Bid cost recovery and variable energy resource settlement

Draft final proposal

May 20, 2015

Table of Contents

1. Changes from the straw proposal

Section 7 – In response to stakeholder questions, the ISO clarifies its comparison of a forecast change to a conventional generator derate. The comparison is isolated to the residual imbalance energy between the non-derated and derated capacity. The ISO does not mean to suggest that the energy from a variable energy resource should be categorized as derate energy.

As discussed during the working group session, the ISO provides additional numeric examples for scenarios 2b and 4a. A spreadsheet with the active cell calculations is provided as a separate document.

Section 8 - The ISO agrees with stakeholder comments that there is a concern the persistent deviation metric may still trigger pursuant to a forecasting error. Therefore, the ISO proposes to no longer apply the metric to variable energy resources when they are responding to a forecast change. For self-scheduled variable energy resources, the metric will be removed for residual imbalance energy. For economically bidding variable energy resources, the metric will be removed when the resource is only responding to a forecast change and when there is simultaneously a forecast and LMP change overlapping in the residual imbalance energy. For economically bidding variable energy resources only responding to a change in the LMP, the persistent deviation metric will apply. This treats the economically bidding variable energy resource similarly to an economically bidding conventional generator.

Section 10 – The ISO has included under step [3] of the day-ahead metered energy adjustment factor consideration of the minimum of the expected energy or the day-ahead scheduled energy. The ISO has provided the series of examples discussed during the stakeholder process and in the working group session as a spreadsheet with the active cell calculations (same document as the settlement examples for scenarios 2b and 4a).

2. Background

On March 20, 2015 the ISO published a market issues bulletin describing a corrected methodology to account for the ramp rates of self-scheduled variable energy resources.[1] This will significantly decrease how often these resources erroneously trigger the persistent deviation metric. The bulletin also clarified the categorization of residual imbalance energy as related to self-scheduled resources.

The bulletin only describes changes that the ISO can make under the ISO's existing tariff authority. This stakeholder initiative will address related items that require stakeholder input leading to tariff changes or clarifications on the existing policy.

[1] CAISO, Market Issues Bulletin: Residual imbalance energy settlement and ramp rate changes for self-scheduled variable energy resources, March 10, 2015. Available at: http://www.caiso.com/Documents/MarketIssuesBulletin_ResidualImbalanceEnergySettlement-RampRateChanges.pdf

3. Schedule for policy stakeholder engagement

The proposed schedule for the policy stakeholder process is listed below. We have omitted the issue paper since the issue was already discussed in the market issues technical bulletin

Date	Event
Thu 4/9/15	Straw proposal posted
Wed 4/15/15	Stakeholder call
Thu 4/30/15	Stakeholder comments due
Fri 5/8/15	Working group session
Wed 5/20/15	Draft final proposal posted
Wed 5/27/15	Stakeholder call
Wed 6/10/15	Stakeholder comments due
Thu/Fri 7/16-7/17/15	Board of Governors meeting

4. Initiative scope

This initiative is narrowly scoped to address potential tariff changes that could not be made pursuant to the ISO's current tariff authority during the market issues bulletin discussion. Specifically, the ISO proposes to revise the current settlement of residual imbalance energy for economically bidding variable energy resources. More broadly for variable energy resources, the ISO will explore the application of the persistent deviation metric and the calculation of a default energy bid. Lastly, this initiative will address minor improvements to the day-ahead metered energy adjustment factor as applied to all resources.

The remainder of this paper is divided into the following sections. Section 5 summarizes all of the proposals. Section 6 clarifies how ramp rates should be reflected in the Master File. Section 7 provides examples of the proposed settlement for residual imbalance energy for economically bidding variable energy resources. Section 8 discusses the application of the persistent deviation metric to variable energy resources and Section 9 discusses the calculation of the default energy bids. Section 10 describes modifications to the day-ahead metered energy adjustment factor as applied to all resources to consider certain boundary conditions. Section 11 notes that tariff clarifications based on discussion with stakeholders relating to the market issues bulletin will be discussed in the tariff stakeholder process. Section 12 discusses next steps.

