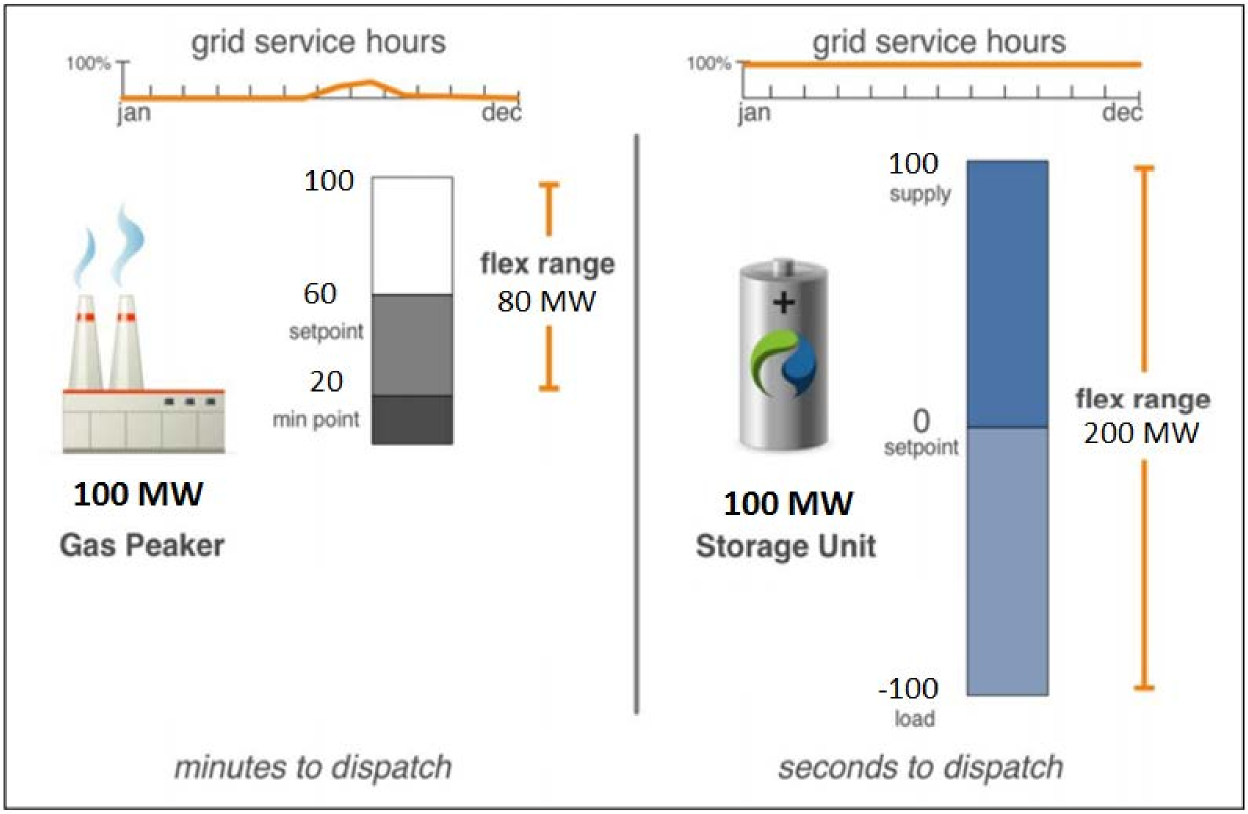

Figure 3: Gas Peaker vs Battery Energy Storage System - high level comparison

The standard electrical configuration of a peaker plant is shown in the conceptual one-line diagram in Figure 4. Note that it is very similar to the PV facility. There are a group of transformers and generators (turbines rather than inverters in this case) and a set of auxiliary loads such as the SCADA equipment and substation lighting, just like the PV facility. The principal difference is that there will be some different aux loads based on the exact technology used at the plant. Specifically the gas peaker will have compressors for the incoming fuel, pumps and fans for cooling, and emissions control technology that are all necessary to run the plant, whereas the Solar PV facility might have just had some fans and tracking hardware.

The gas peaker again has a Single Meter Arrangement, just like PV and other Qualifying Facilities throughout the country. When the gas peaker operates, Station Power is treated the same as the PV plant:

- Station Use is paid for at a retail rate when the plant is not generating

- Station Use is netted from output when the plant is generating

One practical difference between rotary generators and power electronics based ones is that the peaker will require a brief surge in station power to start the pumps and compressors when the unit is brought online, while inverters have no such requirements. During idle periods, the transformer no-load loss and SCADA systems are still fundamentally the same for the peaker as for the PV facility or the storage system.

