

**Comments of Powerex Corp. on
Report on Proposed EIM Greenhouse Gas Enhancements**

Submitted by	Company	Date Submitted
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I. Introduction

Powerex appreciates the opportunity to submit comments on CAISO’s November 17, 2017 Report on Proposed EIM Greenhouse Gas Enhancements (“CAISO GHG Report”), as well as the presentation and analysis conducted by The Brattle Group (“Brattle Analysis”). In these comments, Powerex draws on multiple sources of data to examine the current EIM algorithm and its inaccurate consideration of GHG emissions for EIM imports to California loads. These comments necessarily delve into flaws of the current EIM design and algorithms under certain circumstances; namely, during intervals that the CAISO BAA is a net importer in the EIM. However, these comments should not be misconstrued as a broader critique of the overall economic or environmental performance of the EIM across all intervals. To the contrary, Powerex also highlights in these comments that the data show the EIM provides significant economic and environmental benefits during intervals that the CAISO BAA is a net exporter in the EIM. Furthermore, nothing in these comments should be viewed as a criticism of CAISO, CARB or any market participant; the inaccurate treatment of external GHG emissions is the unintended result of a flawed initial design of the EIM algorithm.

Powerex believes that both the CAISO GHG Report and the Brattle Analysis conclusively demonstrate that the current EIM algorithm fails to properly apply California’s Cap and Trade framework to resources located outside of California that are serving load in the CAISO balancing authority area (“BAA”) through the EIM. Through a simulated analysis comparing the current EIM algorithm to the CAISO’s two-pass proposal, both of these reports highlight the problematic outcomes with the current EIM algorithm. For instance, the CAISO GHG Report estimates that the amount of imports serving CAISO load attributable to natural gas fired resources **would be approximately four times higher** under the two-pass proposal than under the current approach.¹ The Brattle Analysis is even more striking: it estimates **that approximately 90% of imports** serving CAISO load would be attributed to natural gas resources under a two-pass approach.²

While both of these analyses provide some insights into the different outcomes that can be expected to occur under the two-pass proposal relative to the current approach, **Powerex believes both reports significantly understate the extent of the EIM GHG problem that**

¹ GHG Report at 8.

² Brattle Report at 7.

exists today. This is not a criticism of either the CAISO GHG Report or the Brattle Analysis, but rather reflects the limitations of:

1. using a simulated analysis approach, instead of actual real-world data and conditions; and
2. comparing the existing algorithm to the CAISO's proposed two-pass approach, which although an improvement over the *status quo*, will also fail to fully capture the GHG emissions associated with external resources serving California load in the EIM.

In these comments, Powerex provides an in-depth examination of the publicly-available data on EIM transfers for the one-year period of October 2016 through September 2017. This analysis demonstrates that the extent of the EIM GHG problem is likely substantially worse than either the CAISO GHG Report or Brattle Analysis indicate. ***In Powerex's view, it is clear that the GHG problem in the EIM is large, systemic and growing, and is directly undermining the application of California's Cap and Trade program to wholesale electricity imports serving California load.***

Specifically, Powerex's analysis shows that, during the EIM intervals in which the CAISO BAA is a net importer in the EIM:

1. The BAAs that are the largest net exporters are those with a predominantly coal and natural gas resource mix, and with lesser amounts of non-emitting resources
2. EIM prices are sufficiently high to make it highly likely that coal and/or natural gas resources are the marginal resources increasing their production as a result of EIM transfers serving California load
3. The EIM algorithm is incorrectly deeming EIM transfers serving California load to come from non-emitting resources, including from:
 - a. Resources that were fully base-scheduled ahead of the EIM to serve load outside the EIM
 - b. Resources that would have operated at the same level without any EIM transfers serving California load, and
 - c. Resources located in BAAs that are not EIM net exporters during the applicable interval at all

Powerex also outlines a straightforward calculation that CAISO can perform, and which Powerex believes will provide a more complete assessment of the actual GHG emissions associated with external resources serving California load through the EIM. Powerex requests that CAISO perform and publish this type of analysis for at least the past year, and consider providing updates on a monthly basis going forward. This will allow CAISO, CARB and stakeholders to better understand the full extent of the EIM GHG problem to date, as well as to understand the limitations of potential improvements, including the CAISO's proposed two-pass approach.

The EIM has operated now for over three years, during which the EIM GHG problem has existed and grown. Powerex believes it is critically important to the proper functioning of the EIM and CAISO real-time market, as well as the proper application of California's Cap and Trade program, that:

- CAISO provide full transparency on the extent of the EIM GHG problem as discussed above, and
- CAISO, or alternatively CARB, implement material near-term improvements to address this significant and growing issue.

Specifically, Powerex urges CAISO, or alternatively CARB, to take steps to ensure that the entire capacity of participating external resources is no longer automatically considered to be eligible to be deemed to serve California load in the EIM. The quantity eligible to be “deemed” to serve California load should be appropriately restricted to the “headroom quantity”, which is the quantity by which a resource is able to increase its production above the amount that has already been base scheduled to serve load outside the EIM. Powerex believes this is a reasonable and practical improvement that could be implemented without further delay, while CAISO, CARB and stakeholders continue to examine further enhancements and potential longer-term solutions.

II. Overview of the extent of the EIM GHG Problem

The CAISO GHG Report and Brattle Analysis demonstrate that the harm from the current EIM algorithm is not limited merely to understating the quantity of GHG emission allowances that should be retired. Both analyses show that the current EIM algorithm distorts dispatch of external resources—specifically, by dispatching excess amounts of external coal and gas-fired resources. Additionally, both analyses demonstrate that the current EIM algorithm results in excess imports to serve CAISO load; that is, some imports currently occur only *because* the GHG emissions associated with those imports are not properly recognized under the current design. In other words, the existing EIM algorithm is resulting in inefficient dispatch outcomes, with external higher-cost fossil resources displacing lower-cost resources internal to the CAISO BAA, directly as a result of the EIM algorithm’s failure to properly capture the environmental cost of external resource production serving California load. The Brattle Analysis estimates that, while a two-pass approach would reduce GHG emissions both within the CAISO area as well as in the rest of the EIM (compared to emissions without the EIM), the current one-pass approach actually *increases* emissions in the EIM area outside of the CAISO.³

Certain groups of EIM participants undoubtedly benefit from the EIM GHG problem. In particular, the application of the current algorithm can be expected to have the following impacts:

1. it reduces or even prevents the proper application of GHG allowance obligations for sellers of external fossil resource output serving load in California; and
2. it suppresses real-time market prices across the broader CAISO real-time market, through the exclusion of the GHG allowance costs associated with the actual fossil resources serving California load.

³ Brattle Analysis at 10, comparing total CO₂ emissions in 2020 under the 1-pass (*i.e.*, current) approach, 2-pass approach, and without an EIM at all.