5. Summary of proposals

Table 1 summarizes the proposed changes.

Table 1
Summary of proposals

#	Section	Topic	Proposal	Type of change
1	6	Ramp rate for variable energy resources	Ramp rates are physical characteristics and should not be "9999 MW/min"	Clarification on existing policy
2	7	Residual imbalance energy settlement for economic bidding variable energy resources	Residual imbalance energy due to the forecast changes across intervals shall be settled based on LMP rather than bid. Residual imbalance energy due to economic dispatch across intervals shall continue to be settled based on the reference bid.	Tariff
3	8	Persistent deviation metric applied to variable energy resources	Only apply to residual imbalance energy when due to an economic dispatch. Do not apply to residual imbalance energy when moving due to a forecast only or a simultaneous forecast and LMP decrease	Tariff
4	9	Default energy bids for economic bidding variable energy resources	If no cost is provided, will use variable cost option. If LMP option is selected, the variable cost option will be used until the LMP option can be calculated.	Clarification on existing policy
5	10	Day-ahead metered energy adjustment factor	Corrected for boundary conditions	Tariff
6	11	Tariff clarifications following market issues bulletin	Clarifications on tariff language pre-dating MRTU to be provided during the tariff stakeholder process	Tariff (in tariff stakeholder process)

6. Ramp rate for variable energy resources

As explained in the market issues bulletin, the persistent deviation metric evaluates a resource's response based on the "amount the resource can be dispatched at full ramp over the Settlement Interval."[2] However, the "full ramp" for a self-scheduled variable energy resource is not the ramp rate provided in Master File since the ISO market does not consider this value. Instead, the ramp rate is implied from the forecast used by these self-schedules. Consequently, the ISO proposed to use "9999 MW/min" as a proxy for the implied ramp rate for variable energy resources following a forecast and only submitting self-schedules.

Using this proxy does not replace the Master File ramp rate. It only recognizes that the ISO market does not use it when there is only a self-schedule. Ramp rates in the Master File should still reflect the physical capability of the resource and the best operational ramp rate should

[2] CAISO tariff, section 11.17.

reflect the maximum for an upward or downward ramp. Resources should not enter “9999 MW/min” in the Master File.

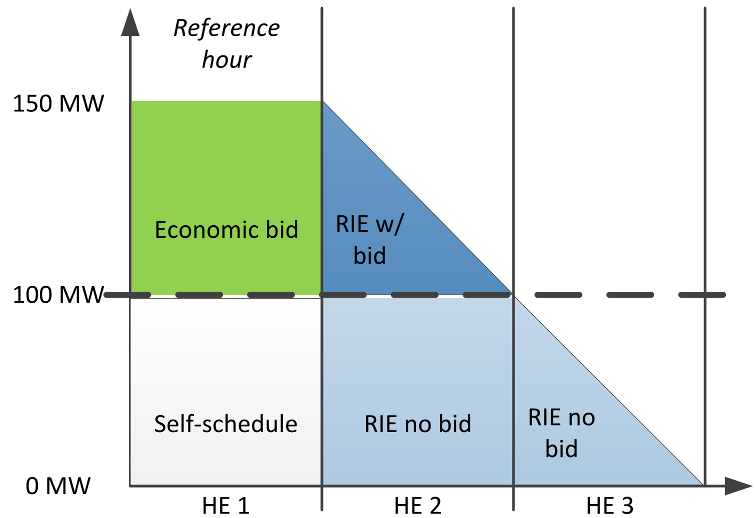
On the other hand, the ISO market will consider the best operational ramp rate of resources with an economic energy bid, whether the resource is a conventional resource or variable energy resource. The ISO market considers the best operational ramp rate as listed in the Master File when it economically dispatches the variable energy resource. Therefore, it is important for all resources to have ramp rates in the Master File that reflect the physical capability of the resource and the best operational ramp rate can reflect an upward or downward ramp. Therefore, resources should not enter “9999 MW/min” in the Master File.