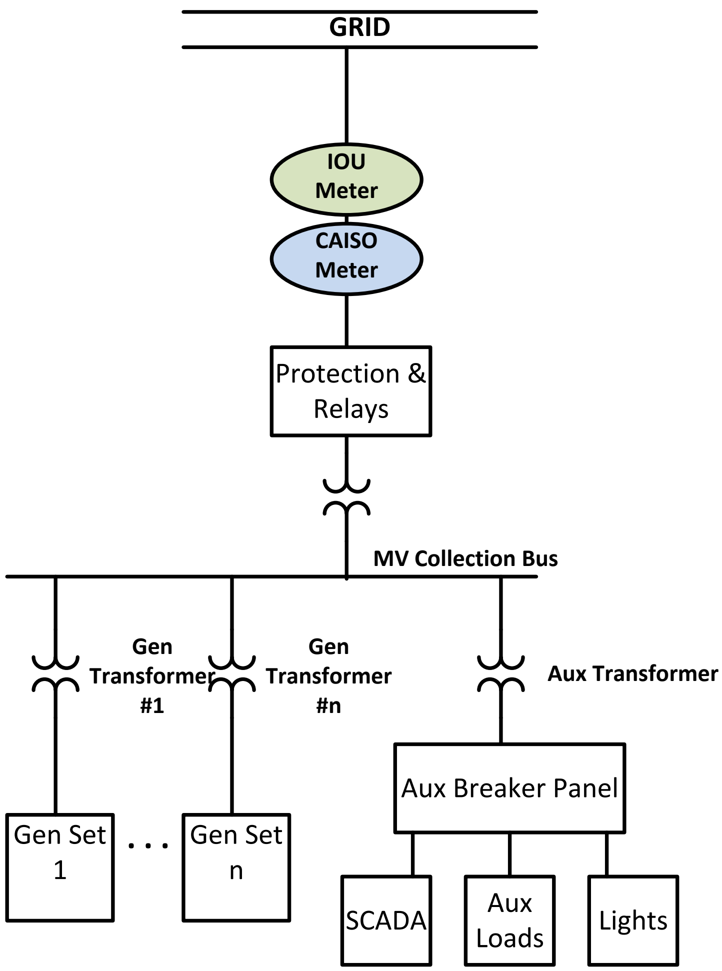

Figure 4: Gas Peaker facility with Single Meter configuration

The electrical configuration of a typical battery energy storage plant is shown with two metering variations in Figures 5 and 6. Looking at Figure 5 it is clear that an energy storage system is just another type of power plant, broadly similar to the solar PV facility and the gas peaker in Figures 2 and 4. Where the Aux Loads included a tracker for the PV and a set of compressors/pumps/fans/scrubbers for the peaker, the BESS will need to provide power to the battery management system (BMS) electronics and HVAC in the battery area. The BMS and HVAC are every bit as integral to operation of the BESS as the pumps/fans/scrubbers are for the peaker.

In light of the broad similarity of how these power plants are all designed, we again urge CAISO and the CPUC to take a stance in their tariff and interconnection rules that does not discriminate against storage relative to other types of generation.

