



California ISO

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## **TECHNICAL BULLETIN**

**Quantifying the Benefits for Participating in EIM**

**Appendix 1**

**July 30, 2015**



### Revision History

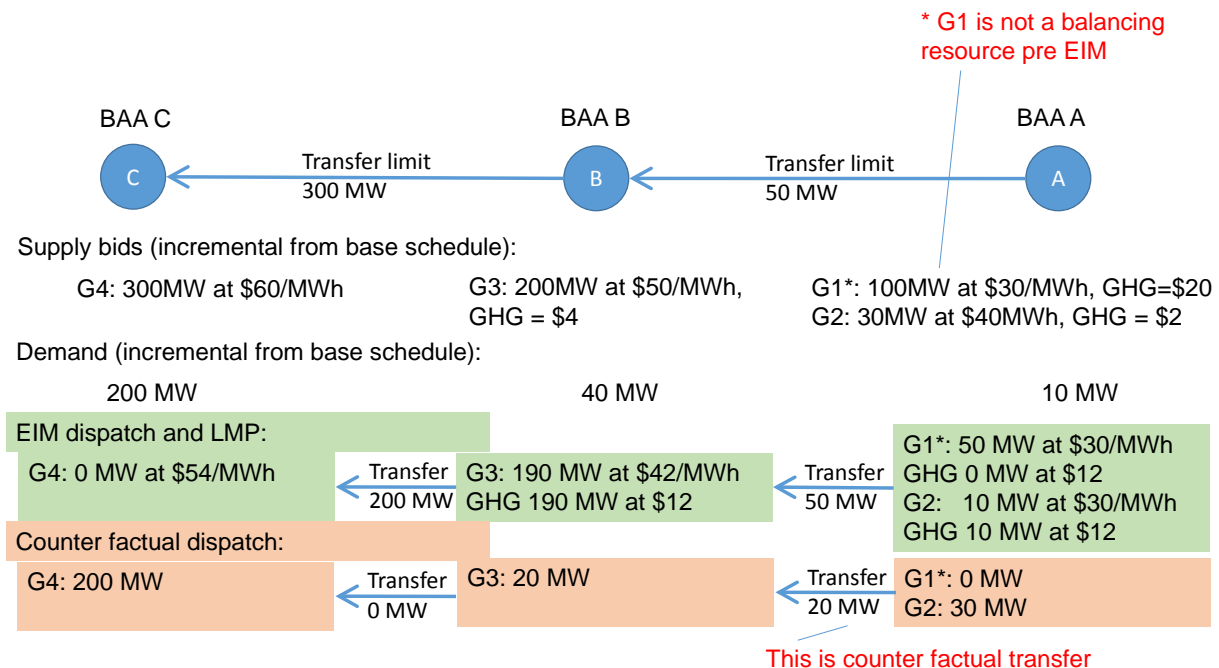
Date	Version	Description	Author
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## Appendix: Improved GHG Revenue Accounting Method in EIM Benefit Calculation

When the ISO is importing power from PacifiCorp, the imported energy is being allocated to individual resources with bid-in GHG adder costs. The allocated GHG awards will also receive a GHG payment at the marginal GHG price. Note that the GHG transfer could be allocated to resources in both PACE and PACW. In the Q4-2014 and Q1-2015 benefit reports, ISO did not explicitly calculate the GHG revenue for individual BAA allocations. Instead all of the GHG revenue was allocated to PACW. While the total benefit is the same, this tends to overestimate the benefit in PACW, and underestimate the benefit in PACE.

Starting from Q2 2015 report, we refine the GHG revenue accounting method so that the GHG revenue will be explicitly calculated based on the allocation. The example below demonstrates how the benefits are calculated in the new method vs the old method. As illustrated in Figure A1, the example consists of three BAAs, where BAA A represents PACE, BAA B represents PACW, and BAA C represent the ISO. Without explaining the dispatches and the LMPs in detail, we will focus on how the benefits are calculated and are divided between BAAs.