7. Residual imbalance energy with regard to variable energy resources

As explained in the market issues bulletin, residual imbalance energy is the appropriate settlement classification for a portion of the energy output of variable energy resources, regardless if the resource is self-scheduled or has economic energy bids.[3] Figure 1 below is reproduced from the bulletin and shows residual imbalance energy produced by a resource ramping down at the top of an hour. It shows that as the energy crosses the hour mark, the portion ramping down from a dispatched economic bid is classified as residual imbalance energy with a bid and the portion ramping down from a self-schedule portion is classified as residual imbalance energy without a bid. Residual imbalance energy with a bid is settled at the “reference hour bid,” which, for a resource ramping down at the top of an hour, is the bid in the previous hour. When there is no dispatched economic bid, the ISO settles the energy at the locational marginal price (LMP). This is true for variable energy resources and conventional generation.

[3] http://www.caiso.com/Documents/MarketIssuesBulletin_ResidualImbalanceEnergySettlement-RampRateChanges.pdf

Figure 1
Residual imbalance energy settlement



During the market issues bulletin discussion, it was concluded that the ISO's current settlement for economically bidding variable energy resources does not differentiate whether the resource is driven by a forecast change or a change in the LMP with regard to the bid. For example, these resources typically submit negative bids, which will be used to settle residual imbalance energy. An inconsistency was identified when the resource is ramping from a forecast change and not because of market dispatch resulting from a resource's bid price relative to the LMP.

Table 2 below describes four main scenarios and whether each scenario requires a change in the current settlement logic. Scenario 1 is for self-scheduled resources while scenarios 2 through 4 are for economically bidding resources. Scenarios 2 through 4 are presented as pairs where one shows an increase and the other shows a decrease in the LMP, forecast, or both. All scenarios assume the persistent deviation metric has not been triggered.

These scenarios are intended to help the discussion. Numeric examples have been added to scenarios 2b and 4a. A spreadsheet with active cell calculations is provided as a separate document. In all of the cases the resource is ramping from a previous hour into the current hour. The exact symmetrical cases can exist for a resource ramping from the current hour into the next hour and the same rules will apply in those scenarios.

Table 2
Residual imbalance energy and optimal energy settlement for variable energy resources

	Scenario	Current settlement	Issue	Proposed solution
1	Self-scheduled with forecast change	Residual imbalance energy settled on LMP	None	None
2a	Economic bidder and forecast increase (no LMP change)	Optimal energy settled on LMP in current hour.	None	None
2b	Economic bidder and forecast decrease (no LMP change)	Residual imbalance energy settled on reference hour bid.	Bid did not drive change in energy.	Settle at LMP in current hour (analogous to derate).
3a	Economic bidder and LMP less than bid (no forecast change)	Residual imbalance energy settled on reference hour bid.	None	None
3b	Economic bidder and LMP higher than bid (no forecast change)	Optimal energy settled on LMP in current hour.	None	None
4a	Economic bidder and LMP less than bid and forecast decrease	Residual imbalance energy settled on reference hour bid.	A portion of the residual imbalance energy is not driven by bid alone.	Settle at LMP for energy above forecast (analogous to derate); settle at reference hour bid for energy within forecast.
4b	Economic bidder and LMP higher than bid and forecast increase	Optimal energy settled on LMP in current hour.	None	None

Scenario 1 is for self-scheduled variable energy resources. Since these resources do not have a bid, the settlement is at the LMP. There are no issues identified with the current approach.

Scenario 2a is a variable energy resource with economic bids but is dispatched up based on an increase in the forecast while the LMP does not change. The increase in energy to the higher forecast is considered optimal energy and was not driven by the bid so the settlement is at the LMP. There are no issues identified with the current approach. A detailed example is provided in Figure 4 below.

