Comments of Powerex Corp. on
EIM Greenhouse Gas Enhancements
Third Revised Draft Final Proposal

Submitted by	Company	Date Submitted
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I. Introduction

Powerex appreciates the opportunity to submit comments on CAISO's April 25, 2018 EIM Greenhouse Gas ("GHG") Enhancements Third Revised Draft Final Proposal ("Proposal"). The primary feature of the Proposal is to restrict the GHG bid quantity that can be submitted for an EIM participating resource. Whereas current rules permit a scheduling coordinator to submit any GHG bid quantity between 0 MW and the maximum output of a participating resource, the Proposal would restrict the GHG bid quantity to a value between (1) 0 MW; and (2) the difference between the resource's upper economic limit and its base scheduled output.

The Proposal explains that "[b]y limiting the GHG bid quantity, the proposal will reduce the potential magnitude of secondary dispatch which will improve the accuracy of the market attribution. The CAISO optimization will limit the quantity attributed to a resource as serving CAISO demand when the resource is also serving demand external to CAISO through a base schedule."[1]

The Proposal would not change the rules related to the GHG bid price for an EIM participating resource.

As described more fully below:

- Powerex supports the Proposal's limitation on the maximum GHG bid quantity for each EIM participating resource.
- Powerex believes the remaining potential for leakage and inaccurate GHG attribution is substantial and requires objective tracking and reporting to guide future enhancements.

II. Powerex Supports The Proposal's Limit On GHG Bid Quantity

Powerex strongly supports the Proposal's limitations on the GHG bid quantity, and agrees with CAISO that these changes will reduce the inaccuracy of GHG emission attribution in the EIM. Currently, the EIM algorithm is able to attribute output as serving CAISO load to resource output that is fully scheduled to serve load outside the CAISO balancing authority area ("BAA") prior to

[1] Proposal at 5-6.

EIM dispatch. The Proposal recognizes such outcomes as inaccurate, and the proposed limitations on the GHG bid quantity will reduce the extent to which they can occur.

Powerex also agrees with the Proposal that the issue is not limited merely to the manner in which GHG emissions associated with serving CAISO load through the EIM are calculated, but impacts the very dispatch solution that the EIM optimization will reach. The current rules provide significant opportunities for the EIM algorithm to serve CAISO load by increasing the output of low-cost but high-GHG-emitting resources, including coal-fired resources, but avoid recognizing the GHG-related costs of that dispatch by systematically "deeming" that the CAISO load was being served from the base scheduled output from low- or non-emitting resources. By reducing the potential magnitude of this inaccurate "deeming," the Proposal should reduce the erroneous dispatch of high-emitting resources that is enabled by this inaccurate attribution, and hence lead to an EIM dispatch that is more aligned with the rules and policies of California's GHG program for output that serve load within the CAISO BAA.

For the above reasons, Powerex supports the Proposal's limitations on the maximum GHG bid quantity for EIM participating resources as a significant improvement over the current rules, and urges CAISO to implement the proposed limit as soon as possible.

III. Remaining Potential For GHG Emissions Leakage Is Substantial And Requires Objective And Transparent Reporting To Guide Future Enhancements

The Proposal recognizes that, while the restrictions on the GHG bid quantity should *reduce* the potential for GHG emissions leakage, it will not eliminate it.[2] Powerex agrees. This is because the Proposal does not limit the GHG attribution to only a participating resource's *actual increase* in output (relative to base schedules), but to its *potential increase* in output. The Proposal explains this using a hypothetical example of a 100 MW resource with an 80 MW base schedule and an EIM dispatch of 85 MW. The GHG bid quantity of this resource is limited to a maximum of 20 MW (*i.e.,* the upper economic limit of 100 MW minus the output base schedule of 80 MW). While the EIM dispatched the resource by 5 MW above its base schedule, up to 20 MW of the resource's output could be deemed to serve CAISO load. Up to 15 MW of energy used to serve CAISO load could therefore be attributed to this resource, even though the additional 15 MW of output was dispatched from other resources. In this example, there is therefore the potential for the EIM algorithm to dispatch up to 15 MW of additional output from other resources, including high-GHG-emitting resources, while ignoring the increased GHG emissions associated with that output.

