APPENDIX D

IMBALANCE ENERGY CHARGE COMPUTATION

D 1 Purpose of charge

The Imbalance Energy charge is the term used for allocating the cost of not only the Imbalance Energy (the differences between scheduled and actual Generation and Demand), but also any Unaccounted for Energy (UFE) and any errors in the forecasted Transmission Losses as represented by the GMMs. Any corresponding cost of Dispatched Replacement Reserve Capacity that is not allocated as an Ancillary Service is also included along with the Imbalance Energy charge.

D 2 Fundamental formulae

D 2.1.1 Uninstructed Imbalance Energy Charges on Scheduling Coordinators

Uninstructed Imbalance Energy attributable to each Scheduling Coordinator in each Settlement Period in the relevant Zone shall be deemed to be sold or purchased, as the case may be, by the ISO and charges or payments for Uninstructed Imbalance Energy shall be settled by debiting or crediting, as the case may be, the Scheduling Coordinator with an amount for each BEEP Interval of each Settlement Period calculated in accordance with the following formulae:

$$DevC = \sum_i GenDevC_i + \sum_i LoadDevC_i + \sum_q ImpDevC_q + \sum_q ExpDevC_q + UFEC$$

$$ASSEDevC = \sum_i ASSEGenDevCi + \sum_i ASSELoadDevCi + \sum_q ASSEImpDevCq$$

$$DevC_{bjxt} = NetDev_{bjxt} * BIP_{bxt}$$

Where:

$$NetDev_{bjxt} = \left[\sum_i GenDev_{bixt} - \sum_i LoadDev_{bixt} + \sum_q ImpDev_{bq\text{-}xt} - \sum_q ExpDev_{bq\text{-}xt} \right]$$

If $NetDev_{bjxt} < 0$, then

BIP_{bxt} = BEEP Interval Price for decremental Energy for BEEP Interval b in Settlement Period t.

If $NetDev_{bjxt} > 0$, then

BIP_{bxt} = BEEP Interval Price for incremental Energy in Zone x for BEEP Interval b in Settlement Period t.

The deviation quantity between scheduled and actual Energy Generation for Generator i represented by Scheduling Coordinator j in Zone x during each BEEP Interval b of each Settlement Period is calculated as follows:

$$\text{GenDev}_{\text{ixbt}} = \left[\left(G_{sb}\right) * \text{GMM}_{\text{f}} - \left[\left(G_{\text{a}} - G_{\text{b,adj}}\right) * \text{GMM}_{\text{a}} - G_{\text{b,a/s}} - G_{b,s/e} \right] - \frac{UnavailAncServMW_{bx}}{HBI} \right]$$

Where:

If the BEEP Interval Ex Post Price for decremental Energy is negative, then:

$UnavailAncServMW_{iX} = 0$

If the BEEP Interval Ex Post Price for decremental Energy is greater than or equal to zero, then:

$UnavailAncServMW_{iX} =$ Max[– ($G_{i,\ oblig}$ – $G_{a/s}$*6) Min(0,Pmax-Ga*6-($G_{i,\ oblig}$ - $G_{a/s}$*6))]

The value of G_a for Generation scheduled on behalf of Participating Generators for each BEEP Interval in each Settlement Period shall be

the actual meter data aggregated on a 10-minute basis. The value of G_{sb} for Generation scheduled on behalf of Participating Generators for each BEEP Interval in each Settlement Period shall be determined as follows for BEEP Intervals 2 through 5:

$$G_{s,b} = \frac{G_s}{6}$$

For BEEP Interval 1 and BEEP Interval 6, implicit Dispatch instructions for ramping will be applied to adjust the Schedules attributed to those BEEP Intervals as follows:

$$G_{s,1} = \left(\frac{G_s}{6}\right) - \left(\frac{(G_s - G_{s-1})}{24}\right)$$

$$G_{s,6} = \left(\frac{G_s}{6}\right) + \left(\frac{(G_{s+1} - G_s)}{24}\right)$$