Scenario 2b is a variable energy resource with economic bids but is dispatched down based on a decrease in the forecast while the LMP does not change. Currently the ISO settles the residual imbalance energy based on the bid. The issue identified is that the bid did not drive the residual imbalance energy from the reference hour. Instead, the resource is dispatched based on its forecast. Note that the ISO currently sets the upper economic limit for economically bid variable energy resources at its forecast. Therefore, a decrease in the forecast is a reduction of this limit, analogous to a derate of the Pmax of a conventional generator.[4] A numeric example has been provided in this paper and in a separate excel document.

In response to stakeholder questions, the ISO clarifies that the derate analogy is for the ramping energy and not to compare to or classify the energy as derate energy. For example, when a conventional generator experiences a derate in its capacity, the ramping energy crossing the hour boundary down to the derated capacity is residual imbalance energy settled at the LMP. Similarly, the ramping energy crossing the hour boundary down to the lower forecast (or up to the higher forecast in the next hour) is residual imbalance energy. The ISO does not mean to suggest that the energy from a variable energy resource should be categorized as derate energy. A detailed example is provided in the discussion of Figure 4 below.

Scenarios 3a and 3b are variable energy resources with economic bids dispatched based on the bid price relative to the LMP. The ISO has not identified any issues with the current settlement of residual imbalance energy on the resource's reference hour bid or optimal energy at the LMP in the current hour. Detailed examples are provided in the discussion of Figure 6 and Figure 7 below.

Scenario 4a is a variable energy resource with economic bids and the LMP is lower than the bid in the current hour *and* the forecast decreases. In this scenario the residual imbalance energy is attributed to both the decrease in LMP and the forecast but it is currently all settled on the bid in the reference hour, as if the LMP was the only driver. Therefore, the ISO proposes to settle the residual imbalance energy due to the forecast changes on the LMP similar to de-rate energy. However, the ISO proposes to settle the portion within the forecast on the bid since the energy is driven by the bid price relative to the LMP. A detailed example is provided in Figure 10 below and a numeric example has been provided in this paper and in a separate excel document.

Scenario 4b is a variable energy resource with economic bids and the LMP is higher than the bid in the current hour *and* the forecast increases. The energy increases because of an increase in the forecast and is supported by the higher LMP. The energy is considered optimal energy settled at the LMP in the current hour and there are no issues identified with the current approach. A detailed example is provided in Figure 10 below.

The following charts illustrate the current and proposed settlement for each scenario listed above.

---

[4] See ISO tariff Section 34.1.6: Eligible Intermittent Resources Forecast and Business Practice Manual for Market Operations, Section 7.8.2: Real-Time Economic Dispatch Constraints & Objectives, version 41. The "Pmax" for an economically bidding variable energy resource is referred to as the "upper economic limit" or "upper dispatch limit."

Figure 2 shows that a self-scheduled variable energy resource will be settled on the LMP for its residual imbalance energy (in blue). There are no proposed changes.

Figure 2
Scenario 1: Self-scheduled with forecast change

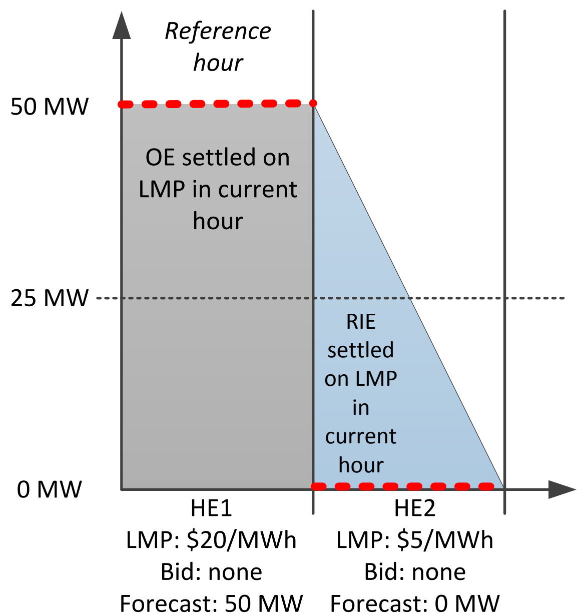
Current	**Proposed**
	None

Figure 3 shows that an economically bidding variable energy resource with a forecast increase but no change in the LMP will not have residual imbalance energy. Instead, the energy in hour ending 2 (HE2) is considered optimal energy (OE) and is settled at the LMP in HE2 (gray triangle). There are no proposed changes to the current settlement.