This is not to imply that these entities, or the CAISO, are in any way taking any deliberate action to create an inappropriate economic benefit. To the contrary, it is the EIM algorithm—on its own—that inappropriately provides economic benefits to sellers of external fossil resource output in the EIM, and to purchasers of EIM energy in the specific intervals that the CAISO BAA is importing.

At the same time, the harmful consequences of the EIM GHG problem include not only greater GHG emissions associated with serving California load, but also economic harm to suppliers of lower-emitting resource output across the entire EIM footprint. This latter impact is occurring in two important ways. First, suppliers of lower-emitting resource output are often being inappropriately displaced in the CAISO's real-time market dispatch process by external EIM fossil resource production that is actually higher cost. Second, even in intervals during which suppliers of lower-emitting resource output are not inappropriately displaced, they receive lower CAISO real-time market prices. Both of these adverse outcomes affect not only to external suppliers in the EIM, but also to suppliers within the CAISO BAA, as well as external suppliers using the CAISO's intertie bidding processes.

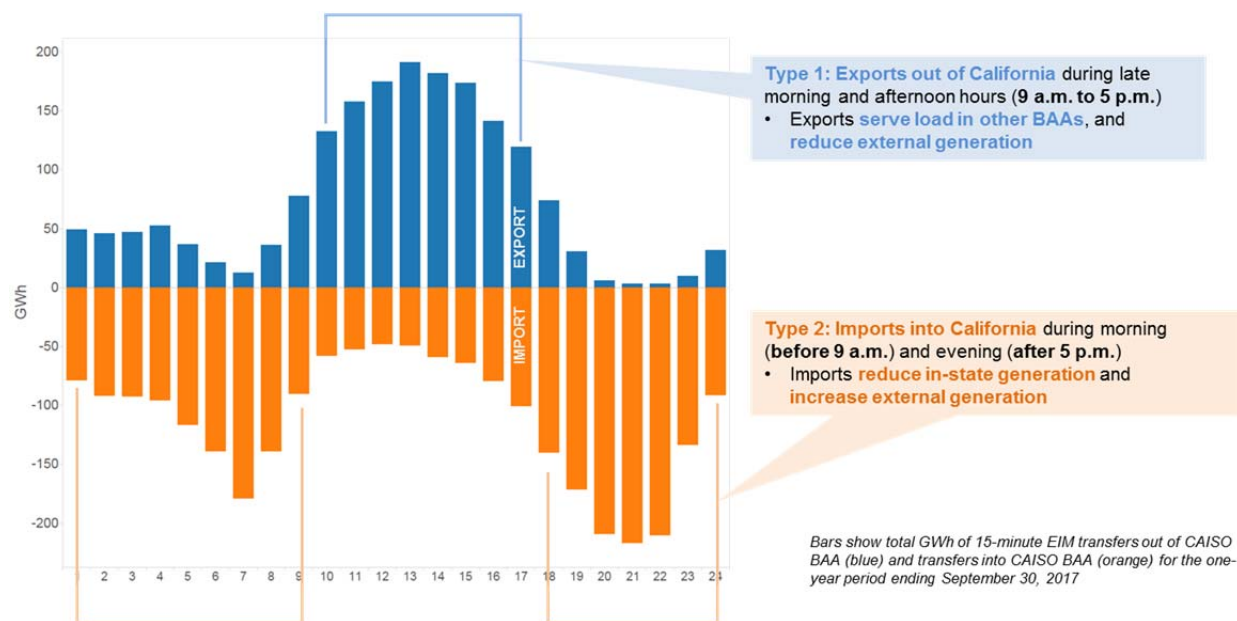
III. The CAISO's GHG Report, the Brattle Analysis, and actual EIM data all confirm that the existing EIM approach to GHG attribution creates harmful unintended consequences related to EIM imports serving CAISO load

The EIM utilizes the CAISO's security constrained economic dispatch framework to minimize the cost of serving load, subject to various transmission, reliability, and other constraints. In this regard, the EIM is a powerful tool in identifying opportunities for the most efficient utilization of physical resources over 15- and 5-minute time intervals. Moreover, the EIM operates beyond the borders of the CAISO BAA; as of the end of 2017, it also includes the participating resources and loads of five other entities: PacifiCorp, NV Energy, Arizona Public Service Company, Puget Sound Energy, and Portland General Electric. Since the EIM optimizes the dispatch of all participating resources across the entire EIM footprint to meet load across the entire footprint, it results in EIM transfers into, out of, and through EIM entities. It is these 15- and 5-minute EIM transfers that drive the economic and environmental benefits of the EIM for the CAISO BAA.⁴

The EIM has substantially increased the opportunities for economic transactions between the CAISO BAA and external areas in real-time. Figure 1, below, shows the total EIM exports and total EIM imports for the CAISO BAA, by operating hour, for the one-year period ending September 30, 2017.

⁴ The CAISO BAA already operated a real-time energy market with security-constrained economic dispatch prior to the advent of the EIM.

Figure 1. Total CAISO EIM Exports and Imports by Hour of Day, October 1, 2016 - September 30, 2017



Source: CAISO OASIS, based on results of Fifteen Minute Market (RTPD)

The above chart reveals that the expansion of sub-hourly organized markets has resulted in two key types of outcomes for California. First, during the mid-day hours, California predominantly engages in sub-hourly exports through the EIM. Second, during the early morning and nighttime hours, California predominantly engages in sub-hourly imports through the EIM.

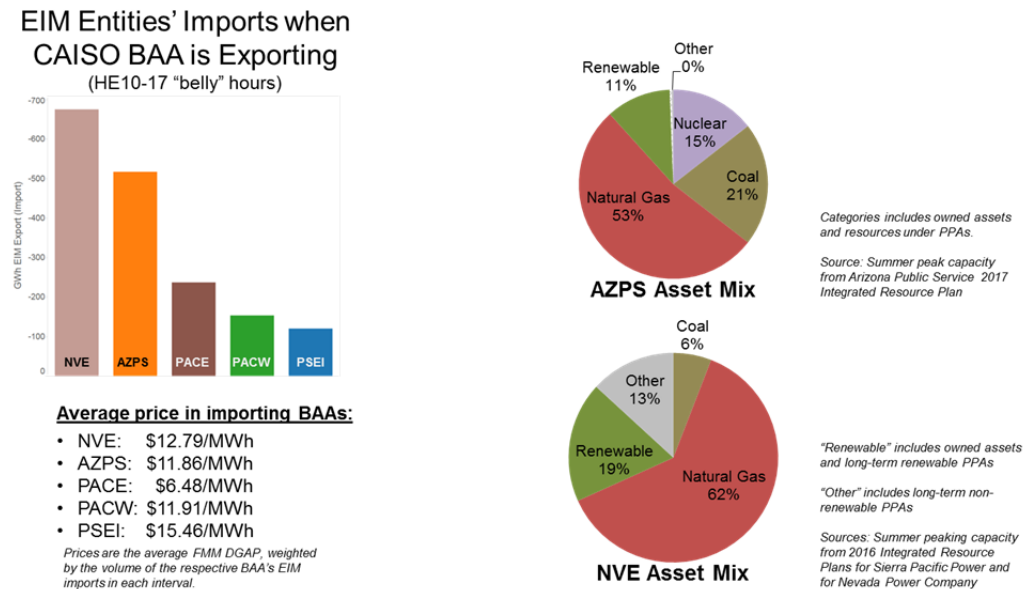
A. During the mid-day hours, the predominant activity is CAISO BAA exports of solar energy that is used to reduce external fossil resource output.

