EIM Quarterly Benefit Report Methodology

Effective with Q1, 2016 EIM benefits report

Revision History

Date	Version	Description	Author
02/01/2016	1.0		Lin Xu
04/30/2016	2.0	Allow the ISO's units to be committed in the counter factual dispatch	Lin Xu

This document illustrates how the EIM benefit is calculated with an example. In the past, the ISO had discussed the method in Technical Bulletins and in the benefit reports. This document consolidates these prior materials into a concise paper for easier understanding.

The total EIM benefit is the cost saving of the EIM dispatch compared with a counterfactual (CF) without EIM dispatch. The counter factual dispatch meets the same amount of real-time load imbalance in each BAA without EIM transfers with neighboring EIM BAAs. For an EIM BAA, the benefit can take the form of cost savings or profit or their combination. A BAA will be likely to have energy cost savings when the BAA is importing energy economically, or its base schedules are being optimized by the EIM. A BAA will be likely to have an energy profit when the BAA is exporting energy economically to other BAAs, and being paid a price higher than the bid cost. A BAA, other than the ISO, may also have a GHG profit when the resource is allocated GHG MWs, and is receiving GHG revenue based on marginal GHG cost that is likely higher than its own GHG bid cost.

For each 5-minute interval, **EIM benefit for a BAA = counterfactual dispatch cost – (EIM dispatch cost + transfer cost) + GHG revenue – GHG cost.** Then the 5-minute level EIM benefit are aggregated every month with a multiplier 1/12 to convert ($/5 min) to a dollar amount.

EIM benefit calculation components

EIM dispatch cost

The total dispatch cost for a BAA for an interval is the sum of all the unit level EIM dispatch cost for that BAA and for that interval.

For all other BAA's other than CAISO, the dispatch cost only includes variable dispatch cost, i.e. the bids submitted by the corresponding Scheduling Coordinator.

For the ISO's long start units, we only consider variable dispatch cost. For the ISO's short start units, we use a generic cost formula, which includes variable dispatch cost, startup cost, and no load cost. Specifically, the three-part cost include

- the variable dispatch cost of RTD, which is equal to the bid cost associated with the delta instruction above or below the base schedule for each interval,
- the no load cost associated with the incremental dispatch, which is equal to the no load cost divided by Pmax and then multiply it with the delta instruction from base schedule,
- the startup cost associated with the incremental dispatch, which is equal to the startup cost divided by the minimum online hours, and then multiply it with the delta instruction from base schedule divided by the Pmax.

The purpose for this generic cost formula is to evaluate cost differences between EIM dispatches and counter factual dispatches without performing sophisticated unit commitment simulations. Prior to Q1 2016, only variable dispatch cost was considered in the EIM benefit calculation. With NV Energy joining EIM and improving the transfer capabilities from and to the ISO, we observed significantly increased transfer volume in EIM. The higher transfer volume cannot be sufficiently replaced by resources online in EIM without committing or decomitting resources. That is why we adopted the three-part cost formula starting from Q1 2016 to allow for unit commitment decisions to better evaluate the production difference between EIM and the counter factual dispatch of the ISO. The unit commitments decisions were made only for short start units that are not combined cycle units. The combined cycle units had complicated models in EIM, so their counter factual commitment status are fixed at the EIM commitment status to avoid oversimplification.

We approximate the ISO's commitment costs by converting the startup cost and no load cost into variable dispatch cost, assuming a committed short start resource will be fully loaded for minimum online hours. For each supply segment, the corresponding three-part variable cost is equal to

bid_price + no_load_cost/Pmax + startup_cost/min_up_hour/Pmax

Note the formula above converts startup cost (in unit $) and no load cost (in unit $/h) into variable dispatch cost (in unit $/MWh). By doing this, the commitment for the ISO's units can be determined based on the economic metric order of the three-part variable cost.

Transfer cost

As a convention, select the importing direction as the default direction for a transfer, so importing transfer is positive and exporting transfer is negative. The transfer cost is equal to the transfer MW times the transfer price. For an importing BAA, the transfer price is the LMP of the BAA minus half of the absolute value of the transfer shadow price. For an exporting BAA, the transfer price is the LMP of the BAA plus half of the absolute value of the transfer shadow price. Transfer could occur in both the 15-minute market and the 5-minute market. In this case, the transfer cost is 15-minute transfer * 15-minute transfer price + (5-minute transfer – 15-minute transfer) * 5-minute transfer price for each 5-minute interval.