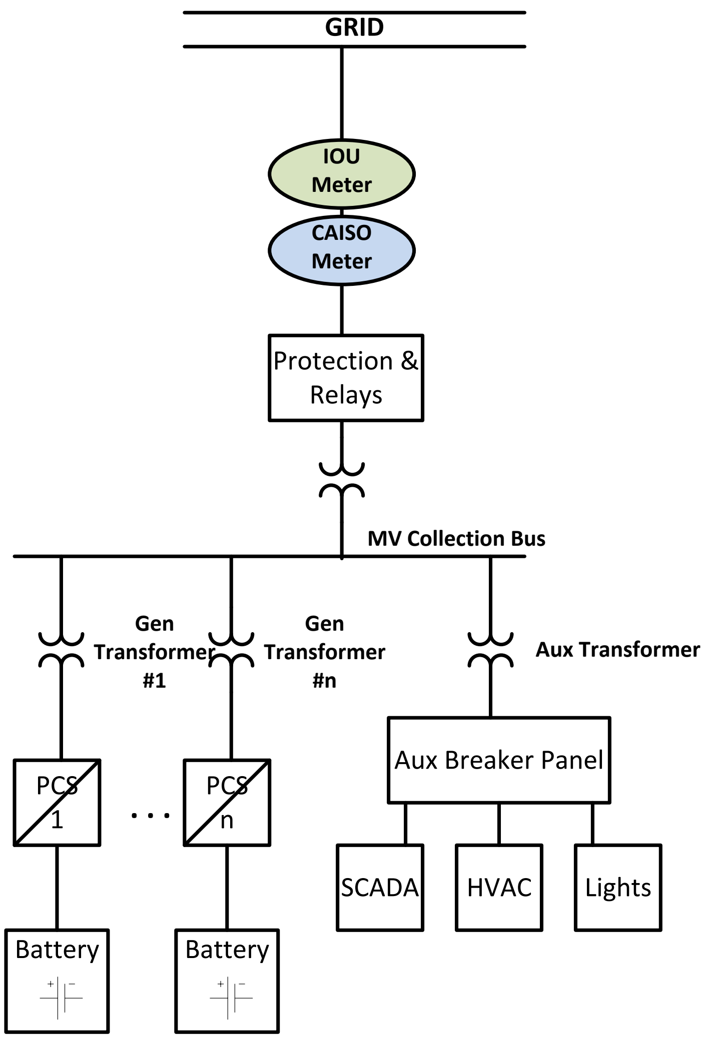

Figure 5: Energy Storage facility with Single Meter configuration (LS Power and CESA proposal)

The difference between Figure 5 and Figure 6 is the metering configuration. Figure 5 is a Single Meter configuration, and is the same as that which is used for all other generation technologies in our experience. There is no reason why this meter configuration should be considered inadequate for storage technology when it is the standard for peakers, combined cycle plants, wind farms, and solar PV facilities throughout the nation. Figure 6 shows the Dual Meter Arrangement proposed by SCE in their comments and at the Station Power workshop. Comparing the one-line diagrams in Figures 5 and 6, it is clear that the Dual Meter configuration adds cost and complexity over the Single Meter version. Further, it would reduce expected reliability of the storage facility, because there are additional single points of failure introduced into the system, should the auxiliary feed become compromised during operation, which is especially likely if a low voltage distribution feeder is used for the aux power when a dedicated high voltage gen-tie is used for the main power path.

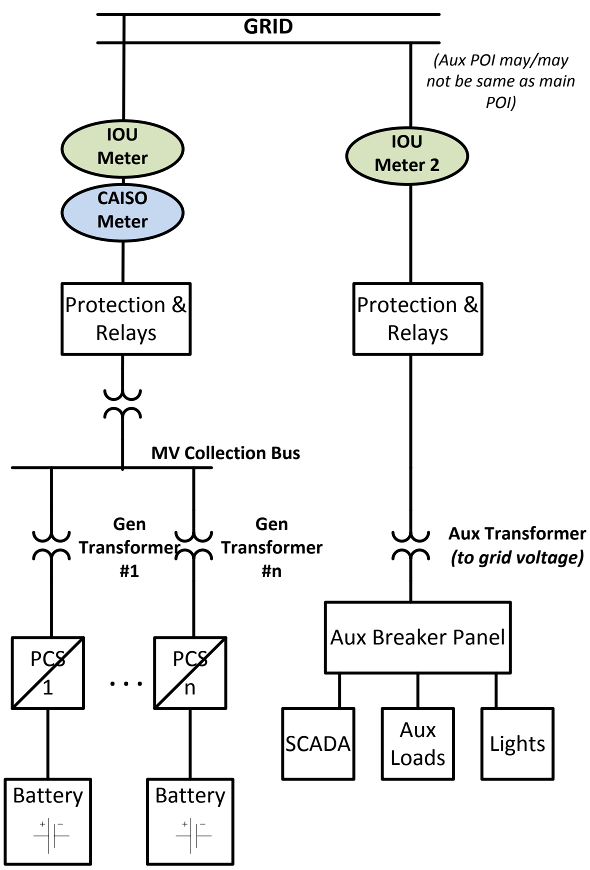

Figure 6: Energy Storage facility with Dual Meter configuration (IOU proposal)

The reason to implement a Dual Meter configuration over a Single Meter configuration would be to capture the project's station loads at retail 24/7. This is inherently discriminatory against storage compared with all other generation types which net their station load against output during operation. SCE has specifically proposed charging energy storage projects a calculated

"Idle load" proportional to the transformer and inverter losses of the project when idle, and adding this un-metered load to the Station Power bill at the retail tariff rate. Solar PV facilities do not pay such a fee despite having nearly identical idle losses in their transformers and PCS, and tariffs should be clarified that such a practice with storage projects is not the norm.

Figure 7 is a slide from SCE that depicts their proposal for metering storage projects using the Dual Meter arrangement shown. Compare the Idle Losses and the separate meter and electrical feed for auxiliary loads on this figure with those for gas and PV facilities, including those in the above example for PV. This is clearly worse for storage than PV. The fair and equal way to treat energy storage systems is to make it clear that:

- Station Use is paid for at a retail rate when the plant is not generating
- Station Use is netted from output when the plant is generating

The only operational difference for storage is that "Generating" includes both Positive and Negative generation, which does not neatly fit the existing tariff language for Permitted Netting, which was written prior to the adoption of bi-directional resources (note that pumped hydro storage has its own custom market participation model and corresponding rules for settlement). We respectfully urge CAISO to modify the Permitted Netting language for bi-directional resources along these guidelines, allowing output to be netted during generation across the resources entire output range.