The CAISO BAA’s EIM exports during the mid-day hours correspond to the hours of California solar production; the so-called “belly of the duck.” These EIM exports from the CAISO BAA occur at a volume-weighted price of approximately \$6/MWh,⁵ implying that it is predominantly solar energy that is being exported (as opposed to, say, natural gas production, which would typically be uneconomic to sell at that price). The EIM, in other words, has been highly effective at facilitating exports of California renewable energy production (primarily from solar resources) that could not be used to meet California load. This is a clear environmental benefit, since renewable production would likely have been curtailed without these exports. Moreover, the EIM is enabling California renewable resource output to be exported to serve load in other states, thereby displacing the out-of-state resources that otherwise would have been used for that purpose. Which out-of-state resources are being backed down to absorb California solar exports can be inferred by examining which BAAs had the greatest net imports during the mid-day intervals that the CAISO BAA was a net exporter in the EIM. As shown below in Figure 2, it

⁵ This refers to the average LMP for SP15 in the RTPD during intervals in which the CAISO BAA is a net exporter in the EIM, weighted by the volume of those net exports.

is primarily NV Energy and Arizona Public Service Company that are the largest net importers during these conditions. The figure also shows that the resource mix of these companies consists primarily of coal and natural gas generations, with a lesser amount of non-emitting resources. It therefore appears highly likely that the EIM exports of California renewable energy largely displaced production from GHG-emitting resources. **Thus, not only has the EIM reduced the need to curtail production from California renewable resources, but the sub-hourly exports arranged through the EIM very likely have reduced GHG emissions from fossil resources outside of California.**

Figure 2. EIM Imports During "Belly of the Duck" Intervals of CAISO EIM Exports, by Entity



Sources: EIM transfers and prices in Fifteen-Minute Market from CAISO OASIS. Resource mix from public resource planning documents for each entity.

While this stakeholder process is focused on issues associated with EIM *imports* into the CAISO BAA, Powerex believes that it is important to recognize that the EIM has enabled unambiguous environmental benefits associated with EIM *exports* out of the CAISO BAA. In addition, the EIM has reduced the costs and challenges of integrating renewable resources, through its sophisticated, centralized dispatch software applied to a broad and growing geographical region. The relevant question in this stakeholder process is not whether the EIM—or increased inter-regional transactions in general—is beneficial overall, but rather how best to ensure that increased inter-regional trading, particularly import activity serving load into California, is pursued while respecting California’s environmental policy objectives, programs, and regulations.

B. During the morning, evening and over-night hours, the predominant EIM activity is the CAISO BAA importing external fossil resource output that is used to displace California natural gas output, without the proper application of California’s Cap and Trade Program.

The CAISO BAA is a recipient of sub-hourly EIM imports from the other areas participating in that market outside of the mid-day hours. This is particularly common during the morning and evening peak hours. In fact, the total quantity of EIM imports into the CAISO BAA is approximately 1.5 times the total quantity of EIM exports out of the CAISO BAA. The EIM has therefore also expanded opportunities for sub-hourly imports into the CAISO BAA of generation from out-of-state resources, reducing the cost of meeting California’s needs. Figure 3 and Figure 4, below, show the quantity of net EIM exports by BAA during the intervals that the CAISO BAA was a net importer, as well as the resource mix in the two BAAs with the greatest EIM exports during these intervals.

Figure 3. EIM Net Exports, by BAA, during intervals with CAISO EIM imports, October 1, 2016 - September 30, 2017

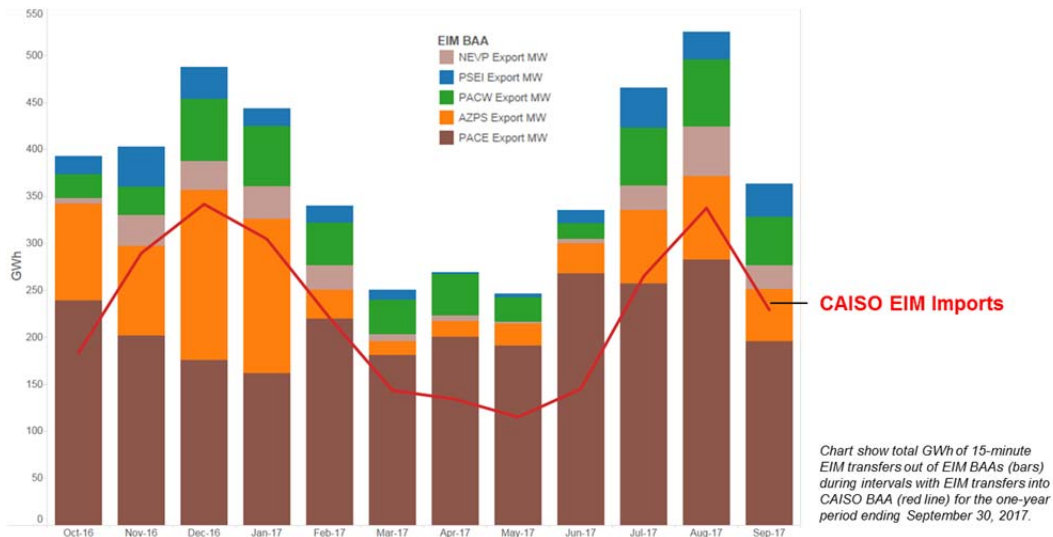
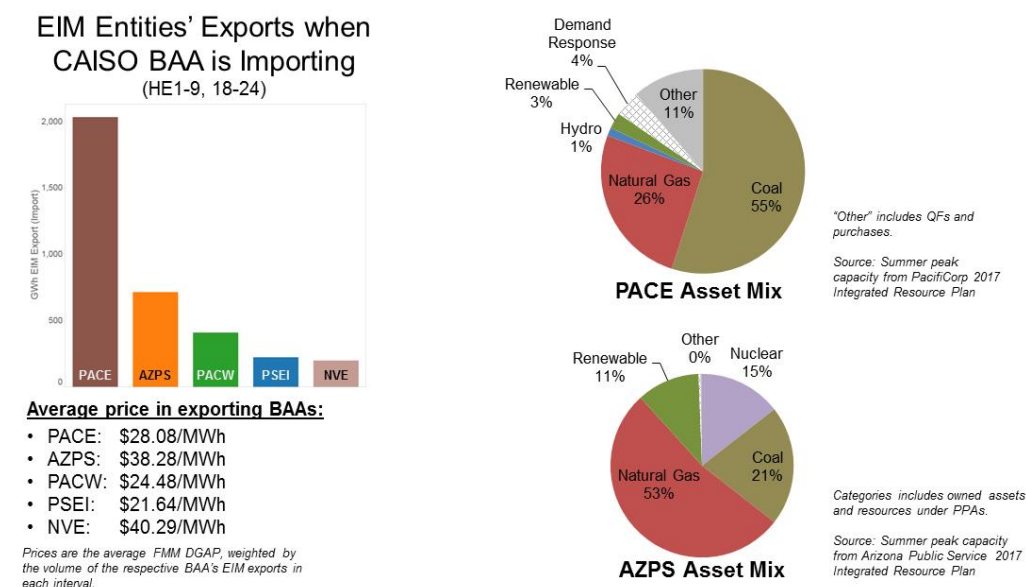