In its comments on the Second Revised Draft Final Proposal, Powerex suggested that CAISO consider addressing this remaining potential for GHG emissions leakage, and outlined an approach for doing so. Specifically, the GHG bid price of participating resources would include a "price adder" on a sliding scale, based on the potential for GHG emissions attributed to the

[2] Proposal at 6.

resource to reflect GHG leakage as opposed to resource-specific emissions.[3] Powerex believes this approach—in which a price adder is proportional to the risk of GHG emissions leakage—is a far better design than the "price floor" that had been previously proposed by the CAISO. The Proposal eliminated the "price floor" design, but did not comment on Powerex's alternative proposal.

Powerex does not oppose implementing the GHG bid quantity restrictions even if the GHG bid price rules are not also revised at the same time, as the CAISO's Proposal would be a significant improvement over the *status quo.* However, Powerex believes that the potential for GHG emissions leakage and dispatch distortions to continue to occur is substantial and requires close monitoring. The magnitude of this remaining GHG leakage is not known at this time, and future enhancements may be necessary to further reduce the potential for GHG leakage. The urgency of such enhancements, as well as the design of those enhancements, will be informed by objective data regarding how much GHG leakage may be occurring.

For this reason, Powerex recommends the development and implementation of a transparent and objective methodology to compare the GHG emissions attributed under the EIM algorithm to the actual increase in GHG emissions from resources dispatched above their base schedules in the EIM.[4] Specifically, Powerex proposes that for each 5-minute interval in which the CAISO BAA receives a net EIM transfer, the following calculations would be performed:

- Determine the average incremental EIM GHG emission rate, which would be equal to:
  - The increased GHG emissions (in $MTCO_2$) from each EIM participating resource's incremental EIM dispatch level (for those EIM resources with a dispatch level above their respective base schedule quantity); *divided by*
  - The sum of the incremental EIM dispatch level (in MWh) above the base schedule quantity (for those EIM resources with a dispatch level above their respective base schedule quantity).
- Calculate the estimated GHG emissions associated with serving CAISO load in that interval, which would be equal to:
  - The average incremental EIM GHG emission rate, calculated above; *multiplied by*
  - The net EIM transfer into the CAISO BAA (in MWh).[5]
- The total GHG emissions associated with California load served in the EIM would be calculated as the sum of the above over all of the 5-minute intervals with net EIM

[3] Comments of Powerex Corp. on EIM Greenhouse Gas Enhancements Second Revised Draft Final Proposal, (March 1, 2018) at 10-14. *Available at:* http://www.caiso.com/Documents/PowerexComments-EIMGHGEnhancements-SecondRevisedDraftFinalProposal.pdf.

[4] Powerex made this same recommendation in its recent comments to CARB on its April 26 Workshop.

[5] In the unlikely event that net EIM transfers into the CAISO BAA exceeds the sum of the incremental output of out-of-state EIM participating resources, the difference could be assumed to incur the default GHG emission rate for unspecified source imports (i.e., currently 0.428 MTCO2/MWh).

transfers into the CAISO BAA in a particular period of interest (*e.g.,* month, quarter, or year).

- This result could also be expressed as an average GHG emission rate for the EIM transfers serving CAISO load over the stated period.

The proposed methodology, which is explained more fully in Appendix A, calculates the average GHG emission rate for all additional output that is dispatched in the EIM in a particular interval. To the extent that the EIM algorithm determines that the GHG emissions to serve CAISO load were substantially lower than this value, this could indicate that the EIM algorithm is inaccurately deeming lower-emitting resource output to California load, and that GHG leakage is occurring. If, on the other hand, both methods yield similar GHG emissions rates, this could indicate that the potential for residual GHG emission leakage may be limited, and further enhancements may not need to be prioritized at the present time.