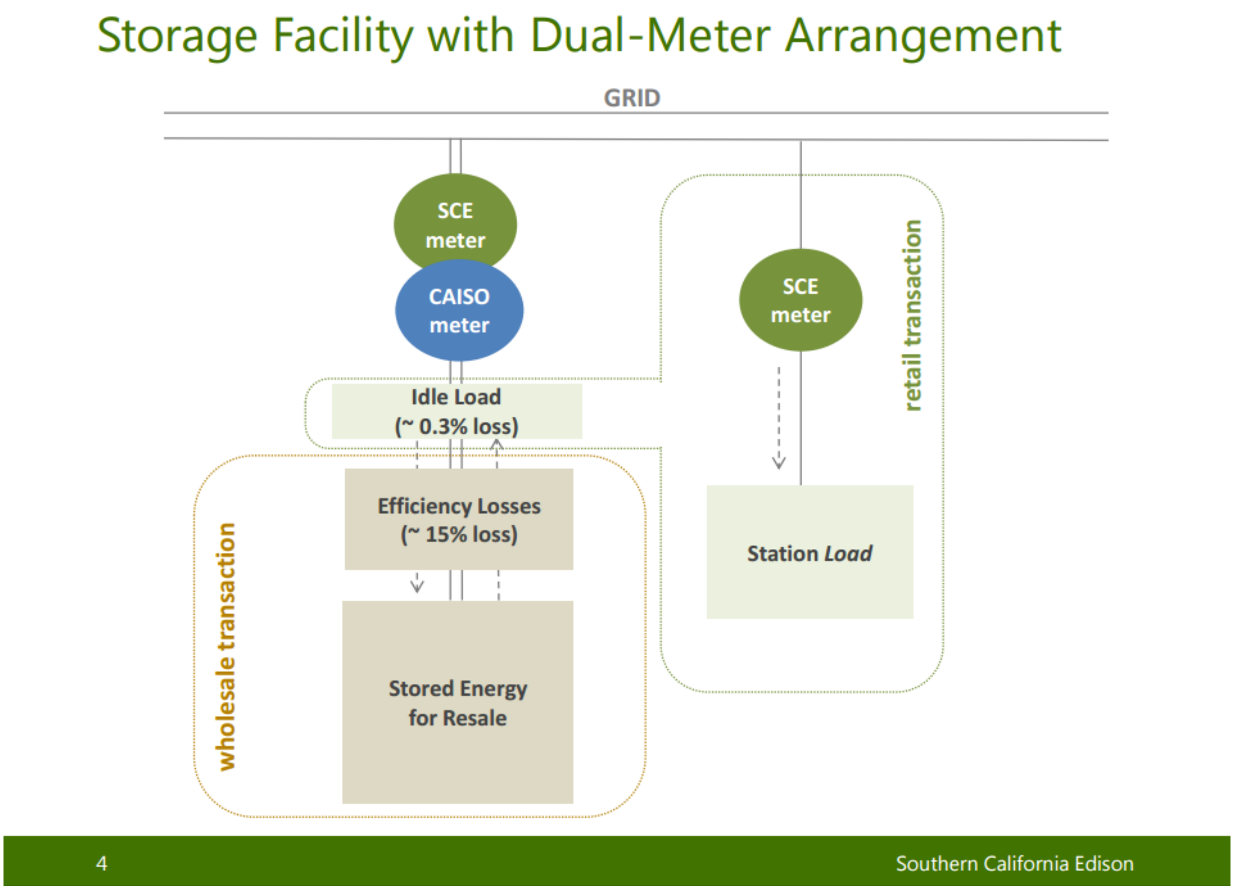

Figure 7: SCE slide depicting the Dual Meter Arrangement. Source: SCE at May 2 workshop, posted at http://www.cpuc.ca.gov/General.aspx?id=3462

Gas Peaker vs Battery Energy Storage System Examples – Market Operation and Settlement

The following example was constructed using CAISO's publicly posted hourly average real-time prices (averages of the five minute or RT5 prices) for a CAISO node in the San Francisco Bay Area on the day of May 20, 2016, which was chosen arbitrarily among days that exhibited a pronounced "duck curve". The 100 MW Gas Peaker and 100 MW BESS are both configured to sell at any price greater than $50/MWh, and the BESS has bid into the market that it will buy/charge at any price below $15/MWh. The BESS is rated for 400 MWh of storage (nameplate power for 4 hours), has a round-trip efficiency of 80%, and starts the day at 0% SOC.

