Day Ahead Market Enhancements Revised Straw Proposal

Comments by Department of Market Monitoring
May 24, 2018

Summary

The Department of Market Monitoring (DMM) appreciates the opportunity to provide comments on *Day Ahead Market Enhancements Revised Straw Proposal* (proposal).[1] The proposal creates fundamental changes to the day-ahead market and resource adequacy design. These changes will have complex interactions with each other and the existing market design. DMM is concerned that the ISO's proposal does not fully consider these complex interactions and their potential impact on market prices, uplift, and efficiency. These comments highlight some potential significant issues with the proposed changes based on DMM's current understanding of the proposal.

Under the ISO's proposed imbalance reserve constraint formulation, the price of *energy* in the day-ahead market will be determined to a significant degree by the imbalance reserve requirement that is administratively set by the ISO. This is a significant change from the current day-ahead market design where only bid-in supply and demand determine the price of energy. Such a significant change to the design and underlying principles of the day-ahead market deserves careful consideration.

The imbalance reserve constraint formulations will also create different settlement prices for physical supply schedules than physical load and virtual schedules. The different settlement prices will result in energy revenue shortfalls or surpluses. These revenue shortfalls or surpluses will equal the sum of all cleared physical generation schedules multiplied by the imbalance reserve shadow values. These energy revenue shortfalls or surpluses could be extremely large. It may be difficult for the ISO to allocate the energy revenue shortfalls or surpluses without undermining the efficiency of the day-ahead market design. The different settlement prices also create potential gaming opportunities using paired physical supply and virtual demand bids.

The following comments provide more detail on these significant issues, as well as discussion of some other concerns DMM has identified.

[1] *Day Ahead Market Enhancements Revised Straw Proposal*, April 11, 2018: http://www.caiso.com/Documents/RevisedStrawProposal-DayAheadMarketEnhancments.pdf
Day-Ahead Market Enhancements Appendix C: Draft Technical Description, April 11, 2018: http://www.caiso.com/Documents/APPENDIXC-Day-AheadMarketEnhancementsDraftTechnicalDescription.pdf

1. Constraint formulation and implied prices

The ISO proposes to add imbalance reserve up (IRU) and imbalance reserve down (IRD) constraints to the day-ahead market. Figure 1 shows a simplified version of the existing power balance constraint and the proposed IRU and IRD constraints. For simplicity losses and congestion are excluded.

While the ISO proposal does not state what the day-ahead market prices will be, the implied market prices can be found by taking the derivative of the proposed optimization's lagrangian with respect to the quantity of each product. These derivatives are the marginal cost of each product. DMM provides a derivation of the market prices implied by the ISO's constraint formulation in Appendix A to these comments.

Figure 1 shows the marginal cost prices from the ISO's formulation. Note that physical generation and imports face different prices for energy than physical load, virtual load and virtual generation. The demand for the imbalance reserves — and the impact of this demand on energy prices — is determined by the ISO and not by day-ahead market participant bids.

Figure 1. Power balance and imbalance reserve constraints with prices

Market Constraints

$$PBC: \sum_i PhysGen_{i,t} + \sum_j VirtSched_{j,t} = \sum_i PhysLoad_{i,t}$$

$$IRU: \sum_i PhysGen_{i,t} + \sum_i IRU_{i,t} \geq ISOForecastLoad_t + IRUR_t$$

$$IRD: \sum_i PhysGen_{i,t} + \sum_i IRD_{i,t} \leq ISOForecastLoad_t + IRDR_t$$

Product prices

Energy Prices

$Physical\ Load$: λ_t^{PBC}

$Physical\ Gen\ and\ Imports$: $\lambda_t^{PBC} + \lambda_t^{IRU} + \lambda_t^{IRD}$

$Virtual\ Schedules$: λ_t^{PBC}

Capacity Prices

$IRU\ Capacity$: λ_t^{IRU}

$IRD\ Capacity$: λ_t^{IRD}

2. Marginal cost pricing under ISO proposal

To maintain marginal cost pricing under the proposed formulation, the ISO would need to use the prices in Figure 1. Using prices other than the Figure 1 prices would result in prices that are not equal to marginal costs and that are not *incentive compatible*. Without incentive compatible prices, market participants would have an incentive to not bid their true costs, undermining the ISO's core market design which aims to minimize costs/maximize value. To maximize market value, the market design must elicit bids that represent the true costs and valuations of market participants.