Counterfactual dispatch cost

The counterfactual dispatch for an EIM BAA mimics the market operations without importing or exporting through the EIM transfers. The counterfactual dispatch moves units inside the BAA to meet the same real-time load imbalance as the EIM dispatch without considering transmission constraints. However, for PacifiCorp, the transfer limit between PACE and PACW is enforced in the counter factual dispatch. Relaxing transmission constraints tends to under estimate the counterfactual dispatch cost and the EIM benefit. However, because few transmission constraints were observed binding in EIM, it is unlikely the EIM benefit will be significantly under estimated.

The counterfactual dispatch makes unit commitment decisions only for the ISO's short start units. The unit commitment decisions are based on the generic three-part variable cost formula, which has converted startup cost and no load cost into variable dispatch cost. So unit commitment can be determined by the economic metric order of the three-part cost.

In cases where a counterfactual dispatch could not be produced for a BAA using available bids, the highest bid dispatched will be extended as the marginal cost for procuring more supply. An EIM BAA may restrict the pool of dispatchable units in the counterfactual dispatch if that the BAA's practice prior to joining EIM was to balance real-time load from a limited pool.

ISO counterfactual dispatch

The ISO would need to meet load without EIM transfers in the counterfactual dispatch. The counterfactual dispatch is constructed in the following way.

1. Calculate the ISO's net EIM transfer;
2. Economically dispatch resources from the ISO to replace the transfer
   A. If the ISO is importing from the EIM,
      a. Find the ISO's undispatched supply with the variable cost (bid and three-part converted) greater than or equal to the transfer price;
      b. Sort and stack the supply by the variable cost from low cost to high cost; and
      c. Clear the supply stack from low cost to high cost up to the transfer megawatts
   B. If the ISO is exporting to the EIM,
      a. Find the ISO's dispatched supply with the variable cost (bid and three-part converted) less than or equal to the transfer point price;
      b. Sort and stack them by the variable cost from high cost to low cost; and
      c. Clear the supply stack from high cost to low cost up to the transfer megawatts

NV Energy counterfactual dispatch

NV Energy's counter factual dispatch is constructed in the following way.

1. Calculate the real-time net load imbalance for NVE;
2. Economically dispatch resources from NVE on top of the base schedules to meet NVE's net load imbalance
   A. If the net load imbalance is positive,

    a. Find NV Energy's bid-in supply above base schedules;
    b. Sort and stack them by the variable cost from low cost to high cost; and
    c. Clear the supply stack from low cost to high cost up to the net load imbalance.
  B. If the net load imbalance is negative,
    a. Find NV Energy's bid-in supply below base schedules;
    b. Sort and stack them by the variable cost from high cost to low cost; and
    c. Clear the supply stack from high cost to low cost up to the net load imbalance.

PacifiCorp counterfactual dispatch

PacifiCorp East BAA and PacifiCorp West BAA would need to meet demand without intra-hour transfers between PacifiCorp and the ISO, but transfers could occur between PACE and PACW in the counterfactual dispatch. The PacifiCorp counter factual dispatch will be constructed in the following way:

1. Calculate the real-time net load imbalance for each BAA;
2. Economically dispatch resources from the limited pool on top of the base schedules to meet net PacifiCorp load imbalance without violating the transfer limitations between PACE and PACW.
  A. If the net load imbalance is positive,
    a. Find PacifiCorp's bid-in supply above base schedules;
    b. Sort and stack them by the variable cost from low cost to high cost; and
    c. Clear the supply stack from low cost to high cost up to the net load imbalance subject to the transfer limit between PACE and PACW
  B. If the net load imbalance is negative,
    a. Find PacifiCorp's bid-in supply below base schedules;
    b. Sort and stack them by the variable cost from high cost to low cost; and
    c. Clear the supply stack from high cost to low cost up to the net load imbalance subject to the transfer limit between PACE and PACW

GHG revenue

Greenhouse gas (GHG) revenue for a resource is equal to its GHG allocation MW times the GHG price.