Both the gas peaker and BESS are assumed to have idle loads of ~0.4% of their nameplate output, similar to the PV example previously. The gas peaker has a start-up spike in its station power use to 2.5 MW. Both the gas peaker and BESS are assumed to have 2 MW of various necessary auxiliary loads during operation as described above, and this 2 MW is inclusive of the idle loads. The retail rate for station power in this example is $0.15 / kWh.

Figures 8, 9, and Tables 1-3 display the day's results for the Peaker and the BESS. The results show both units selling energy during the 4 high priced hours beginning at Hour Ending 1800. The BESS charges during 6 low priced hours throughout the day. The Figures and a discussion follow, and the Tables are located at the end of this document.

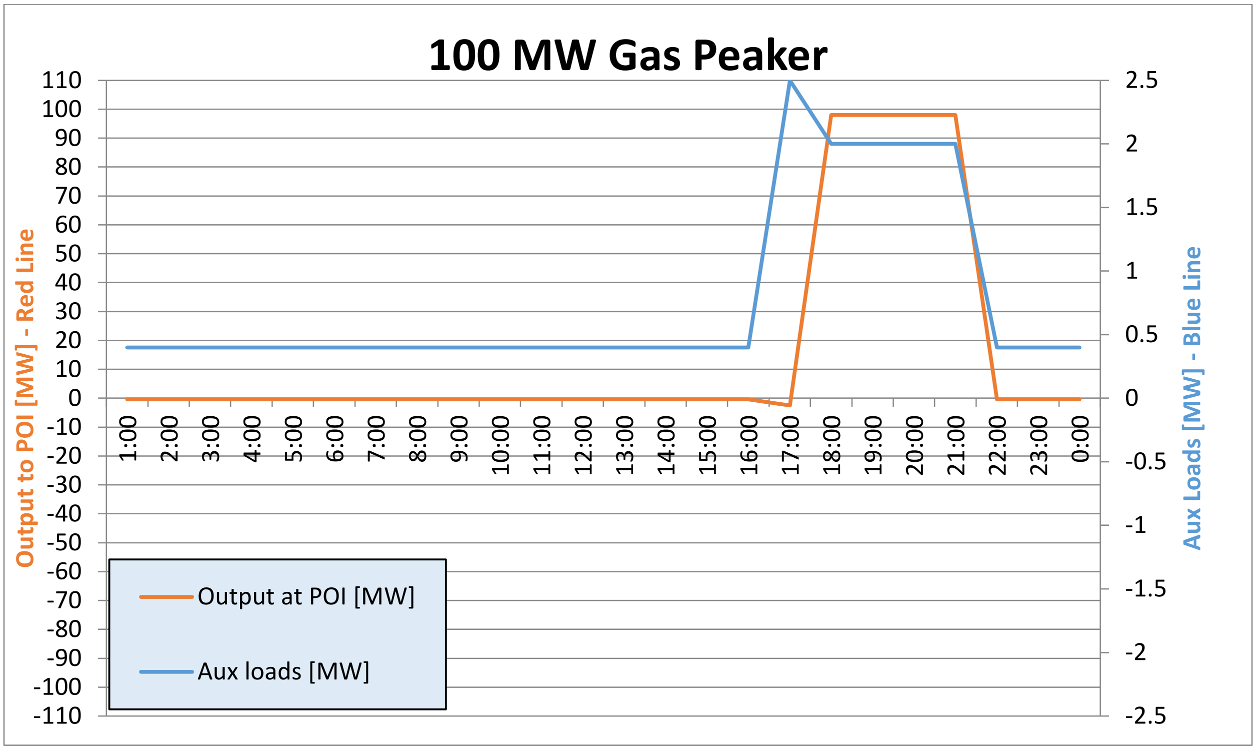

Figure 8: Gas Peaker real-time market dispatch for 5/20/2016, hourly averages

To summarize the performance of the gas peaker shown in Figure 8 and Table 1:

- Total revenues are $51,921.12
- Fuel costs are beyond the scope of this example
- Total cost of Station Power is $2,553.42, this includes
  - $1,038.42 for station power requirements netted at wholesale during generation
  - $1,515.00 for station power purchased at retail rates when not operating