Powerex believes that the proposed calculation will enable CAISO, CARB and stakeholders to meaningfully assess the accuracy of GHG attribution in the EIM. In particular, the proposed calculation will enable the assessment of:

1. The extent of current EIM GHG attribution inaccuracies, by comparing the actual average emissions rate of the external resources that increase their output during intervals when the CAISO BAA is importing to the GHG emissions attributed under the EIM's current "deemed delivered" approach;
2. The improvements in EIM GHG attribution accuracy resulting from implementation of the CAISO's proposed EIM design enhancements; and
3. The extent of GHG emissions leakage that occurs after these enhancements are implemented.

Powerex requests that CAISO work with CARB to implement a methodology to monitor and quantify the accuracy of GHG attribution in the EIM, such as the methodology discussed above. Such a methodology should be implemented in parallel with the implementation of the Proposal's restrictions on participating resources' GHG bid quantity, and should form part of the CAISO's regular reporting on GHG-related performance of the EIM.

Appendix A:

Proposed Methodology for Calculating Incremental EIM GHG Emissions Associated with Serving California Load

The proposed methodology consists of two basic steps. The first step is to calculate the increase in GHG emissions associated with resources located outside of the CAISO BAA that are dispatched by the EIM to an output level that is greater than the base schedule quantity for the resource. A hypothetical example for a single interval is shown below.

Interval 1

[1]	[2]	[3]	[4]	[5]	[6] =Max(0,[5] - [4])	[7] =[6]/12	[8] =[7] * [3]	
Resource ID	Type	Emission Factor (MTCO2/MWh)	Base Schedule (MW)	RTD Dispatch (MW)	EIM Inc. Output (MW)	EIM Inc. Output (MWh)	EIM Inc. GHG (MTCO2)	
1	Coal	0.92	60	100	40	3.3	3.07	
2	Coal	0.96	80	120	40	3.3	3.20	
3	Gas	0.43	80	100	20	1.7	0.72	
4	Gas	0.51	100	100	-	-	-	
5	Wind	0.00	50	45	-	-	-	
6	Hydro	0.00	-	-	-	-	-	
					100	8.3	6.98	0.84

For each resource, the increase in output (Column 6) is calculated from the positive difference between the Real-Time Dispatch (RTD) instructed output quantity (Column 5) and the base schedule quantity for the resource (Column 4). Since this change in output applies to only a 5-minute interval, representing one-twelfth of an hour, Column 7 calculates the increase in *energy* production (in MWh) by dividing Column 6 by 12. The increase in GHG emissions (Column 8) is equal to the increase in output (Column 7) multiplied by the resource's emission factor (EF), in metric tons of CO_2 equivalent per megawatt-hour, or $MTCO_2$/MWh (Column 3).

After calculating the increased GHG emissions from resources that are dispatched to increase output in the EIM, the total incremental EIM GHG emissions can be calculated as the sum of Column 8 over all EIM participating resources. This total can be divided by the total incremental energy production from EIM participating resources (sum of Column 7) to yield an average GHG emission rate for incremental EIM production in that interval.

In the above example, EIM dispatches resulted in a 40 MW increase in output from each of two coal-fired resources plus a 20 MW increase in output from a gas-fired resource. Other EIM participating resources were dispatched either to the same level as their base schedule output (*e.g.,* Resources 4 and 6) or were dispatched to a level below their base schedule output (*e.g.,* Resource 5). The sum of the additional GHG emissions from resources that were dispatched to a level above their base schedules is nearly 7 $MTCO_2$ in this example. The output of these resources was 100 MW higher than their base schedules during this interval, implying an average GHG emission rate of 0.84 $MTCO_2$/MWh for this additional output.

The table below shows this same approach applied to four additional hypothetical intervals, each consisting of different levels of resource base schedule output and EIM dispatch.