Figure 4. EIM Exports During Early Morning and Evening Intervals of CAISO EIM Imports, by Entity



Sources: EIM transfers and prices in Fifteen-Minute Market from CAISO OASIS. Resource mix from public resource planning documents for each entity.

PacifiCorp East is the BAA with the greatest quantity of net EIM exports during intervals of CAISO BAA net EIM imports over the one-year period covered by the analysis; Arizona Public Service Company is the BAA with the second-largest quantity. Both the PacifiCorp East and the Arizona Public Service Company BAAs participate in the EIM with a resource mix consisting primarily of coal and natural gas resources (although Powerex believes it is important to acknowledge that entities in these BAAs have also invested in substantial quantities of renewable, non-emitting resources in recent years). The fact that CAISO's EIM imports are primarily associated with EIM exports from BAAs with predominantly fossil resources appears to imply that CAISO load in those intervals is being served by increases in fossil resource output. This is further supported by the average EIM prices in these BAAs during the relevant intervals, which were between \$28.08/MWh and \$40.29/MWh, as shown above in Figure 4. Such price levels strongly indicate that it is likely coal and/or natural gas resources that are the resources supporting EIM exports to the CAISO BAA, since the non-emitting resources in these BAAs are largely nuclear and renewable resources that would be running anyway (*i.e.*, in the absence of CAISO EIM Imports and lower EIM prices). Put another way, it is almost certainly coal and natural gas resources in these BAAs that are predominantly the "marginal resources" supporting EIM transfers to California, and are the resources that would have operated at a lower output level in the absence of their BAAs' exports serving load in the CAISO BAA.

The CAISO's *Market Performance Report* includes information on the percentage of EIM transfers serving CAISO load **attributed to** different types of resources under the current EIM algorithm. The information for the same one-year period covered by the above charts is reproduced in Table 1, below:

Table 1. Attribution of CAISO EIM Imports Under Current Algorithm

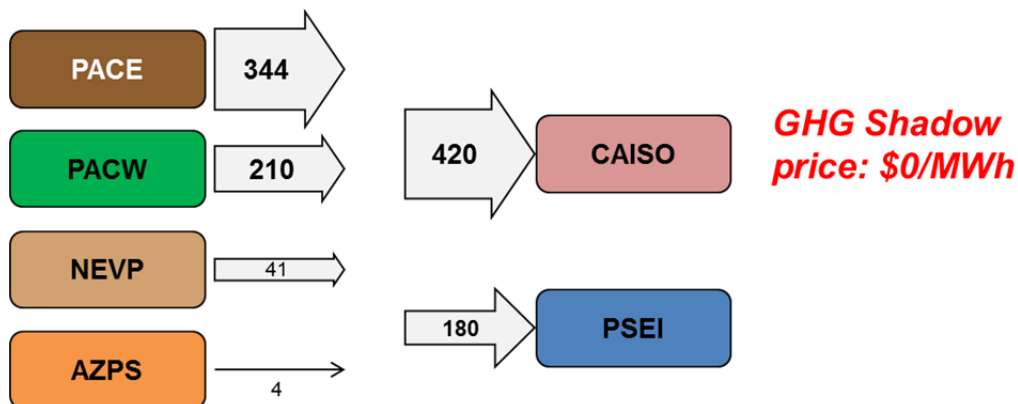
Month	Coal (%)	Gas (%)	Non-Emitting (%)	Total
Oct-16	0.00%	43.82%	56.18%	100%
Nov-16	0.00%	30.74%	69.26%	100%
Dec-16	0.00%	53.77%	46.23%	100%
Jan-17	0.00%	69.88%	30.12%	100%
Feb-17	0.00%	36.42%	63.58%	100%
Mar-17	0.00%	13.37%	86.63%	100%
Apr-17	0.00%	15.47%	84.53%	100%
May-17	0.00%	18.47%	81.53%	100%
Jun-17	0.00%	21.33%	78.67%	100%
Jul-17	0.00%	36.08%	63.92%	100%
Aug-17	0.00%	59.20%	40.80%	100%
Sep-17	0.00%	45.94%	54.06%	100%

Source: CAISO "Market Performance Report" for September 2017, Table 8. Available at: <http://www.caiso.com/Documents/MarketPerformanceReportforSeptember2017.pdf>

Notably, the current EIM algorithm avoids attributing *any* EIM imports serving CAISO load to coal-fired resources, and attributes the majority of imports to non-emitting resources in 9 of the 12 months. The results for March 2017 highlight Powerex's concerns regarding the attribution of imports under the current EIM algorithm. Specifically, the *Market Performance Report* shows that the EIM algorithm attributed 86% of imports serving CAISO load to "non-emitting" resources. However, Figure 3, above, shows that the total EIM exports from BAAs *other than* PacifiCorp East were less than the quantity of CAISO's EIM imports, implying that a substantial amount of the CAISO load that was served by EIM imports *must* have been from resources in the PacifiCorp East BAA.

The skewed attribution under the current EIM algorithm is powerfully illustrated by examining a single interval in detail. Figure 5 shows the EIM transfers for each BAA for September 15, 2017, HE7, FMM Interval 3:

Figure 5. Example of Flawed GHG Attribution Under Current EIM Algorithm: September 15, 2017 HE7, FMM Interval 3



Mathematically, it appears clear that at least *some* of the exports from the PacifiCorp East BAA *must* be serving load in the CAISO BAA during this interval. The resources in the PacifiCorp East BAA consist primarily of coal and natural gas-fired generation. The price in the PacifiCorp BAA during this interval was approximately \$40/MWh, suggesting it was indeed coal or natural gas resources that were likely increasing their production to support EIM transfers to California (and would be the resources reducing their production if there were no EIM transfers serving California load in this interval). But in this interval, *all* of the imports serving load in the CAISO BAA were deemed to be from “non-emitting” resources, as evident from the GHG shadow price of \$0/MWh.