Consider an example of a competitive market where market participants behave as price takers. Assume the power balance constraint shadow value is $25 and the imbalance reserve up shadow value is $10. Under the proposed formulation the marginal cost price for energy for physical generators would be $35 = $25 + $10.

In this example, a 10 MW generator with a $24/MW energy cost (and bid price) receives market awards for 10 MW of energy and 0 MW of imbalance reserve up. The generator's economic profit would be $110 = 10 x ($35-$24). If the generator increased their bid above actual costs to $40/MW they would receive a 0 MW energy award and 10 MW imbalance reserve up. The generator's profit would fall from $110 to $100 = 10 x $10. Thus, the generator is better off submitting its actual cost than inflating its bid above actual costs.

However, consider what may occur if physical generation was paid only the shadow value on the power balance constraint ($25) rather than the imbalance reserve shadow value for energy ($35). The generator's economic profit would be $10 = 10 x ($25-$24). If the generator changed its bid to $40 it could change its market awards to 0 MW of energy and 10 MW of imbalance reserve up — and receive profits of $100 (10 x $10). The generator would have an incentive to bid in excess of its true costs because it could receive higher profits by not bidding its true costs. Moreover, the generator's energy output would be replaced by energy costing $25/MW rather than $24/MW, increasing the actual costs incurred to meet load by $100 (or reducing total cleared load).

Thus, if the ISO were to not use the marginal cost prices defined in Figure 1, the incentive to submit bids representing actual costs would be reduced. This would undermine the ability of the market to minimize costs and maximize market value.

The point of this section is to explain that the ISO would need to use the prices in Figure 1 if the ISO adopts the current proposal's formulation for imbalance reserve products. The following two sections of these comments (3 and 4) discuss the problems involved in allocating energy revenue shortfalls or surpluses that would result if the ISO used the prices in Figure 1 under the formulation for imbalance reserve products described in the current proposal.

These problems cannot be solved by excluding the imbalance reserve shadow prices from the physical generation energy prices without creating other significant problems. In fact, as discussed in Section 4, excluding the imbalance reserve shadow values from the physical generator's or importer's price is equivalent to allocating the energy revenue shortfalls or surpluses to physical generators and imports.[2]

3. Different prices for physical and virtual bids at the same location creates gaming opportunities

Under the ISO proposed formulation, physical generation would face a different price than load, virtual load and virtual generation at the same location. Different bid types facing different prices at the same location creates opportunities for gaming.

For example, consider the case where the imbalance reserve up shadow price is a positive value such as $5/MW. A market participant could self-schedule both physical generation and virtual load in the same quantity at the same location into the day-ahead market. The market participant can then not bid the physical generation into the real-time market.

Under this scenario, the market participant would be paid $5/MW more for the physical generation than the virtual demand is charged in the day-ahead market. In real-time the physical generation buy-back costs would be precisely offset by the payments to virtual demand. The market participant would receive $5/MW in profit without providing any net energy or service of value to the ISO system.

The $5/MW payment the market participant receives in this scenario does not come directly from any other participant bidding in the day-ahead market. The payment comes initially from the ISO. But the ISO must charge someone to fund this payment and maintain revenue neutrality.

The ISO could charge cleared day-ahead market load, including virtual load, $5/MW. Charging the virtual load the $5/MW would eliminate the gains from the physical generation virtual load pairing. However, as discussed in the next section, funding the imbalance reserve energy payment with charges to day-ahead loads creates other problems.

4. The proposed change to energy price formation is a fundamental change to the day-ahead market design and principles

Under the proposed imbalance reserve formulation, the ISO pays physical generation a different price than it charges load. Settling physical generation and loads on different prices will create *energy* revenue deficits or surpluses. How the ISO allocates these revenue deficits or surpluses can significantly affect day-ahead market efficiency and create incentives for market participants to not bid their true costs or values into the market.

The source of the energy price difference is the imbalance reserve requirements set by the ISO. Therefore, the value of *energy* in the day-ahead market will be determined to a

[2] For ease of exposition, we will refer to only physical generators/generation going forward even though we also mean imports.

significant degree by an administrative demand on energy set by the ISO. Placing administrative demands for energy into the market is a significant change from the current day-ahead market design where only bid-in supply and demand determine the value of energy. Such a significant change to the design and underlying principles of the day-ahead market deserves careful consideration.