Interval 2

Resource ID	Type	Emission Factor (MTCO2/MWh)	Base Schedule (MW)	RTD Dispatch (MW)	EIM Inc. Output (MW)	EIM Inc. Output (MWh)	EIM Inc. GHG (MTCO2)	
1	Coal	0.92	80	100	20	1.7	1.53	
2	Coal	0.96	100	120	20	1.7	1.60	
3	Gas	0.43	60	100	40	3.3	1.43	
4	Gas	0.51	50	100	50	4.2	2.13	
5	Wind	0.00	50	40	-	-	-	
6	Hydro	0.00	60	80	20	1.7	-	
					150	12.5	6.69	0.54

Interval 3

Resource ID	Type	Emission Factor (MTCO2/MWh)	Base Schedule (MW)	RTD Dispatch (MW)	EIM Inc. Output (MW)	EIM Inc. Output (MWh)	EIM Inc. GHG (MTCO2)	
1	Coal	0.92	100	100	-	-	-	
2	Coal	0.96	100	80	-	-	-	
3	Gas	0.43	130	130	-	-	-	
4	Gas	0.51	180	100	-	-	-	
5	Wind	0.00	60	55	-	-	-	
6	Hydro	0.00	20	100	80	6.7	-	
					80	6.7	0.00	0.00

Interval 4

Resource ID	Type	Emission Factor (MTCO2/MWh)	Base Schedule (MW)	RTD Dispatch (MW)	EIM Inc. Output (MW)	EIM Inc. Output (MWh)	EIM Inc. GHG (MTCO2)	
1	Coal	0.92	100	70	-	-	-	
2	Coal	0.96	100	90	-	-	-	
3	Gas	0.43	20	100	80	6.7	2.87	
4	Gas	0.51	30	120	90	7.5	3.83	
5	Wind	0.00	50	60	10	0.8	-	
6	Hydro	0.00	40	70	30	2.5	-	
					210	17.5	6.69	0.38

Interval 5

Resource ID	Type	Emission Factor (MTCO2/MWh)	Base Schedule (MW)	RTD Dispatch (MW)	EIM Inc. Output (MW)	EIM Inc. Output (MWh)	EIM Inc. GHG (MTCO2)	
1	Coal	0.92	85	100	15	1.3	1.15	
2	Coal	0.96	80	100	20	1.7	1.60	
3	Gas	0.43	60	100	40	3.3	1.43	
4	Gas	0.51	70	100	30	2.5	1.28	
5	Wind	0.00	75	60	-	-	-	
6	Hydro	0.00	80	80	-	-	-	
					105	8.8	5.46	0.62

The second step in the calculation is to multiply the average incremental GHG emission rate by the quantity of EIM transfers serving California load in that interval. Since California load is served by out-of-state EIM resources only during intervals that the CAISO BAA is a net recipient of EIM transfers, intervals in which the CAISO BAA is a net supplier of EIM transfers need not be considered in this step.[6]

The table below shows how this second step in the calculation works. Columns 1-4 simply report the values calculated in the prior step, discussed above. Column 5 is the volume of net EIM transfers into the CAISO BAA (*i.e.,* the volume of California load served by out-of-state resources dispatched in the EIM). Note that this is the rate of EIM transfers in each 5-minute interval (in MW); to obtain the total energy of the EIM transfers (in MWh), this value must be divided by 12, which is shown in Column 6. Column 7 multiplies the energy of EIM transfers by the EIM average incremental GHG emission rate (Column 4), yielding the quantity of GHG emissions associated with serving California load from out-of-state resources in the EIM in that interval.