Figure 3
Scenario 2a: Economic bidder and forecast increase (no LMP change)

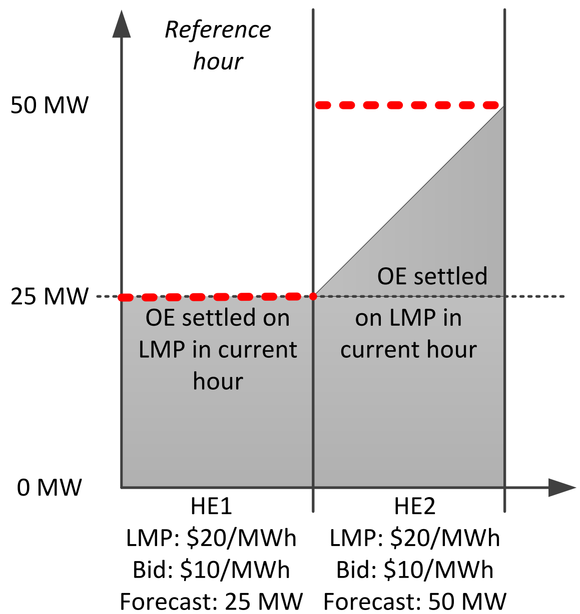
Current	Proposed
	None

Figure 4 below compares the difference between the current and proposed settlement for an economic bidder dispatched in hour ending 2 (HE2) pursuant to a decrease in the forecast. The forecast in this example decreases from 50 MW to 25 MW from the first to second hour (shown by the dotted red line). As mentioned above, the forecast for an economically bidding variable energy resource is its upper economic limit, analogous to a Pmax of a conventional generator. HE2 is therefore similar to a derate from the first hour so that the ramping energy crossing the hour boundary is residual imbalance energy. The current settlement uses the negative $10/MWh bid for all residual imbalance energy, which is lower than the prevailing LMP of $40/MWh (shown in green on the left).

The ISO proposes to settle for the portion of residual imbalance above the forecast on the LMP, the same as the ISO's current settlement of residual imbalance energy when conventional resources experience a derate (shown in blue on the right).

Figure 4
Scenario 2b: Economic bidder and forecast decrease (no LMP change)