The value of G_s and G_a for Generation which has not undertaken in writing to be bound by the ISO Tariff in accordance with Article 5 shall be determined as follows for all six BEEP Intervals:

$$G_{s,b} = \frac{G_{s,t}}{6}$$

$$G_a = \frac{G_{at}}{6}$$

The deviation quantity between scheduled and actual Load consumption for Load i represented by Scheduling Coordinator j in Zone x for each BEEP Interval of each Settlement Period t is calculated as follows:

$$LoadDev_{ibxt} = L_{s_b} - \left[\left(L_a - L_{b,adj}\right) + L_{b,a/s} + L_{b,s/e} - \frac{UnavailDispLoadMW_{bx}}{HBI}\right]$$

Where;

If the BEEP Interval Ex Post Price for decremental Energy is negative, then:

$$\text{UnavailDispLoadMW}_{\text{IX}} = 0$$

If the BEEP Interval Ex Post Price for decremental Energy is greater than or equal to zero, then:

$$UnavailDispLoadMW_{ix} = Max[0, [((L_{i,\ oblig}) - L_{a/s}*6) - (L_a*6]]$$

The value of $L_{b,a/s}$,$L_{b,s/e}$ and L_{adj} are determined on a 10-minute basis. The value of L_a for Load scheduled on behalf of Participating Loads for each BEEP Interval in each Settlement Period shall be the actual meter data aggregated on a 10-minute basis. The value of L_{sb} for Load scheduled on behalf of Participating Loads for each BEEP Interval in each Settlement Period t, shall be determined as follows:

For BEEP Intervals 2 through 5,

$$L_{sb} = \frac{L_s}{6}$$

For BEEP Interval 1 and BEEP Interval 6, implicit Dispatch instructions for ramping will be applied to adjust the schedules attributed to those BEEP Intervals as follows:

$$L_{s,1} = \left(\frac{L_s}{6}\right) - \left(\frac{\left(L_s - L_{s-1}\right)}{24}\right)$$

$$L_{s,6} = \left(\frac{L_s}{6}\right) + \left(\frac{\left(L_{s+1} - L_s\right)}{24}\right)$$

The value of L_{sb} and L_a for Loads that are not Participating Loads shall be determined as follows for all six BEEP Intervals:

$$L_{sb} = \frac{L_s}{6}$$

$$L_a = \frac{L_{at}}{6}$$

L_{at} is Load i hourly metered quantity for Settlement Period t.

The deviation quantity between forward scheduled and Real Time adjustments to Energy imports*, adjusted for losses, for Scheduling Point q represented by Scheduling Coordinator j into Zone x during each BEEP Interval of each Settlement Period t is calculated as follows:

$$ImpDev_q = I_{sb} * GMM_{fq} - [(I_a + I_{b,a/s} - I_{b,adj}) * GMM_{ahq}] + I_{b,a/s}$$

The values of $I_{b,a/s}$, I_a and $I_{b,adj}$ are determined on a 10-minute basis. The value of I_{sb} shall be determined as follows:

* Note that this deviation is a difference between a forward Market value and a Real Time value. It is not inadvertent energy.

For BEEP Intervals 1 through 6,

$$I_{sb} = \frac{I_S}{6}$$

The deviation quantity between forward scheduled and Real Time adjustments to Energy exports* for Scheduling Point q represented by Scheduling Coordinator j from Zone x for each BEEP Interval for each Settlement Period *t* is calculated as follows:

$$ExpDev_q = E_{s,b} - E_a - E_{adj,b}$$

The values of E_a and $E_{b,adj}$ are determined on a 10-minute basis. The value of $E_{s,b}$ shall be determined as follows:

For BEEP Intervals 1 through 6,

$$E_{sb} = \frac{E_S}{6}$$

The Hourly Ex Post Price in applicable to uninstructed deviations in Settlement Period t in each zone will equal the Energy weighted average of the BEEP Interval charges in each zone, calculated as follows:

$$P_{xt} = \frac{(\sum_{ji} \left| MWh_{jix} \right| * BIP_{ix})}{\sum_{ji} \left| MWh_{jix} \right|}$$

Where:

BIP_{ix}= BEEP Interval Ex Post Prices to be used for settlement of Uninstructed Imbalance Energy. The BEEP Interval Price for incremental Energy will be charged to decremental uninstructed deviations in that interval, and the BEEP Interval Price for incremental Energy will be charged to incremental uninstructed deviations in that interval.