Different prices for generation and load will create revenue imbalances

Under the ISO proposal, the price paid to physical generation includes the shadow values on the imbalance reserve constraints while the price paid by load does not. When the imbalance reserve up constraint is binding, the price physical generation is paid for energy is higher than the price load pays. With the ISO paying generation more than it collects from load the ISO will have a revenue shortfall. When the imbalance reserve down constraint is binding, the price physical generation is paid for energy is lower than the price load pays, creating revenue surplus or rent.

Allocating the energy revenue imbalances can significantly affect market efficiency

The imbalance reserve shadow values will be applied to <u>all cleared energy from physical generators</u>, rather than just the imbalance reserve capacity procured by the ISO. The revenue shortfalls/surpluses created by the proposal will equal the shadow values multiplied by cleared energy from physical generators. To the extent that the imbalance reserve shadow values are significant, the shortfalls/surpluses will be significant. Further the deficits/surpluses will change with changes in cleared physical generation. Therefore the allocation of the energy revenue shortfalls/surpluses can significantly affect market efficiency.

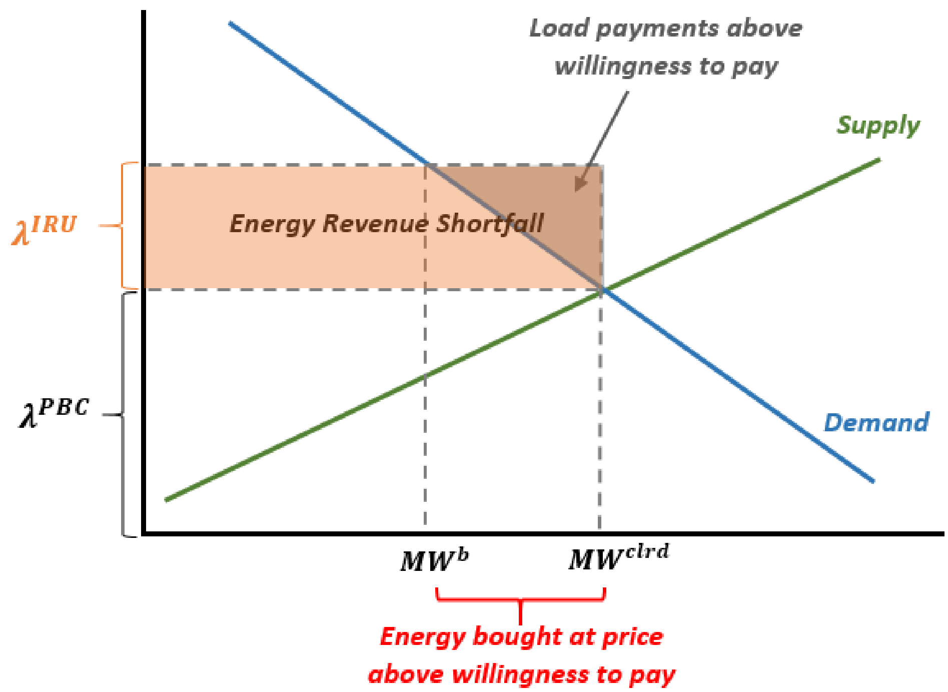
Consider what would occur if the shortfalls/surpluses were allocated to physical generators based on day-ahead schedules. This allocation would have the effect of undoing the energy payment to physical generators that derives from the imbalance constraints. Allocating the shortfalls/surpluses to generators in this way would be equivalent to not paying them the shadow values on the imbalance constraints. As explained in Section 2, not paying the full marginal cost price for energy would undermine incentive compatibility and market efficiency. Further, market participants could still carry out the paired physical generation and virtual demand game described in Section 3.

The ISO could allocate the revenue shortfalls /surpluses to load. Allocating the shortfalls/surpluses to load (both physical and virtual resources) based on cleared day-ahead schedules would eliminate the paired physical generation virtual load game. But allocating the revenue shortfalls/surpluses to load has the effect of changing the price paid per MWh of load by an amount equal to the imbalance reserve shadow prices.

Section 1 shows that the marginal cost energy price for load does not include the imbalance reserve shadow prices. If the ISO allocated the shortfalls/surpluses to load, the change in effective price paid by load would undermine incentive compatibility and market efficiency in similar ways to paying generators the wrong price discussed in Section 2.

Figure 2 below shows an example of how allocating the revenue shortfalls created by a binding imbalance reserve up constraint undermines incentive compatibility and market efficiency. For simplicity there are no virtual schedules. MW^{clrd} is the cleared energy load and supply. Load pays λ^{PBC} for energy in the market. Generation is paid $\lambda^{PBC} + \lambda^{IRU}$ for energy. The energy revenue shortfall equals λ^{IRU} x MW^{clrd}.