**Figure A1: Energy transfers in the 15-minute market**



In the example, there is 50 MW transfer from A to B with shadow price  $SP_{AB} = -\$12$ , and 200 MW transfer from B to C with shadow price  $SP_{AB} = \$0$ , because the transfer limit from B to C is not reached. The LMP difference between B and C \$12 is due to the binding GHG allocation constraint.

The energy bids, GHG adder, EIM dispatch, GHG allocation, and counter factual dispatch are listed in Table A1.

gen	Bid cost (c)	GHG cost (gc)	EIM dispatch (e)	GHG allocation (g)	Counter factual dispatch (q)
<b>G1</b>	\$30/MWh	\$20/MWh	50 MW	0 MW	0 MW
<b>G2</b>	\$40/MWh	\$2/MWh	10 MW	10 MW	30 MW
<b>G3</b>	\$50/MWh	\$4/MWh	190 MW	190 MW	20 MW
<b>G4</b>	\$60/MWh	\$0/MWh	0 MW	0 MW	200 MW

**Table A1: Comparison of GHG revenue accounting methods**

Transfer between PACE and PACW is allowed in the counter factual dispatch, and it is 20 MW transfer from A to B. Transfer between PACW and the ISO is disallowed in the counter factual dispatch, and it is 0 MW transfer from B to C.

Total EIM benefit is the dispatch cost difference between the counter factual dispatch and the EIM dispatch.

- The counter factual dispatch cost =  $q1*c1+q2*c2+q3*c3+q4*c4 = 0*30 + 30*40 + 20*50 + 200*60 = \$14,200$ .
- The EIM energy dispatch cost =  $e1*c1+e2*c2+e3*c3+e4*c4 = 50*30 + 10*40 + 190*50 + 0*60 = \$11,400$ .
- The EIM GHG cost =  $g1*gc1+g2*gc2+g3*gc3 = 0*20 + 10*2 + 190*4 = \$780$ .
- The total EIM benefit =  $\$14,200 - (\$11,400 + \$780) = \$2,020$ .

Below we demonstrate how to divide the total benefit between BAAs.

**The new method (allocating GHG revenue to both BAAs)**

BAA A (transfer price  $P_{AB} = P_A - 0.5*SP_{AB} = 30 - 0.5*(-12) = \$36$ )

- The counter factual dispatch cost =  $q1*c1+q2*c2 = 0*30 + 30*40 = \$1,200$
- The EIM energy dispatch cost =  $e1*c1+e2*c2 - \Delta T_{AB} * P_{AB} = 50*30 + 10*40 - (50-20)*36 = \$820$
- The EIM GHG cost =  $g1*gc1+g2*gc2 = 0*20+10*2 = \$20$
- The EIM GHG revenue =  $g1*gp1+g2*gp2 = 0*12+10*12 = \$120$
- **BAA A's EIM benefit =  $1,200 - (820+20-120) = \$480$**

Note that BAA A transfer 20 MW to BAA B in the counter factual dispatch, and transfers 50 MW in the EIM dispatch, so the delta transfer is  $\Delta T_{AB} = 50-20=30$  MW. The delta transfer is sold to BAA B at the transfer price  $P_{AB}$ .

BAA B (transfer price  $P_{AB} = P_B + 0.5 * SP_{AB} = 42 + 0.5 * (-12) = \$36$ , transfer price  $P_{BC} = P_B - 0.5 * SP_{BC} = 42 - 0.5 * 0 = \$42$ )

- The counter factual dispatch cost =  $q3 * c3 = 20 * 50 = \$1,000$
- The EIM energy dispatch cost =  $e3 * c3 + \Delta T_{AB} * P_{AB} - \Delta T_{BC} * P_{BC} = 190 * 50 + (50 - 20) * 36 - (200 - 0) * 42 = \$2,180$
- The EIM GHG cost =  $g3 * gc3 = 190 * 4 = \$760$
- The EIM GHG revenue =  $g3 * gp3 = 190 * 12 = \$2,280$
- **BAA B's EIM benefit =  $1,000 - (2,180 + 760 - 2,280) = \$340$**

BAA C (transfer price  $P_{BC} = P_C + 0.5 * SP_{BC} = 54 + 0.5 * 0 = \$54$ )

- The counter factual dispatch cost =  $q4 * c4 = 200 * 60 = \$12,000$
- The EIM energy dispatch cost =  $e4 * c4 + \Delta T_{BC} * P_{BC} = 0 * 60 + 200 * 54 = \$10,800$
- So BAA C's EIM benefit =  $12,000 - 10,800 = \$1,200$

We can verify that the three BAAs' benefits add up to the total benefit:  $480 + 340 + 1,200 = \$2,020$ .