P xt = the Hourly Ex Post Price in Zone x

MWH jix = the Instructed Imbalance Energy for Scheduling Coordinator j for the BEEP Interval i in Zone x

D 2.1.2 Instructed Imbalance Energy Charges on Scheduling Coordinators

Implicit Dispatch instructions for ramping Energy shall be calculated based on Final Hour Ahead Schedules for Energy to result in a linear ramp by all Participating Generators and Participating Loads

beginning 10 minutes prior to the start, and ending 10 minutes after the start of each Settlement Period. Ramping Energy shall be deemed delivered and settled at a price of zero dollars per MWh.

The amount of Instructed Imbalance Energy to be delivered in each BEEP Interval will be determined based on the ramp rates and time delays bid in accordance with SBP 5 and 6. Payment due a Load, Generator, Import or Export for Instructed Imbalance Energy to be delivered in a BEEP Interval shall be calculated based on the actual Energy delivered to the ISO Grid in accordance with the Dispatch instruction.

Instructed Imbalance Energy by an Import or Export is deemed delivered. The actual Energy delivered by a Load or Generator in response to Dispatch instructions will be determined by first attributing Energy deviations to any Energy associated with redispatch of that Load or Generation in that BEEP Interval according to Section 7.2.6.2, or to Dispatch orders to be settled in accordance with Section 11.2.4.2. If instructions for both incremental and decremental Energy are issued in a BEEP Interval, then any instructions described in the previous sentence for decremental Energy, together with any decremental Dispatch instructions on Supplemental Energy, shall be deemed delivered.

Any remaining deviation will then be sequentially attributed to Instructed Imbalance Energy, first from Supplemental Energy, then from Replacement Reserve, then from Non-Spinning Reserve, and then from Spinning Reserve in that BEEP Interval.

Residual Instructed Imbalance Energy arising due to Dispatch instructions shall be priced based on the applicable BEEP Interval Ex Post Price for the BEEP Interval to which the Dispatch instruction applied. If Instructed Imbalance Energy is to be delivered in the last BEEP Interval of the hour preceeding the Settlement Period to which a Dispatch instruction applies shall be settled at the applicable BEEP Interval Ex Post Price for the first BEEP Interval of the Settlement Period for which the bid was submitted.

Subject to the above conditions, the Instructed Imbalance Energy charge for each BEEP Interval b of each Settlement Period t for Scheduling Coordinator j for Zone x is calculated using the following formulas:

The instructed Generation deviation payment/charge is calculated as follows:

$IGDC_{ib} = G_{ib} * P_b$

The instructed Load deviation payment/charge is calculated as follows:

$ILDC_{ib} = L_{ib} * P_b$

The instructed import deviation payment/charge is calculated as follows:

$IIDC_{qb} = I_{qb} * P_b$

D 2.2 Unaccounted for Energy Charge

The Unaccounted for Energy Charge on Scheduling Coordinator j for each BEEP Interval of each Settlement Period t for each relevant Zone is calculated in the following manner:

The UFE for each utility service territory *k* is calculated as follows,

$$E_{UFE\_UDC\_k} = \left(I_k - E_k + G_k - \left(RTM_k + LPM_k\right) - TL_k\right)$$

The Transmission Loss calculation for each BEEP Interval of each Settlement Period t per relevant Zone for each utility service territory k is calculated as follows,

$$TL_k = Total\_TLRC_{Losses} * (UDC_k\_Branch_{Losses} / Total\_Branch_{Losses})$$