The Brattle Analysis provides additional explanation of how the current EIM algorithm reaches such results, explaining that “The currently-deployed 1-Step Approach creates opportunities for some secondary dispatch and backfilling, and under-allocates external emissions to CAISO load.”⁶ This “secondary dispatch and backfilling” refers to the fact that external resources may be deemed to serve CAISO load even for the portion of output that was already committed to serve non-CAISO load in the resource base schedules. In other words, the amount of a resource’s output that is deemed to serve CAISO load under the current EIM algorithm is not limited to the *additional* output from the resource that is dispatched in the EIM. Resources that would have run with or without EIM imports into the CAISO BAA—resources such as non-dispatchable wind and solar, or economic non-emitting resources such as hydro—are routinely identified by the EIM algorithm as the resources that serve CAISO load in the EIM. This happens even when the output of such resources is base-scheduled ahead of the EIM (and hence already scheduled to serve load *outside* of the CAISO BAA). It is this disconnect that permits the current EIM algorithm to increase the output of external coal or natural gas resources in order to increase EIM imports into the CAISO, but avoid recognizing the additional GHG emissions from those external resources.

The CAISO’s GHG Report and the Brattle Analysis also show the multiple types of harmful effects caused by the flaws in the current EIM algorithm:

- **GHG emissions for serving CAISO load are understated.** This leads to too few California GHG emissions allowances being retired, meaning too many GHG emissions allowances remain in circulation and available to support additional emissions under California’s cap-and-trade program. Beginning in 2018, Powerex understands that CARB has put in place a bridge solution to address, at least partially, this particular outcome.⁷
- **California in-state resources are inefficiently displaced by out-of-state generation.** As explained in the Brattle Analysis, “Under the [current EIM algorithm], gas plants in CAISO ramp down and are replaced by external gas generation that comes in without CO₂ costs due to secondary dispatch effects.”⁸ CAISO’s GHG Report shows similar

⁶ Brattle Analysis, at 12.

⁷ See CARB’s addition of Section § 95852b(1)(D) to the Cap and Trade Regulation.

⁸ Brattle Analysis, at 6.

outcomes.⁹ Brattle further acknowledges that this may also be external coal resources that replace CAISO gas plant output.¹⁰ Powerex believes this is likely the case, given its historical analysis of which BAAs are exporting in the intervals the CAISO BAA is importing, as well as the relative marginal cost of natural gas generation versus coal generation in those BAAs in recent years. These transfers are inefficient, and occur precisely *because* the GHG emissions of those out-of-state resources are currently not properly recognized in the EIM's dispatch optimization.

- **The current EIM algorithm does not efficiently select *which* external resources to dispatch to serve CAISO load.** The GHG Report shows that the current EIM algorithm dispatches external gas or coal resources to serve CAISO load, even when non-emitting hydro resources are both available and economic, once GHG emissions are properly considered.¹¹ But because the GHG emissions of the additional production are not fully captured under the current approach, higher-emitting resources artificially appear to be more economic, and are dispatched.
- **GHG shadow prices are suppressed under the current EIM algorithm.** While the Brattle Analysis and GHG Reports do not address the impact of the current EIM algorithm on prices, the GHG attribution of EIM transfers serving CAISO load are directly linked to the GHG shadow prices. This also lowers the CAISO's real-time market prices more generally, across its broader real-time market footprint.

In short, the unintended consequences of the current EIM algorithm go well beyond merely miscalculating the GHG emissions to serve CAISO load. The current algorithm has resulted in the EIM inadvertently creating significant new opportunities for the sale of energy from out-of-state fossil resources to serve California load but without appropriately recognizing their GHG emissions. Conversely, the current algorithm has resulted in the EIM failing to encourage the sale of energy from lower-emitting in-state and lower-emitting out-of-state resources to serve California load. While this has been labeled a "secondary emissions" problem, it is perhaps more accurately described as a "primary emissions" problem, whereby out-of-state fossil resources increase their output specifically as a result of serving California load in the EIM.

Both the Brattle Analysis and the CAISO's GHG Report observe that the unaccounted for GHG emissions due to the flaws in the current EIM algorithm represent a small share of overall GHG emissions. This should provide no comfort, however, nor should it excuse any delay in addressing the issue, for at least two reasons. First, Powerex believes the historical analysis of actual EIM data, contained herein, strongly suggests that both the Brattle Analysis and CAISO GHG Report may significantly understate the extent of the problem that is actually occurring.

⁹ GHG Report at 9, showing that the 2-pass approach would eliminate EIM transfers that result in CAISO gas (and some hydro) output being replaced by external coal and gas generation.

¹⁰ The Brattle Analysis assumes a natural gas price of \$4.1/MMcf; whereas current natural gas prices in the major market areas outside the CAISO BAA are appreciably lower. Brattle acknowledges that its "simulations show relatively less coal backfilling under the [current EIM algorithm] than what would be expected with lower gas prices." (Brattle Analysis at 12)

¹¹ GHG Report at 9. The change in generation in the non-CAISO EIM footprint has an *overall* reduction in generation, consistent with a reduction in EIM transfers to the CAISO BAA, but is also shows an increase in generation from hydro resources. This implies that even when EIM transfers to the CAISO BAA do occur, the dispatch of external resources is distorted under the current EIM algorithm.

Second, the fact that unaccounted for GHG emissions are relatively small is not because the distortions of the EIM algorithm are small, but because the EIM represents a small share of total generation in the footprint. The GHG Report shows that, under the current EIM algorithm, the GHG emissions of EIM transfers serving CAISO load are *understated by a factor of four*.¹² Regardless of whether the actual understatement is much greater, as Powerex believes, an understatement error of the magnitude suggested by the GHG Report, if not meaningfully addressed, represents a potential threat to continued broad support for the EIM, as well as support for extending the EIM framework to the day-ahead timeframe,¹³ where the volume of imports affected by the attribution framework would be much larger.

Powerex believes there is now undisputed evidence that the GHG attribution under the current EIM algorithm is fatally flawed, causes significant harm, and is inconsistent with California's environmental policy objectives and programs. Powerex urges CAISO, together with CARB, to take immediate action to meaningfully improve the GHG attribution in the EIM as soon as possible.

IV. Additional work is necessary to identify a comprehensive and accurate framework for GHG attribution in the EIM, and in any future multi-state day-ahead market

CAISO staff have worked diligently to explore potential ways to improve the accuracy of GHG attribution in the EIM. Powerex commends CAISO for dedicating resources both to identifying enhancements and to testing the efficacy of those enhancements through rigorous analysis, such as in the GHG Report and in the Brattle Analysis. These analyses unequivocally demonstrate that the proposed two-pass solution would lead to a major improvement in the performance of the EIM algorithm with regard to incorporating information on GHG emissions for resources serving CAISO load.