[1]	[2]	[3]	[4]	[5]	[6] =[5]/12	[7] =[6] * [4]	
Interval	EIM Inc. Output (MW)	EIM Inc. GHG (MTCO2)	EIM Inc. EF (MTCO2/MWh)	CAISO Net EIM Transfer In (MW)	CAISO Net EIM Transfer In (MWh)	EIM GHG for CA Load (MTCO2)	
1	100	6.98	0.84	80	6.7	5.59	
2	150	6.69	0.54	100	8.3	4.46	
3	80	0.00	0.00	20	1.7	0.00	
4	210	6.69	0.38	180	15.0	5.74	
5	105	5.46	0.62	80	6.7	4.16	
					38.3	19.94	0.52

The results from individual intervals can be aggregated over time (*e.g.,* a day, month, quarter or year). This is accomplished by summing the GHG emissions to serve California load from EIM resources (Column 7) over all relevant intervals in the period, and dividing by the total energy of EIM transfers into the CAISO BAA in those intervals (Column 6). In this example, the total GHG emissions to serve California loads from EIM resources over all five intervals was just under 20 $MTCO_2$, and the total quantity of net EIM transfers into the CAISO BAA was 38.3 MWh. As a result, the average GHG emission rate associated with serving California load from out-of-state EIM resources was 0.52 $MTCO_2$/MWh in this example.

One possible, albeit unlikely, circumstance is an interval in which net EIM transfers into the CAISO BAA are greater than the sum of incremental dispatch of EIM resources. This might occur if there are net EIM transfers into the CAISO BAA in the same interval that other EIM entities experience load that is substantially less than base schedule levels, or if EIM entities experience renewable generation output that is substantially greater than base schedule levels. In such a scenario, there could be EIM transfers into the CAISO BAA without requiring that EIM participating resources increase output above base schedules. In other words, the need to dispatch EIM resources upward to produce electricity for import into the CAISO BAA could be

[6] Reductions in the GHG emissions of out-of-state resources resulting from exports of California energy are not part of CARB's Cap and Trade Program, but the proposed analytical approach could also be used to estimate the out-of-state GHG emissions reductions during intervals of net EIM transfers out of the CAISO BAA.

more than offset by the need to dispatch EIM resources downward to balance the additional out-of-state renewable generation or to balance the lower-than-anticipated out-of-state load. EIM transfers into the CAISO BAA tend to be large and occur at fairly predictable times (*e.g.,* during the morning and evening net load ramps), however, and Powerex believes it would be highly unlikely for energy imbalances in other EIM entity areas to exceed these imports.

Nevertheless, such a scenario could be readily accommodated under the proposed methodology by applying the default emission factor for unspecified-source energy imports to any quantity by which net EIM transfers into the CAISO BAA exceed the sum of incremental dispatch of EIM resources. This is shown in the table below. If Interval 1 included net EIM transfers into the CAISO BAA of 120 MW (Column 8), but there was only 100 MW of incremental dispatch from EIM resources (Column 2), then an additional 20 MW of EIM supply would need to be inferred in this interval (Column 4). This would add 0.71 $MTCO_2$ using the default emission factor for unspecified electricity imports (Column 5) resulting in an adjusted quantity of GHG emissions from EIM supply serving California load (Column 6). This leads to an adjusted emissions factor for EIM supply (Column 7), which, when applied to the energy of EIM transfers serving California load (Column 9) yields the total GHG emissions for such EIM transfers in that interval (Column 10).

[1]	[2]	[3]	[4] =MAX(0,[8]-[2])	[5] =[4]/12*0.428	[6] =[5]+[3]	[7] =[6]/([2]+[4])*12	[8]	[9] =[8]/12	[10] =[9] * [7]
Interval	EIM Inc. Output (MW)	EIM Inc. GHG (MTCO2)	Inferred EIM Imbalance Supply (MW)	GHG Emissions of Inferred EIM Imbalance Supply, at Unspecified Rate (MTCO2)	Adjusted GHG Emissions from EIM (MTCO2)	Adjusted EIM EF (MTCO2/MWh)	CAISO Net EIM Transfer In (MW)	CAISO Net EIM Transfer In (MWh)	EIM GHG for CA Load (MTCO2)
1	100	6.98	20	0.71	7.70	0.77	120	10.0	7.70