Figure 2. Effects of allocation IRU created energy revenue shortfalls to load



Allocating the shortfall to load has the effect of charging load $\lambda^{PBC} + \lambda^{IRU}$ for energy. But load is only willing to buy MW^b of energy at a price of $\lambda^{PBC} + \lambda^{IRU}$, not MW^{clrd}. Load pays more for the energy MW^{clrd} - MW^b than they are willing to pay.

Furthermore, because market participants buying load will know they can end up paying a price higher than their bid, they will have an incentive to lower their bids to avoid paying above their actual willingness to pay. Price paid by load, after considering the shortfall allocation, will not be incentive compatible with submitting load bids representing the actual value of load.

Therefore, the ISO's proposal will undermine the ability of the day-ahead market to maximize value. Allocating the rent created by the imbalance reserve down constraint can undermine incentive compatibility and market efficiency in similar ways.

The reason it will be difficult to allocate the energy revenue shortfalls/surpluses created by the imbalance reserve constraints without undermining market efficiency is that the costs are created by an administrative intervention into the day-ahead energy market.

The ISO's demand for energy, as determined by the imbalance reserve constraints, creates the change in value of physical generation perceived by the market optimization. But this 'value' is not actually in any bids from market participants.[3]

5. Fifteen minute vs hourly bidding granularity

Fifteen minute reserve awards

The ISO proposes to award imbalance reserves on an interval by interval basis, but to maintain hourly bidding in all markets. If bids are hourly, however, it appears that resources may not be able to comply with their awards without over providing imbalance reserves. If a resource receives an award for 1 interval, it needs to submit bids honoring that award for the whole hour. The resource has the same requirements as if it receives an award for three or four intervals during that hour. In addition to fairness concerns, this creates some challenges for determining the requirements. Requirements must be set properly to account for this if bidding remains hourly in the day-ahead and real-time markets.

Price and schedule variation

If bidding can only vary on an hourly basis, forecasts of variable energy resources (VERs) and the ISO load forecast will drive all intra hourly price variation and scheduling. In that case, DMM is not confident that physical load and generation will be scheduled in the day-ahead market in a way that will facilitates real-time ramping needs.

In order for total day-ahead generation schedules to match the expected fifteen-minute market load forecasts, day-ahead bidding for load (and possibly generation) may need to have fifteen minute granularity. This would match the granularity of load bidding that occurs in the fifteen-minute market. In the fifteen-minute market, the ISO load forecast is a price taking bid whose quantity changes with each interval. The current ISO proposal allows day-ahead market load bidders to place a cap on their bids that can move in fifteen minute increments. But DMM currently has no reason to think that this will have an impact at all times, and believes that the potential impact will depend on bidding behavior.

Without fifteen minute bidding granularity, day-ahead schedules may not be shaped properly and real-time bidding requirements may be compensated unevenly. DMM suggests that the ISO seriously explore the costs of adding fifteen minute bidding to the day-ahead markets if they intend to go forward with the proposed enhancements.

[3] This is in stark contrast to revenue shortfalls created by bid cost recovery payments, where the optimization explicitly considers the total cost of generation against the value of load.

6. Imbalance reserve requirements and resource adequacy

The ISO's straw proposal promised that more detail would soon follow on how the ISO plans to set the requirement for the quantity of imbalance reserves procured in each interval of the new day-ahead market. In the revised proposal, the ISO suggests that the quantity of imbalance reserves needed in any interval will be related to some measure of variance around the load forecast errors.[4] This variance is certainly an important component in determining the amount of imbalance reserves that will be needed. However, the proposed design for imbalance reserves also suggests other factors that may be important in setting requirements.

The ISO proposes to eliminate real-time must offer obligations for resource adequacy (RA) contracted resources. Specifically, "as noted in imbalance reserve bidding section above, unless RA resources obtain a day-ahead schedule, an ancillary service, or an imbalance reserve award, the RA resource will no longer have a real-time must offer obligation."[5] Currently most RA resources are required to make themselves available to the ISO real-time markets, so this proposal constitutes a significant change from the current RA requirement.

Moving the determination of the real-time must offer obligation to the day-ahead market appears consistent with logic that the RA program provides sufficient resources for the day-ahead market and the day-ahead market then provides sufficient resources for the real-time markets. But the removal of the RA real-time must offer obligations should be contingent on the imbalance reserve products providing a suitable replacement for the real-time RA obligations.