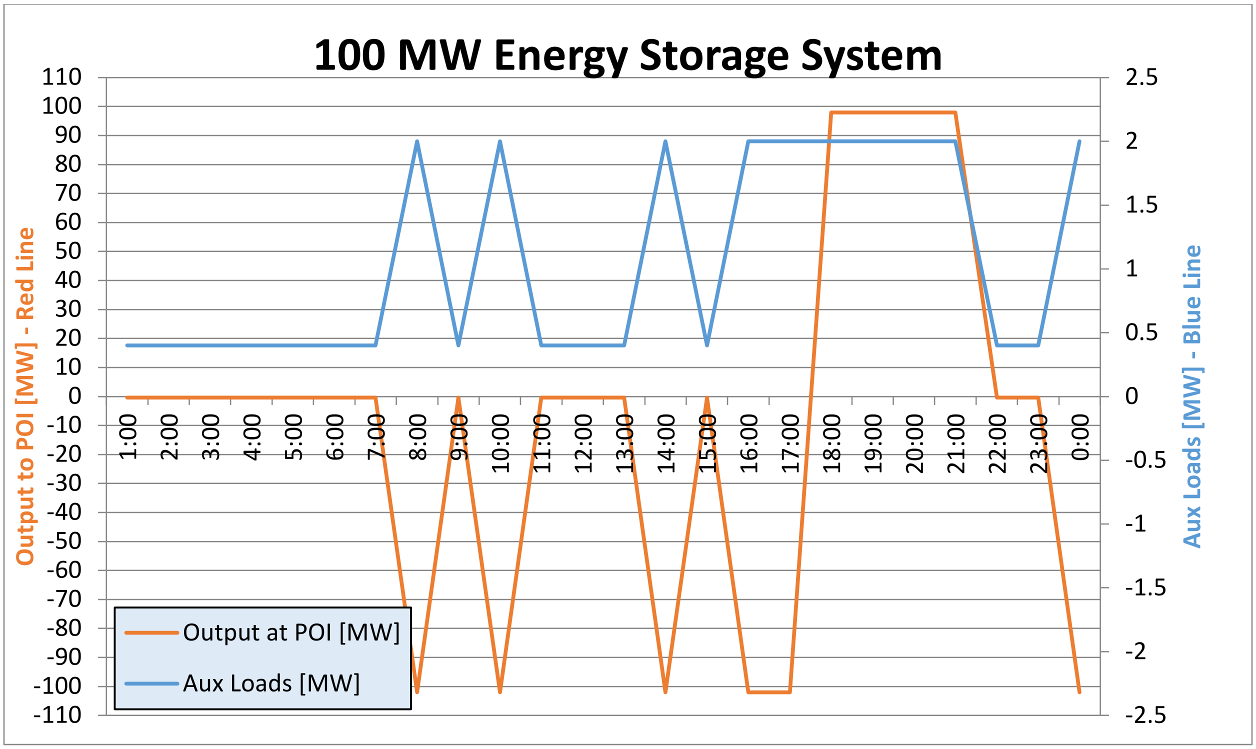

Figure 9: BESS real-time market dispatch for 5/20/2016, hourly averages

Figure 9 and Table 2 show the performance of the BESS under the current rules for Station Power and Permitted Netting, using the Single Meter Configuration in Figure 5. To summarize:

- Total revenues are $51,921.12
- Total wholesale charging costs are $7,825.74 (operationally, equivalent to fuel costs)
- Total cost of Station Power is $3,678.42, this includes:
  - $1,038.42 for station power requirements netted at wholesale during generation (same as the peaker)
  - $2,640.00 for station power purchased at retail rates when not operating (74% higher than for the peaker)

Note that the Dual Meter configuration depicted in Figures 6/7, which includes the calculated 24/7 idle loss retail charge proposed by SCE was not shown here. That scenario raised the Station Power bill to $3,840.00 in this model for the same dispatch.

Table 3 shows the results with the Permitted Netting definition proposed here and by other stakeholders, that station power during Negative Generation would also be netted from the wholesale output rather than settled at retail rates. The results in this scenario are:

- Total revenues are $51,921.12 (same as the peaker)
- Total wholesale charging costs are $7,825.74 (the same as before)
- Total cost of Station Power is $2,034.94, this includes:

- $1,194.94 for station power requirements netted at wholesale during generation
- $840.00 for station power purchased at retail rates when not operating

This 44.6% difference in a single day's BESS station power cost is driven by the low wholesale prices during the times that the asset is in the market providing Negative Generation. Inspecting those hours, we see that the average cost for station power netted against output in those hours is $26.09, which compares to $300 for hours where the retail rate is paid. That is an 11.5x reduction in operating cost for the storage resource.

The difference would be even greater on a day with negative pricing due to over generation. This order of magnitude difference in a key operating cost is a completely unnecessary handicap for storage. An energy storage system with these parameters would need to be paid an extra $3/MWh on discharged energy to account for this operating cost. As various parties have pointed out, the entire market would clear $3 higher if such a resource is on the margin in the market, and this would be an artificial and completely avoidable burden which falls on all ratepayers.