Some stakeholders have recently raised concerns about the incentives that may be associated with implementing the two-pass solution as proposed by CAISO. Specifically, the two-pass solution would use a resource's bid price for two purposes: to establish the "GHG base" in the first pass, and to establish the actual dispatch of the resource in the second pass. The concern expressed by some commenters is that sellers of lower-emitting resources would have an incentive to raise their energy offer price to a level high enough to *not* be accepted in the first pass, since this allows more of the resource's actual output can be deemed to serve load in the CAISO BAA, for which it will receive additional compensation in the form of the GHG shadow price.

¹² GHG Report at 12, showing the average GHG intensity of EIM transfers serving CAISO load of 0.05 mTCO₂/MWh under the current algorithm compared to 0.20 mTCO₂/MWh under the proposed 2-pass approach. Powerex believes the actual understatement is even larger, as the proposed 2-pass solution does not fully eliminate leakage, and continues to allocate the output from lower-emitting resources preferentially to serving CAISO load.

¹³ The 2018 Draft Policy Initiatives Roadmap at 4-6, discussing initiative to "extend day-ahead market to EIM Entities." With regarding day-ahead GHG attribution, CAISO proposes to "Extend EIM real-time market approach to day-ahead." (*Id.* at 6) Available at: <http://www.caiso.com/Documents/2018DraftPolicyInitiativesRoadmap.pdf>

Powerex recognizes the theoretical basis for the concern, but does not agree that it would materially alter behavior in practice. Specifically, increasing the energy offer price so the resource is not accepted in the first pass runs the risk that the offer will also not be accepted in the binding market run (*i.e.*, the second pass). Thus, an effort to increase the portion of output that receives the relatively modest GHG shadow price could result in substantial lost market sales, foregoing not only the GHG shadow price but the comparatively larger energy price as well. Market participants' ability to "thread the needle" between an offer price that is high enough to not be taken in the first pass, but not so high to jeopardize sales in the second pass will depend on the predictability of prices in the first and second passes. Moreover, market participants submit offer curves for the entire hour, which apply to the four 15-minute intervals and to the twelve 5-minute intervals therein. Even if a particular bid price is "successful" in one interval, those same prices are likely to result in substantial losses in other intervals, making it potentially impossible—or at least extremely risky—to identify a higher offer price that achieves net gains over the entire hour.

While Powerex disagrees that the behavioral concerns that have been raised will manifest themselves in practice, it respects the need for CAISO to diligently assess the robustness of changes to market design. CAISO has identified potential modifications to its two-pass solution proposal to address the concerns that have been raised. For example, CAISO has raised the idea of using resources' Default Energy Bids to perform the first pass. Alternatively, a trailing average of recent historical bids could be used to perform the first pass. Either of these approaches would break the connection between the offer prices submitted by the participant for that hour and the GHG attribution for the resource. This should fully address theoretical concerns with bidding incentives associated with a two-pass solution.

In addition, it is important to highlight that the proposed two-pass solution, as well as the alternative two-pass approaches described above, would all continue to allow some amount of leakage, and would still attribute eligible output from low-emitting resources preferentially to CAISO load. The magnitude of this residual inaccuracy is not known at this time, but the CAISO GHG Report indicates it may not be trivial.¹⁴ Further, the historical analysis of EIM data suggests the average emissions rate associated with external resources serving California load is potentially much higher than would be attributed even in the simulated two-pass analyses conducted by Brattle and CAISO. This further suggests that the two-pass solution may only be partially successful in addressing the EIM GHG problem.

Other commenters have suggested that CAISO instead apply a hurdle rate to all EIM transfers serving CAISO load, but otherwise leave the existing GHG attribution unchanged. This was an idea discussed over a year ago, and which CAISO staff had previously decided not to pursue.¹⁵

¹⁴ There is a significant discrepancy between the portion of EIM transfers to CAISO load attributed to gas resources in the GHG Report (approximately 40%; slide 8) and in the Brattle Analysis (over 90%; slide 7), indicating that implementation details will be very important to achieving accurate outcomes. Moreover, the average GHG intensity of EIM transfers to CAISO load under the GHG Report is less than half of the "default" emission rate (GHG Report at 12), suggesting a significant portion of EIM transfers to CAISO load would still be attributed to non-emitting resources whose output is not increased in the EIM.

¹⁵ See, e.g., CAISO presentation at October 13, 2016 technical workshop in this stakeholder process, at slides 27-28. Available at: <http://www.caiso.com/Documents/UpdatedAgenda-Presentation-RegionalIntegrationCaliforniaGreenhouseGasCompliance-TechnicalWorkshop.pdf>

A hurdle rate would fail to address several of the harmful consequences of the current algorithm. In particular, it does nothing to ensure the EIM dispatch more accurately selects between external resources with different GHG emission rates. The scenario documented in the GHG Report—in which external coal or gas is dispatched, even where external non-emitting hydro resources are available and economic—would continue to occur. Worse, a hurdle rate would further discourage participation by lower-emitting resources in the EIM, since these resources would face a hurdle rate for serving CAISO load that is greater than their actual emission rate. By the same token, a hurdle rate based on average performance would tend to understate the actual GHG emissions of external fossil resources that are dispatched to serve CAISO load. Thus, the EIM would continue to offer market opportunities for external fossil resources to sell their output to serve CAISO load without fully accounting for the associated GHG emissions.

The foregoing indicates that, while there are multiple promising approaches available to improve how the EIM incorporates GHG emissions of external resources, additional work appears to be necessary to identify the most appropriate long-term solution. While a thorough assessment of market design changes is both prudent and necessary, such an assessment also inevitably takes time. It has already been more than three years since the launch of the EIM, and more than a year since potential enhancements were identified, with additional time seemingly required to identify a comprehensive and fully effective long-term solution, all while the current EIM algorithm remains in place and the harm from its unintended consequences continue to mount.

Powerex therefore urges CAISO to immediately implement provisional and limited changes to the existing one-pass approach, described more fully in the following section, which will improve the accuracy of the GHG attribution in the EIM. This provisional solution will mitigate the ongoing harm caused by current EIM algorithm, while CAISO, CARB and stakeholders work toward a longer-term solution.

V. The root cause of the current flaw can be immediately addressed by restricting a resource's GHG attribution to available capacity in excess of its base schedule

While identifying the best long-term framework for incorporating GHG emissions into the EIM design has proven challenging, the need to avoid continued harm under the current EIM algorithm is critical. The elusiveness of fully satisfactory solutions in no way reduces the severity of the problem. To the contrary, the fact that a long-term solution may take additional time to identify and refine creates an urgent need for interim measures that reduce the ongoing harmful consequences of the existing design.