GHG cost

GHG cost for a resource is equal to its GHG allocation MW times its GHG bid.

Example

This example illustrates how the EIM benefit is calculated.

The transfers out of the EIM optimization are listed below. Base scheduled transfers have been excluded in the FMM transfers and RTD transfers.

from BAA	to BAA	FMM transfer	FMM transfer price	RTD incremental transfer	RTD transfer price	transfer cost
PACE	NEVP	140	$26	10	$25	$3,890
NEVP	CISO	160	$26	20	$30	$4,760
PACE	PACW	190	$26	10	$25	$5,190
PACW	CISO	110	$26	-10	$30	$2,560

BAA to BAA transfers and prices

Assume the EIM energy imbalance and prices are as follows. Every BAA is balanced with Gen + Transfer – Load = 0. Assume the EIM optimization results in $1 GHG price, which means the ISO's LMP is $1 higher than the neighboring BAA (NEVP and PACW), because there is no congestion going into the ISO in the example. In the table below, positive transfer MW means the BAA is importing and negative transfer MW means it is exporting. Also, transfers in the table are sum of the transfers occur in both the FMM and the RTD with base scheduled transfer being excluded.

BAA	Gen	Load	Net transfer in MW	LMP	GHG price
CISO	0	280	280	$31	$0
NEVP	50	20	-30	$30	$1
PACE	150	-200	-350	$20	$1
PACW	100	200	100	$30	$1

EIM energy imbalance and prices by BAA for one 5-minute interval

Transfer cost

The transfers occur in both FMM and RTD, and their volume and prices are listed below. They are calculated from applying the convention that importing is positive and exporting is negative the BAA to BAA transfers, and summing them over all the neighboring BAAs.

BAA	transfer cost
CISO	$7,320 = $4,760+$2,560
NEVP	($870) = $3,890-$4,760

PACE	($9,080) = -$3,890-$5,190
PACW	$2,630 = $5,190-$2,560

EIM transfer cost by BAA

EIM dispatch cost

Now calculate the total bid cost associated with the EIM dispatches (delta from base schedules). The EIM dispatch costs are listed below.

BAA	Gen_EIM	EIM dispatch cost
CISO	0	$0
NEVP	50	$1,450
PACE	150	$2,700
PACW	100	$2,800

EIM dispatch cost by BAA

Counterfactual dispatch cost

Then construct the counter factual dispatches as described in the previous section, and sum up the counter factual dispatch cost for each BAA.

BAA	Gen_CF	Counterfactual dispatch cost
CISO	280	$9,240
NEVP	20	$640
PACE	-200	($3,800)
PACW	200	$6,200

Counterfactual dispatch cost by BAA

GHG cost and revenue

The GHG costs associated with the 280 MW of importing transfer into CISO, and the revenues received by the GHG allocated MWs in both FMM and RTD are listed below.

BAA	GHG FMM MW	GHG RTD MW	GHG cost	GHG revenue
CISO	0	0	$0	$0
NEVP	0	0	$0	$0
PACE	200	200	$20	$200
PACW	70	80	$75	$80

GHG cost and revenue by BAA

EIM benefit

With all the cost and revenue for each BAA available, we can use the formula EIM benefit for a BAA = counterfactual dispatch cost – (EIM dispatch cost + transfer cost) + GHG revenue – GHG cost to calculate EIM benefit for each BAA.

BAA	CF dispatch cost	EIM dispatch cost	Transfer cost	GHG cost	GHG revenue	EIM benefit
CISO	$9,240	$0	$7,320	$0	$0	**$1,920**
NEVP	$640	$1,450	($870)	$0	$0	**$60**
PACE	($3,800)	$2,700	($9,080)	$20	$200	**$2,760**
PACW	$6,200	$2,800	$2,630	$75	$80	**$775**

EIM benefit for one 5-minute interval

This calculation is performed for each 5-minute interval with unit $/hr. We convert the $/hr benefit into the dollar benefit by multiplying 1/12. Then the 5-minute interval benefits in dollar amount can be aggregated into the monthly benefit by summing all the 5-minute intervals in the month.