Where:

$$Total\_TLRC_{Losses} = \sum \left[G_a * \left(1 - GMM_a\right)\right] + \sum \left[I_a \left(1 - GMM_{aq}\right)\right]$$

$$Total\_Branch_{Losses} = \frac{\left(\sum UDC_k - Branch_{Losses}\right)}{6}$$

Each metered demand point, either ISO grid connected or connected through a UDC, is allocated a portion of the UFE as follows:

$$E_{UFE\_z} = \frac{D_z}{\sum_z D_z} E_{UFE\_UDC\_k}$$

The UFE charge for Scheduling Coordinator j for each BEEP Interval b of each Settlement Period t per relevant Zone is then,

$$UFEC_j = (\sum_z E_{UFE\_Z})^* BIP_{bxt}$$

D 3 Meaning of terms of formulae

D 3.1 IEC_j – $

The Imbalance Energy charge on Scheduling Coordinator j in Trading Interval t for each relevant Zone.

D 3.2 $GenDev_i$ – MWh

The deviation between scheduled and actual Energy Generation for Generator i represented by Scheduling Coordinator j in Zone x during Trading Interval t.

D 3.3 $LoadDev_i$ – MWh

The deviation between scheduled and actual Load consumption for Generator i represented by Scheduling Coordinator j in Zone x during Trading Interval t.

D 3.4 $ImpDev_q$ – MWh

The deviation between forward scheduled and Real Time adjustments to Energy imports, as adjusted for losses, for Scheduling Point q represented by Scheduling Coordinator j into Zone x during Trading Interval t.

D 3.5 $ExpDev_q$ – MWh

The deviation between forward scheduled and Real Time adjustments to Energy exports for Scheduling Point q represented by Scheduling Coordinator j

from Zone x during Trading Interval t.

D 3.6 G_S – MWh

The total scheduled Generation of Scheduling Coordinator j for Generator i in Settlement Period t as a result of both the Day-Ahead Final Schedule and the Hour-Ahead Final Schedule.

D 3.6.1 G_{s-1}

The total scheduled Generation of Scheduling Coordinator j for Generator i in settlement Period t-1 as a result of both the Day-Ahead Final Schedule and the Hour-Ahead Final Schedule.

D3.6.2 **G_{s+1}**

The total scheduled Generation of Scheduling Coordinator j for Generator i in settlement Period t+1 as a result of both the Day-Ahead Final Schedule and the Hour-Ahead Final Schedule.

D3.6.3 **$G_{b,adj}$**

Is Deviation in real time ordered by the ISO in BEEP Interval b according to Section 7.2.6.2, or for settlement according to Section 11.2.4.2.

D 3.7 **G_{at} - MWh**

The total actual metered Generation of Scheduling Coordinator j for Generator i in Settlement Period t.

D 3.8 **G_{adj} – MWh**

Deviations in real time ordered by the ISO for purposes such as Congestion Management.

D 3.9 **$G_{a/s}$ – MWh**

The Energy generated from Ancillary Service resource i due to ISO dispatch instructions. This value will be calculated based on the projected impact of the Ancillary Services dispatch instruction(s) over the time period within the Trading Interval for which such Ancillary Services dispatch instruction(s) applies.

D.3.9.1 $G_{s/e}$ -MWh

The Energy generated from Supplemental Energy resource i due to ISO dispatch instructions. This value will be calculated based on the projected impact of the Supplemental Energy dispatch instruction(s) over the time period within the Trading Interval for which such Supplemental Energy dispatch instruction(s) applies.

D 3.10 **GMM_f – fraction**

The forecasted Generation Meter Multiplier (GMM) for Generator i as provided to the Scheduling Coordinator by the ISO in advance of the operation of the Day-Ahead Market.

D 3.11 **GMM_{fq} – fraction**

The forecasted Generation Meter Multiplier for an Energy import at Scheduling Point q as provided to the Scheduling Coordinator by the ISO in advance of the Day-Ahead Market.

D 3.12 **GMM_{ah} – fraction**

The final forecasted Generation Meter Multiplier (GMM) for a Generator i as calculated by the ISO at the hour-ahead stage (but after close of the Hour-Ahead Market).