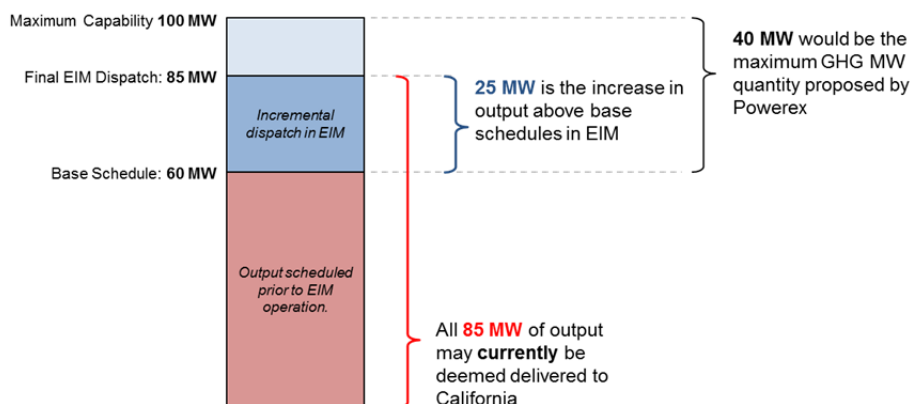
Generally speaking, the root cause of the flaw under the existing EIM algorithm is the unfettered ability to allocate EIM transfers to any or all of the output of any external participating resource willing to accept that allocation. A resource's output may be entirely committed to serve load outside the CAISO, but the EIM could still deem that entire output to serve CAISO load. For example, external participating renewable resources, such as wind and solar resources, ***that may be fully base-scheduled to serve load outside of California and would run at the***

same level - with or without EIM transfers to California - may still have all of their output deemed delivered to California under the current EIM algorithm. Similarly, external participating hydro resources, **including those in BAAs that have no net EIM exports, those that may be fully base-scheduled to serve load outside of California, and those that may need to run at their full output to avoid spill** – all with or without EIM transfers to California - may nevertheless have *all* of their output deemed delivered to California. Under the current EIM algorithm, clean resource output that is base scheduled ahead of the EIM provides a deep pool of clean energy that can be “deemed” to serve CAISO load in the EIM, and thus directly enables the EIM algorithm to increase the output of coal and natural gas resources without incurring GHG-related costs. The proposed two-pass solution dramatically restricts this attribution to only the output that is increased above a hypothetical scenario without EIM transfers to CAISO load. Powerex has been, and remains, supportive of this approach. But it is not the *only* approach; other approaches are available that also substantially restrict the attribution of EIM transfers to CAISO load, but do not raise the same implementation challenges or incentive compatibility concerns that have been raised with the two-pass solution.

Powerex believes that the accuracy of the GHG attribution in the EIM could be significantly improved by simply limiting the GHG MW quantity that can be submitted for each resource. EIM participating resources currently have the discretion to submit *any* GHG MW quantity between a minimum value of 0 MW and a maximum value equal to the resource’s maximum output. Powerex believes this discretion is excessive, as it allows up to 100% of a resource’s output to be deemed to serve CAISO load, regardless of how much of the resource’s output is due to its dispatch in the EIM. Powerex recommends that the GHG MW quantity submitted for a resource should be limited to the portion of the resource’s maximum output above its EIM base schedule quantity. That is, a resource could only be deemed to serve CAISO load for a quantity that is equal or less than its “headroom” above its base schedule.

This proposed simple enhancement is illustrated in Figure 6, below.

Figure 6. Example of eligible quantity that can be deemed delivered to CAISO load



The above example shows a hypothetical 100 MW resource. The resource has a maximum capacity of 100 MW, with 60 MW of its output base-scheduled to serve load outside the EIM. Under the current approach in the EIM, the seller of this resource’s output could elect to make

up to the full 100 MW of capacity eligible to be deemed delivered to serve California load in the EIM (*i.e.*, by submitting a GHG MW quantity of up to 100 MW). In the above example, this may result in the resource being deemed delivered to California for its full dispatched output of 85 MW, even though it has only increased its production by 25 MW above its base schedule. If this is a non-emitting resource, it is much more likely that it will indeed be deemed delivered to California for its full 85 MW of output, thereby enabling external emitting resources to increase their production and serve California load (without properly applying these resources GHG-related costs in the dispatch and pricing of the EIM, and without applying CARB reporting and GHG allowance obligations). Powerex's proposed improvement would simply limit the quantity that could be deemed delivered to California to the "headroom" of 40 MW, which is the amount the resource could increase its production above the base-scheduled quantity that has already been identified as serving load outside the EIM. While this still enables the resource to be deemed delivered to serve California load for 40 MW when it has only increased its production by 25 MW, it would be a significant improvement over the *status quo*.

From an implementation standpoint, this approach appears to require minimal changes to existing systems, as it simply restricts the valid range of values for a resource attribute (*i.e.*, the GHG MW quantity) that is already in use. The manner in which the GHG MW quantity is used would not need to be changed. Indeed, the EIM algorithm would operate in exactly the same way as if market participants self-limited the GHG MW quantities they submitted in this manner, or if CARB required market participants to limit the GHG MW quantities in this manner. Critically, this approach does not require an additional market run in order to be implemented, thus eliminating concerns regarding whether it can be achieved within the market timelines. It also appears that the system modifications could be achieved in considerably less time than for more technically involved solutions, such as the two-pass proposal.

The use of base schedules to limit a resource's GHG attribution avoids concerns about incentives for EIM bidding behavior. And while base schedules could conceivably be adjusted to maximize the output of non-emitting resources that can be deemed to serve CAISO load, this ability already exists today, and is entirely unlimited. For example, there is currently nothing to prevent an EIM participant from submitting the maximum GHG MW quantity for each of its non-emitting participating resources, while submitting zero GHG MW quantities for each of its higher-emitting participating resources. Powerex's proposal would at least limit the ability to selectively allocate GHG MW quantities in this manner, as the maximum GHG MW of the non-emitting resources in this example would be limited to the capability of each resource in excess of its base schedule. Furthermore, the ability to adjust base schedules is itself substantially limited. Resource base schedules must be in balance with the base schedules for demand and interchange as part of the CAISO's resource sufficiency framework. Efforts to deliberately minimize base schedules for non-emitting resources (to maximize headroom) would require an EIM participant to increase base schedules from other resources to pass the CAISO's resource sufficiency tests, which it may not have (or it may have committed to other uses). Finally, the extent the CAISO is concerned about systemic over- or under-statement of base schedules in order to affect the GHG attribution of a resource in the EIM, such behavior should be relatively straightforward to identify.