The ISO has not defined how it will determine the imbalance reserve product requirements. Therefore, DMM cannot assess whether or not the imbalance reserve products could adequately replace real-time RA must-offer obligations.

One issue of particular importance is the role that real-time RA must-offer obligations serve in mitigating system level market power in the real-time markets. In the proposal, the ISO has not specified how it is going to set the imbalance reserve product requirements in a way that helps to mitigate the exercise of real-time system level market power. The ISO would need to define the imbalance reserves products requirements in much more detail before DMM could assess whether or not DMM supports the product as a suitable replacement for real-time RA must-offer obligations.

In addition, DMM notes that in other RTOs with capacity markets, must-offer obligations for resources being relied upon to meet capacity (including imports) continue into the real-time market. This reflects the fact that many of the contingencies that drive capacity requirements occur in real-time after the day-ahead market. Thus, DMM would be cautious about design changes that could decrease available resources in real-

[4] On p.48 of the revised straw proposal, the ISO states that initially "[r]equirement will be determined based on differences between the DAM and RTD" although in the April 18 stakeholder meeting an ISO representative clarified that this was a typo and should have FMM instead of RTD.

[5] http://www.caiso.com/Documents/RevisedStrawProposal-DayAheadMarketEnhancments.pdf p.25

time on high load days. If anything, DMM recommends that the ISO consider changes to increase the reliability and availability of resource adequacy imports in real-time, rather than making changes that might reduce availability of resource adequacy capacity in real-time.

7. Imbalance reserve requirements and cost allocation

The exact method for setting the requirements also plays an important role in determining appropriate cost allocation. Costs are allocated to the entities who cause them so that they have an incentive to take actions that can lower system costs. Until the ISO specifies how it proposes to set imbalance reserve requirements, the cause of the costs will be unknown and therefore the cost allocation cannot be designed efficiently. Inconsistencies between requirements and cost allocation can lead to incentive issues in imbalance reserve and energy markets. DMM recommends that the ISO determine the method for setting requirements before spending much effort on designing the cost allocation.

8. Allowing RA resources to submit non-zero bids for imbalance reserve products

The current RUC market only accepts positive value bids from capacity that is not fulfilling a resource adequacy contract at that time. Similarly, non-zero RUC payments are only made to this non-RA capacity. The proposal will allow resources to submit bids for availability of real time capacity without regard to whether or not they have already sold or been paid for this capacity in the RA market. This would also alter the current RA resource compensation structure, because RA compensation would include revenue earned from imbalance reserve sales.

These changes to obligations and compensation would need to be factored into the RA market over time. The process of adjusting RA contracts for future capacity should be informed by expectations of revenue that will be earned from the imbalance reserve markets. Until those markets are well established, revenue expectations may vary considerably. These factors will likely result in a significant period of adjustment in the RA markets. The ISO should carefully consider the potential impact of the proposed changes on the RA market.

9. Changes to structure of incentives for virtual bids

In previous comments on this initiative, DMM discussed the usefulness of a careful consideration of total impact to incentives for virtual bids. In its response, the ISO stated that the intention was to apply some of the costs of the imbalance reserve procurement to virtual bidders to offset the loss of RUC BCR as a cost to virtual bidders.[6] However, there are several key differences between BCR costs and imbalance reserve costs. In particular, RUC BCR can incorporate commitment costs, and in general is structured differently than the proposed allocation for imbalance reserve costs. The ISO should provide significantly more detail on the cost allocation to virtual bids, and provide several examples so that stakeholders can evaluate the proposal. Changes to the cost structure of virtual bidding can lead to changes in virtual bidding strategy that may not lead to efficient market outcomes.

[6] *Revised Straw Proposal*, p. 26: "Virtual bids will no longer be allocated bid cost recovery (BCR); they will be allocated the imbalance reserve costs."

Appendix A

Product prices under day-ahead enhancements optimization formulation

The marginal cost product prices are found by taking the partial derivative of the proposed optimization formulation with respect to each product. The products here are physical load ($Load_{i,t}$), physical generation ($Gen_{i,t}$), virtual load or generation ($Virt_{j,t}$), imbalance reserve up capacity ($IRU_{i,t}$), and imbalance reserve down capacity ($IRD_{i,t}$). Intervals are indexed by t. Individual product bids are indexed by i.