D 3.13 **GMM_{ahq} – fraction**

The forecasted Generation Meter Multiplier for an Energy import at Scheduling Point q as provided to the Scheduling Coordinator by the ISO after close of the Hour-Ahead Market.

D 3.14 **L_S – MWh**

The total scheduled Demand of Scheduling Coordinator j for Demand i in Settlement Period t as a result of both the Day-Ahead Final Schedule and the Hour-Ahead Final Schedule.

D 3.15 **L_a – MWh**

The total actual metered Demand of Scheduling Coordinator j for Demand i in BEEP Interval b of Settlement Period t.

D 3.15.1 **L_{at} – MWh**

The total actual metered Demand of Scheduling Coordinator j for Demand i in Settlement Period t.

D 3.15.2 **$L_{b,adj}$**

Is Deviation in real time ordered by the ISO in BEEP Interval b according to Section 7.2.6.2, or for settlement according to Section 11.2.4.2.

D 3.16 **[Not Used]**

D 3.17 **$L_{a/S}$ – MWh**

The Energy reduction by curtailable Load due to ISO dispatch of Ancillary Services from such curtailable Load (i.e., Load bidding into the Ancillary Services markets). This value will be calculated based on the projected impact of the Ancillary Services dispatch instruction(s) over the time period within the Trading Interval for which such Ancillary Services dispatch instruction(s) applies.

D 3.17.1 **$L_{s/e}$ -MWh**

The Energy reduction by curtailable Load due to ISO dispatch of Supplemental Energy from such curtailable Load. This value will be calculated based on the projected impact of the Supplemental Energy dispatch instruction(s) over the time period within the Trading Interval for which such Supplemental Energy dispatch instruction(s) applies.

D 3.18 **I_S – MWh**

The total scheduled Energy import of Scheduling Coordinator j through Scheduling Point q in Settlement Period t as a result of both the Day-Ahead Final Schedule and the Hour-Ahead Final Schedule.

D 3.19 **I_a – MWh**

The total actual Energy import of Scheduling Coordinator j through Scheduling Point q in BEEP Interval b in Settlement Period t. This is deemed to be equal to the total scheduled Energy import I_S.

D 3.20 **$I_{b\text{-}adj}$ – MWh**

The deviation in real time import ordered by the ISO for congestion management, overgeneration, etc. or a result of an import curtailment. This value will be calculated based on the projected impact of the Dispatch instruction(s) (or curtailment event) between the close of the Hour-Ahead Market and the end of the Trading Interval for which such Dispatch Instructions(s) (or curtailment event) applies.

D 3.21 **$I_{a/s}$ – MWh**

The Energy generated from Ancillary Service System Resources pursuant to Existing Contracts or Supplemental Energy from interties due to ISO's Dispatch instruction.

D 3.22 **E_S – MWh**

The total scheduled Energy export of Scheduling Coordinator j through Scheduling Point q in Settlement Period t as a result of both the Day-Ahead Final Schedule and the Hour-Ahead Final Schedule.

D 3.23 **E_a – MWh**

The total actual Energy export of Scheduling Coordinator j through Scheduling Point q in BEEP Interval b of Settlement Period t. This is deemed to be equal to the total scheduled Energy export E_S.

D 3.24 **E_{adj} – MWh**

The deviation in Real Time export ordered by the ISO for Congestion Management, Overgeneration, etc. or as a result of an export curtailment. This value will be calculated based on the projected impact of the Dispatch Instruction(s) (or curtailment event between the close of the Hour-Ahead Market and the end of the Trading Interval for which such Dispatch Instruction (or curtailment event) applies.

D 3.25 **P_{xt} – $/MWh**

The Hourly Ex Post Price for Imbalance Energy for the relevant Trading Interval. This value is calculated as the weighted average of the 12 Five Minute Ex Post Prices in each Zone during each hour. The Five Minute Ex Post Price is equal to the bid price of the marginal resource accepted by the ISO for dispatch and deemed eligible to set the price during a five minute period.

D 3.25.1 **P_{eff} – $**

Effective Price for Instructed Imbalance Energy for the relevant Settlement Period.