### The old method (allocating GHG revenue to only one BAA)

BAA A (transfer price  $P_{AB} = P_B + 0.5 * SP_{AB} = 42 + 0.5 * (-12) = \$36$ )

- The counter factual dispatch cost =  $q1 * c1 + q2 * c2 = 0 * 30 + 30 * 40 = \$1,200$
- The EIM energy dispatch cost =  $e1 * c1 + e2 * c2 - \Delta T_{AB} * P_{AB} = 50 * 30 + 10 * 40 - (50 - 20) * 36 = \$820$
- The EIM GHG cost =  $g1 * gc1 + g2 * gc2 = 0 * 20 + 10 * 2 = \$20$
- **BAA A's EIM benefit =  $1,200 - (820 + 20) = \$360$**

BAA B (transfer price  $P_{AB} = P_B + 0.5 * SP_{AB} = 42 + 0.5 * (-12) = \$36$ , transfer price  $P_{BC} = P_C + 0.5 * SP_{BC} = 54 + 0.5 * 0 = \$54$ )

- The counter factual dispatch cost =  $q3 * c3 = 20 * 50 = \$1,000$
- The EIM energy dispatch cost =  $e3 * c3 + \Delta T_{AB} * P_{AB} - \Delta T_{BC} * P_{BC} = 190 * 50 + (50 - 20) * 36 - (200 - 0) * 54 = -\$220$
- The EIM GHG cost =  $g3 * gc3 = 190 * 4 = \$760$
- **BAA B's EIM benefit =  $1,000 - (-220 + 760) = \$460$**

BAA C (transfer price  $P_{BC} = P_C + 0.5 * SP_{BC} = 54 + 0.5 * 0 = \$54$ )

- The counter factual dispatch cost =  $q4 * c4 = 200 * 60 = \$12,000$
- The EIM energy dispatch cost =  $e4 * c4 + \Delta T_{BC} * P_{BC} = 0 * 60 + 200 * 54 = \$10,800$
- **BAA C's EIM benefit =  $12,000 - 10,800 = \$1,200$**

We can verify that in the old method, the three BAAs' benefits also add up to the total benefit:  $360 + 460 + 1,200 = \$2,020$ .

As demonstrated in the example, the old method does not calculate the BAA level GHG revenue. The transfer price between B and C at \$54 (MALIN price minus half of the transfer shadow price) includes the needed payment for the GHG allocation awards. Because of this, the GHG revenue only goes to BAA B, but cannot reach to BAA C, even BAA C may have GHG allocation awards.

In contrast, the new method explicitly calculates the GHG revenue for each BAA. So the GHG revenue will go to each BAA which has GHG allocation awards. To avoid double counting of the GHG revenue, we should exclude the GHG cost portion from the energy transfer price for the corresponding BAA that already receives GHG allocation revenue. That is why we use the \$42 transfer price for BAA B in the new method, which is \$12 lower than the price with GHG cost \$54.

The benefit results for the old and new methods are summarized in Table A2. In Table A2, we can see that BAA C's benefit is the same in both methods, so the new method has no impact on BAA C's benefit calculation. The old method will underestimate BAA A's benefit, and overestimate BAA B's benefit, compared with the new method.

method \ BAA	A	B	C	total
<b>Old method</b>	\$360	\$460	\$1,200	\$2,020
<b>New method</b>	\$480	\$340	\$1,200	\$2,020

**Table A2: Comparison of GHG revenue accounting methods**