Note that we changed the interval subscript convention from that used in the proposal so that it is easier to see the alignment of awards and prices in an interval. The subscript convention change does not alter the final optimization awards or payments, but would require applying the convention change to all the resource constraints.

$$
\begin{aligned}
L = C(X) &+ \sum_{i,t} \lambda_t^{PBC} \left(\sum_i Load_{i,t} - \sum_i Gen_{i,t} - \sum_i Virt_{i,t} \right) \\
&+ \sum_{i,t} \lambda_t^{IRU} \left(ISOForecastLoad_t + IRUR_t - \sum_i Gen_{i,t} - \sum_i IRU_{i,t} \right) \\
&+ \sum_{i,t} \lambda_t^{IRD} \left(ISOForecastLoad_t + IRDR_t - \sum_i Gen_{i,t} - \sum_i IRD_{i,t} \right)
\end{aligned}
$$

$$\frac{\partial L}{\partial Load_t} = 0 \;\therefore\; \frac{\partial C(X)}{\partial Load_t} - \lambda_t^{PBC} = 0 \;\therefore\; \frac{\partial C(X)}{\partial Load_t} = \lambda_t^{PBC}$$

$$\frac{\partial L}{\partial Gen_t} = 0 \;\therefore\; \frac{\partial C(X)}{\partial Gen_t} - \lambda_t^{PBC} - \lambda_t^{IRU} - \lambda_t^{IRD} = 0 \;\therefore\; \frac{\partial C(X)}{\partial Gen_t} = \lambda_t^{PBC} + \lambda_t^{IRU} + \lambda_t^{IRD}$$

$$\frac{\partial L}{\partial Virt_t} = 0 \;\therefore\; \frac{\partial C(X)}{\partial Virt_t} - \lambda_t^{PBC} = 0 \;\therefore\; \frac{\partial C(X)}{\partial Virt_t} = \lambda_t^{PBC}$$

$$\frac{\partial L}{\partial IRU_t} = 0 \;\therefore\; \frac{\partial C(X)}{\partial IRU_t} - \lambda_t^{IRU} = 0 \;\therefore\; \frac{\partial C(X)}{\partial IRU_t} = \lambda_t^{IRU}$$

$$\frac{\partial L}{\partial IRD_t} = 0 \;\therefore\; \frac{\partial C(X)}{\partial IRD_t} - \lambda_t^{IRD} = 0 \;\therefore\; \frac{\partial C(X)}{\partial IRD_t} = \lambda_t^{IRD}$$

Net product settlement payments

The net market payments are the sum of all the product awards multiplied by the product prices.

The energy payments related to the power balance constraint shadow value net to zero.

When their imbalance reserve shadow values are non-zero, the imbalance reserve up and down capacity payments do not net zero. The imbalance reserve capacity costs must be allocated in some manner for the ISO to remain revenue neutral. The ISO discusses this in the proposal.

However, the energy payments to physical generation related to the imbalance reserve constraint shadow values do not net to zero either. The net energy payments related to the imbalance reserve shadow values will also need to be allocated. This point has not been discussed by the ISO in any of its proposals.

$$Net\ Market\ Payments_t =$$

$$\lambda_t^{PBC}\sum_i Load_{i,t} + \lambda_t^{PBC}\sum_j Virt_{j,t} + (\lambda_t^{PBC} + \lambda_t^{IRU} + \lambda_t^{IRD})\sum_i Gen_{i,t} + \lambda_t^{IRU}\sum_i IRU_{i,t} + \lambda_t^{IRD}\sum_i IRD_{i,t}$$

$$= \lambda_t^{PBC}\left(\sum_i Load_{i,t} + \sum_j Virt_{j,t} + \sum_i Gen_{i,t}\right) + \lambda_t^{IRU}\left(\sum_i Gen_{i,t} + \sum_i IRU_{i,t}\right) + \lambda_t^{IRD}\left(\sum_i Gen_{i,t} + \sum_i IRD_{i,t}\right)$$

$$= \lambda_t^{PBC}(0) + \lambda_t^{IRU}\left(\sum_i Gen_{i,t} + \sum_i IRU_{i,t}\right) + \lambda_t^{IRD}\left(\sum_i Gen_{i,t} + \sum_i IRD_{i,t}\right)$$

$$= (\lambda_t^{IRU} + \lambda_t^{IRU})\sum_i Gen_{i,t} + \lambda_t^{IRU}\sum_i IRU_{i,t} + \lambda_t^{IRD}\sum_i IRD_{i,t}$$