D 3.27 **$E_{UFE\_UDC\_k}$ – MWh**

The Unaccounted for Energy (UFE) for utility service territory k.

D 3.28 **E_{UFE_z} – MWh**

The portion of Unaccounted for Energy (UFE) allocated to metering point z.

D 3.29 **$RRDC_j$**

The Replacement Reserve Capacity Dispatch Charge for Scheduling Coordinator j for Trading Interval t.

D 3.30 **RRC – $**

The Dispatched Replacement Reserve Capacity Cost which is to be allocated to Scheduling Coordinators in proportion to their contributions to Imbalance Energy requirements. The RRC is, in turn, calculated as the total cost of Replacement Reserve capacity in Trading Interval t (as determined in the Hour-Ahead and Day-Ahead Markets) less the Undispatched Replacement Reserve Capacity Cost. [Note: Both these costs are dealt with in the Ancillary Services payments in Appendix C]

D 3.31 **G_k – MWh**

The total metered Generation in BEEP Interval b of Settlement Period t in utility service territory k.

D 3.32 **D_z – MWh**

The Demand including Exports in BEEP Interval b of Settlement Period t at metered point z.

D 3.33 **I_k – MWh**

The total metered imports into utility service territory k in BEEP Interval b of Settlement Period t.

D 3.34 **E_k – MWh**

The total metered exports from utility service territory k in BEEP Interval b of Settlement Period t.

D 3.35 **RTM_k – MWh**

The Trading Interval t total of the real-time metering in utility service territory k in BEEP Interval b of Settlement Period t.

D 3.36 **LPM_k – MWh**

The calculated total of the Load Profile metering in utility service territory k per BEEP Interval b of Settlement Period t.

D 3.37 **TL_k – MWh**

The Transmission Losses per BEEP Interval b of Settlement Period t in utility service territory k.

D 3.38 **$IGDC_{ib}$ - $**

The total of instructed Generation deviation payments/charges for Scheduling Coordinator j in BEEP Interval b of Settlement Period t.

D 3.39 **$ILDC_{ib}$ - $**

The total of instructed Load deviation payments/charges for Scheduling Coordinator j in BEEP Interval b of Settlement Period t.

D 3.40 **$IIDC_{ib}$ - $**

The total of instructed import deviation payments/charges for Scheduling Coordinator j in BEEP Interval b of Settlement Period t.

D 3.41 **G_{ib} - MW**

Instructed Energy for Generating Unit i during BEEP Interval b.

D 3.42 **L_{ib} - MW**

Instructed Energy for Load L during BEEP Interval b.

D 3.43 **I_{iqb} – MW**

Instructed Energy for import q during BEEP Interval b.

D 3.44 **P_b -- $/MWh**

The BEEP Incremental Ex Post Price for BEEP Interval b if the net instructed Energy for resources is positive, or the BEEP decremental Ex Post Price for BEEP Interval b if the net instructed Energy for resources is negative.

D 3.45 **HBI – Number**

The number of BEEP Intervals in Settlement Period t, currently set to 6.

D 3.46 **$ReplObligRatio_{jxt}$ – fraction**

$$ReplObligRatio_{jxt} = \frac{ReplOblig_{jxt}}{\sum_{j} ReplOblig_{jxt}}$$

where:

$ReplOblig_{jxt}$ is the replacement reserve capacity obligation as defined in Appendix C Section C 3.67.

D 3.47 **$G_{i,\ oblig}$**

The amount of Spinning Reserve, the amount of Non-Spinning Reserve, and the amount of Replacement Reserve that Generating Unit or System Resource i has been selected to supply to the ISO, as reflected in final Ancillary Services Schedules.

D 3.48 **$PMax_i$**

The maximum capability (in MW) at which Energy and Ancillary Services may be scheduled from the Generating Unit or System Resource i.

D 3.49 **$L_{i,\ oblig}$**

The amount of Non-Spinning Reserve and Replacement Reserve that dispatchable Load i has been selected to supply to the ISO as reflected in final Ancillary Services schedules for Settlement Period t.