Table 1: 100 MW Gas Peaker Example

		Modeled Gas Peaker Plant: will sell for price > $50					
Hour Ending	LMP [$/MWh]	Generated MW	Aux loads [MW]	Output at POI [MW]	Permitted netting ? [Y/N]	Revenue from Generation	Cost of Station Power
1:00	$ 23.20	0	0.4	-0.4	FALSE	$ -	$ (60.00)
2:00	$ 21.97	0	0.4	-0.4	FALSE	$ -	$ (60.00)
3:00	$ 18.19	0	0.4	-0.4	FALSE	$ -	$ (60.00)
4:00	$ 18.96	0	0.4	-0.4	FALSE	$ -	$ (60.00)
5:00	$ 19.39	0	0.4	-0.4	FALSE	$ -	$ (60.00)
6:00	$ 27.79	0	0.4	-0.4	FALSE	$ -	$ (60.00)
7:00	$ 26.23	0	0.4	-0.4	FALSE	$ -	$ (60.00)
8:00	$ 13.82	0	0.4	-0.4	FALSE	$ -	$ (60.00)
9:00	$ 16.61	0	0.4	-0.4	FALSE	$ -	$ (60.00)
10:00	$ 12.75	0	0.4	-0.4	FALSE	$ -	$ (60.00)
11:00	$ 17.14	0	0.4	-0.4	FALSE	$ -	$ (60.00)
12:00	$ 19.79	0	0.4	-0.4	FALSE	$ -	$ (60.00)
13:00	$ 18.00	0	0.4	-0.4	FALSE	$ -	$ (60.00)
14:00	$ 13.88	0	0.4	-0.4	FALSE	$ -	$ (60.00)
15:00	$ 15.41	0	0.4	-0.4	FALSE	$ -	$ (60.00)
16:00	$ 12.46	0	0.4	-0.4	FALSE	$ -	$ (60.00)
17:00	$ 13.85	0	2.5	-2.5	FALSE	$ -	$ (375.00)
18:00	$ 68.30	100	2	98	**TRUE**	$ 6,829.71	**$ (136.59)**
19:00	$ 160.11	100	2	98	**TRUE**	$ 16,010.65	**$ (320.21)**
20:00	$ 173.95	100	2	98	**TRUE**	$ 17,395.05	**$ (347.90)**
21:00	$ 116.86	100	2	98	**TRUE**	$ 11,685.71	**$ (233.71)**
22:00	$ 23.07	0	0.4	-0.4	FALSE	$ -	$ (60.00)
23:00	$ 24.22	0	0.4	-0.4	FALSE	$ -	$ (60.00)
0:00	$ 11.50	0	0.4	-0.4	FALSE	$ -	$ (60.00)
					Totals	*$ 51,921.12*	*$ (2,553.42)*

Table 2: 100 MW Battery Energy Storage System example - Single Meter - Station Power netted on Positive Generation only

		Modeled Energy Storage System: Charge Price < $15, Discharge Price > $50								
Hour Ending	LMP [$/MWh]	Charge MW	Discharge MW	Aux Loads [MW]	Output at POI [MW]	SOC [%]	Permitted netting ? [Y/N]	Cost of Charging Energy	Revenue from Discharge	Cost of Station Power
1:00	$ 23.20	0	0	0.4	-0.4	0	FALSE	$ -	$ -	$ (60.00)
2:00	$ 21.97	0	0	0.4	-0.4	0	FALSE	$ -	$ -	$ (60.00)
3:00	$ 18.19	0	0	0.4	-0.4	0	FALSE	$ -	$ -	$ (60.00)
4:00	$ 18.96	0	0	0.4	-0.4	0	FALSE	$ -	$ -	$ (60.00)
5:00	$ 19.39	0	0	0.4	-0.4	0	FALSE	$ -	$ -	$ (60.00)
6:00	$ 27.79	0	0	0.4	-0.4	0	FALSE	$ -	$ -	$ (60.00)
7:00	$ 26.23	0	0	0.4	-0.4	0	FALSE	$ -	$ -	$ (60.00)
8:00	$ 13.82	100	0	2	-102	20%	FALSE	$ (1,381.95)	$ -	$ (300.00)
9:00	$ 16.61	0	0	0.4	-0.4	20%	FALSE	$ -	$ -	$ (60.00)
10:00	$ 12.75	100	0	2	-102	40%	FALSE	$ (1,274.79)	$ -	$ (300.00)
11:00	$ 17.14	0	0	0.4	-0.4	40%	FALSE	$ -	$ -	$ (60.00)
12:00	$ 19.79	0	0	0.4	-0.4	40%	FALSE	$ -	$ -	$ (60.00)
13:00	$ 18.00	0	0	0.4	-0.4	40%	FALSE	$ -	$ -	$ (60.00)
14:00	$ 13.88	100	0	2	-102	60%	FALSE	$ (1,388.02)	$ -	$ (300.00)
15:00	$ 15.41	0	0	0.4	-0.4	60%	FALSE	$ -	$ -	$ (60.00)
16:00	$ 12.46	100	0	2	-102	80%	FALSE	$ (1,245.61)	$ -	$ (300.00)
17:00	$ 13.85	100	0	2	-102	100%	FALSE	$ (1,385.44)	$ -	$ (300.00)
18:00	$ 68.30	0	100	2	98	75%	**TRUE**	$ -	$ 6,829.71	**$ (136.59)**
19:00	$ 160.11	0	100	2	98	50%	**TRUE**	$ -	$ 16,010.65	**$ (320.21)**
20:00	$ 173.95	0	100	2	98	25%	**TRUE**	$ -	$ 17,395.05	**$ (347.90)**
21:00	$ 116.86	0	100	2	98	0%	**TRUE**	$ -	$ 11,685.71	**$ (233.71)**
22:00	$ 23.07	0	0	0.4	-0.4	0%	FALSE	$ -	$ -	$ (60.00)
23:00	$ 24.22	0	0	0.4	-0.4	0%	FALSE	$ -	$ -	$ (60.00)
0:00	$ 11.50	100	0	2	-102	20%	FALSE	$ (1,149.93)	$ -	$ (300.00)
							Totals	*$ (7,825.74)*	*$ 51,921.12*	*$ (3,678.42)*