Some commenters may observe that base schedules are not a suitable baseline for GHG attribution because they do not necessarily reflect the optimal scheduling of resources in the EIM footprint (absent EIM transfers serving California load). This misses the point, however. While CAISO's proposed two-pass solution seeks to identify a "counterfactual" output without EIM transfers to CAISO load, this proposal does not. Rather, this proposal is based on the concept that resource output that has been committed to serve load outside the CAISO prior to the operation of the EIM should simply not be eligible to be re-labeled as serving CAISO load in the EIM. ***CAISO and CARB should be highly skeptical of arguments that the status quo, which allows the re-labelling of supply that has already been base scheduled to serve load outside the EIM, is a more accurate and more appropriate approach.*** It is far more accurate to assume that the tens of thousands of MWs of external supply that has been base scheduled to serve load outside the EIM actually serves that load, rather than to assume it is available to be selectively "deemed delivered" to California load in the EIM.

Powerex believes that limiting GHG MW quantities to a resource's "headroom" above base schedules will significantly reduce the discretion with which the EIM algorithm deems output to serve CAISO load. This proposal will more closely align GHG attribution in the EIM to the EIM's dispatch of resources, which Powerex believes is a more valid basis for specified-source reporting of imports under CARB's cap-and-trade program. Powerex does not claim that this proposal will be precisely as accurate as the proposed two-pass solution, or that it would be the optimal long-term solution. Indeed, both Powerex's proposal to limit a resource's GHG MW quantity to its "headroom" as well as the proposed two-pass solution will likely result in a material remaining understatement of GHG emissions in the EIM's dispatch solution. Powerex does believe, however, that its proposed approach will result in significantly more accurate GHG attribution in the EIM compared to the current algorithm, is much more appropriate than the *status quo*, and can be implemented with limited effort or delay. This approach can be replaced and/or supplemented, if and when a longer-term solution or enhancements are developed.

In light of the undeniable evidence of significant and ongoing harm caused by the current EIM algorithm, Powerex respectfully requests that CAISO limit the GHG MW quantities that may be submitted for each EIM participating resource, as described above, as soon as possible.

If CAISO is unable to achieve such an outcome, Powerex suggests that CARB consider whether EIM "deemed deliveries" for quantities that exceed a resource's "headroom" above base schedules should be permissible under its regulations.

VI. Additional analysis of historical EIM data is necessary to estimate the GHG emissions of external resources serving California load in the EIM

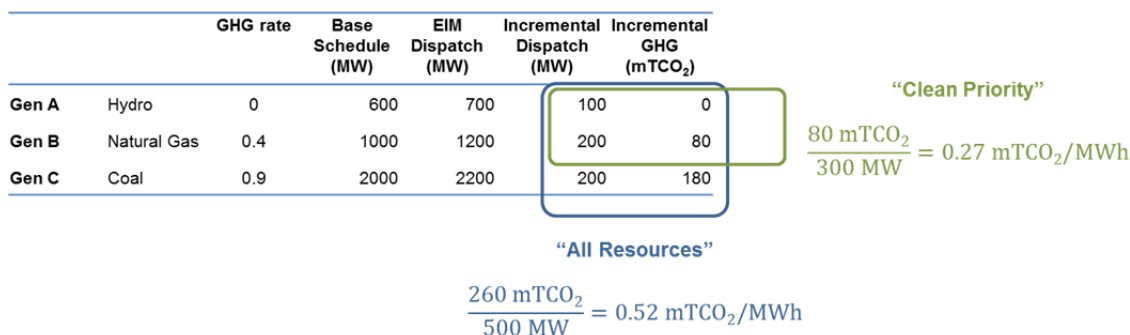
Powerex's conclusions regarding the inaccurate GHG attribution under the current EIM algorithm is based exclusively on the publicly available data on EIM transfers. While Powerex believes this public data is more than sufficient to demonstrate that the EIM algorithm is flawed, the public data lacks the resource-level granularity needed for more precise estimates of the GHG emissions associated with the EIM's dispatch of external resources to serve CAISO load. For example, when the EIM has dispatched out-of-state resources to serve CAISO load, has the

mix been 40% coal, 40% natural gas, and 20% non-emitting resources, or has the mix consisted of 10% coal, 80% natural gas, and 10% non-emitting resources? Stated differently, has the weighted average GHG intensity of external resources dispatched to serve CAISO load been 0.2 mTCO₂/MWh? 0.4 mTCO₂/MWh? or 0.6 mTCO₂/MWh?

Powerex believes that it should be relatively straight-forward for CAISO to perform an analysis of this issue. More specifically, CAISO has data regarding each resource’s EIM dispatch and each resource’s base schedules. For each interval that the CAISO BAA was a net importer in the EIM, the CAISO could calculate the average GHG emission rate for all out-of-state resources that were dispatched above their base scheduled quantity.

Consider an interval with 300 MW of EIM transfers serving CAISO load. In this interval, there is a total of 500 MW of resource output in excess of base schedules, including 100 MW from a non-emitting hydro plant, 200 MW from a natural gas generator (with a GHG emission rate of 0.4 mTCO₂/MWh), and 200 MW from a coal-fired generator (with a GHG emission rate of 0.9 mTCO₂/MWh). Figure 7 shows two possible approaches to calculating the average GHG emission rate associated with the 300 MW of EIM transfers serving CAISO load. The first method, labeled “All Resources,” is simply based on the weighted average of all out-of-state resources that are dispatched above base schedules, weighted by the amount of incremental dispatch. The second method, labeled “Clean Priority,” assigns incremental dispatch to the EIM transfers serving CAISO load from each resource in order of emission rate. This second method may be viewed as a lower bound on GHG emissions associated with serving CAISO load, while recognizing that not all resource output above base schedules is due to transfers to CAISO.

Figure 7. Same Calculation of Incremental GHG Emission Rate of EIM Transfers to CAISO Load



The above would yield the GHG emission rate of EIM transfers to CAISO load in a given interval. Each interval within a given period (e.g., month or year) would then be weighted based on the volume of EIM net imports into the CAISO BAA for that interval.

This type of approach could be used to evaluate, for example:

1. The percent of EIM transfers serving California load from coal, natural gas and non-emitting resource output above base-schedules (Similar to Table 1)

2. The total volume of GHG emissions associated with EIM transfers serving California load each month
3. The total volume by which GHG emissions associated with EIM transfers serving California load were understated by the current attribution methodology in each month
4. The weighted average intensity of external resource output, above base-schedules, serving California load in the EIM each month, and over the course of each year.

Powerex believes that this analysis would be valuable to stakeholders in several ways. First, this analysis would help quantify the extent of the current and historical EIM GHG problem, particularly when compared to the external resource types that have been attributed to serve load in California each month (as shown in Table 1). Second, this analysis could be used to benchmark the expected effectiveness of proposed solutions, including the two-pass solution, Powerex's proposed limitation on the GHG MW quantity to "headroom" above base scheduled quantities, and other potential solutions and enhancements. For example, the GHG emissions attributed to serving CAISO load under a proposed solution could be compared to the GHG emissions associated with dispatch above base schedules to gauge how fully the proposed solution accounts for incremental GHG emissions. Finally, this analysis could be used to confirm the quantity of additional GHG allowances that CARB retires under its interim bridge solution beginning in 2018.