Table 3: 100 MW Battery Energy Storage System example - Single Meter - Proposed rules where Station Power is netted on Positive and Negative Generation

		Modeled Energy Storage System: Charge Price < $15, Discharge Price > $50								
Hour Ending	LMP [$/MWh]	Charge MW	Discharge MW	Aux Loads [MW]	Output at POI [MW]	SOC [%]	Permitted netting ? [Y/N]	Cost of Charging Energy	Revenue from Discharge	Cost of Station Power
1:00	$ 23.20	0	0	0.4	-0.4	0	FALSE	$ -	$ -	$ (60.00)
2:00	$ 21.97	0	0	0.4	-0.4	0	FALSE	$ -	$ -	$ (60.00)
3:00	$ 18.19	0	0	0.4	-0.4	0	FALSE	$ -	$ -	$ (60.00)
4:00	$ 18.96	0	0	0.4	-0.4	0	FALSE	$ -	$ -	$ (60.00)
5:00	$ 19.39	0	0	0.4	-0.4	0	FALSE	$ -	$ -	$ (60.00)
6:00	$ 27.79	0	0	0.4	-0.4	0	FALSE	$ -	$ -	$ (60.00)
7:00	$ 26.23	0	0	0.4	-0.4	0	FALSE	$ -	$ -	$ (60.00)
8:00	$ 13.82	100	0	2	-102	20%	**TRUE**	$ (1,381.95)	$ -	**$ (27.64)**
9:00	$ 16.61	0	0	0.4	-0.4	20%	FALSE	$ -	$ -	$ (60.00)
10:00	$ 12.75	100	0	2	-102	40%	**TRUE**	$ (1,274.79)	$ -	**$ (25.50)**
11:00	$ 17.14	0	0	0.4	-0.4	40%	FALSE	$ -	$ -	$ (60.00)
12:00	$ 19.79	0	0	0.4	-0.4	40%	FALSE	$ -	$ -	$ (60.00)
13:00	$ 18.00	0	0	0.4	-0.4	40%	FALSE	$ -	$ -	$ (60.00)
14:00	$ 13.88	100	0	2	-102	60%	**TRUE**	$ (1,388.02)	$ -	**$ (27.76)**
15:00	$ 15.41	0	0	0.4	-0.4	60%	FALSE	$ -	$ -	$ (60.00)
16:00	$ 12.46	100	0	2	-102	80%	**TRUE**	$ (1,245.61)	$ -	**$ (24.91)**
17:00	$ 13.85	100	0	2	-102	100%	**TRUE**	$ (1,385.44)	$ -	**$ (27.71)**
18:00	$ 68.30	0	100	2	98	75%	**TRUE**	$ -	$ 6,829.71	**$ (136.59)**
19:00	$ 160.11	0	100	2	98	50%	**TRUE**	$ -	$ 16,010.65	**$ (320.21)**
20:00	$ 173.95	0	100	2	98	25%	**TRUE**	$ -	$ 17,395.05	**$ (347.90)**
21:00	$ 116.86	0	100	2	98	0%	**TRUE**	$ -	$ 11,685.71	**$ (233.71)**
22:00	$ 23.07	0	0	0.4	-0.4	0%	FALSE	$ -	$ -	$ (60.00)
23:00	$ 24.22	0	0	0.4	-0.4	0%	FALSE	$ -	$ -	$ (60.00)
0:00	$ 11.50	100	0	2	-102	20%	**TRUE**	$ (1,149.93)	$ -	**$ (23.00)**
							Totals	*$ (7,825.74)*	*$ 51,921.12*	*$ (2,034.94)*