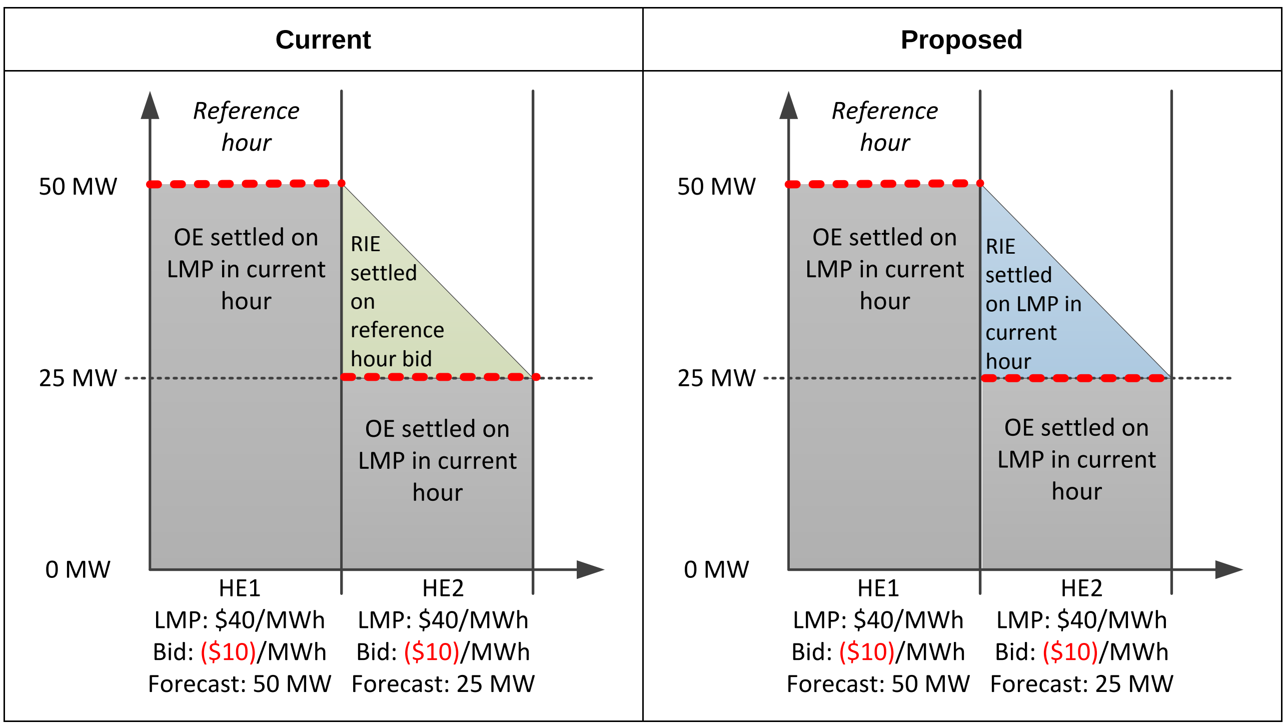


Figure 5 below shows an illustrative settlement example for hour ending 2 (HE2) for the full hour using round numbers.[5]

[5] For example, the ramp rate of the resource has not been calculated and would likely be quite slow compared to actual variable energy resources.

Figure 5
Calculation for scenario 2b: Economic bidder and forecast decrease (no LMP change)

Assumptions							
	Economically bidding VER						
	Settlement is for all of hour ending 2 (HE2)						
	No start-up cost, minimum load cost, CAISO commitment in RTM, no DAM award						
Resource characteristics							
	Pmin	0	MW				
	Pmax	100	MW				
Market inputs							
	RTM LMP (current hour)	$40	/MWh				
	Bid: reference hour	($10)	/MWh				
	Bid: current hour	($10)	/MWh				
	Forecast	25	MW				
		Current settlement			**Proposed settlement**		
Expected energy types							
	Meter	37.5	MWh		37.5	MWh	
	RIE above forecast, current	12.5	MWh		n/a	MWh	
	RIE above forecast, proposed	n/a	MWh		12.5	MWh	
	Optimal energy	25	MWh		25	MWh	
BD names							
	RTM energy revenue - RIE	($125)			$500		
	RTM energy bid cost - OE	($250)			($250)		
	RTM energy revenue - OE	$1,000			$1,000		
	RTM net amount - OE	$1,250			$1,250		

The current settlement is provided on the left while the proposed settlement is on the right. The example shows that the expected energy types do not change. Both have 12.5 MWh above the forecast categorized as residual imbalance energy (RIE) and both have 25 MWh below the forecast categorized as optimal energy (OE).

The difference is in the settlement of the residual imbalance energy. Under the current settlement, the 12.5 MWh energy is settled at the negative $10/MWh bid price for a total of negative $125 (12.5 MWh x -$10/MWh).[6] For the proposed settlement, the LMP is used instead of the bid resulting in $500 revenue (12.5 MWh x $40/MWh).

[6] Actual settlements statements will present this as a negative number but for illustrative purposes in this policy paper we assume that a positive revenue is a payment and a negative revenue is a charge.

The optimal energy calculation remains the same under the proposed settlement where the bid is based on the bid cost of the current hour and the revenue is based on the LMP of the current hour. This results in a charge of negative $250 (25 MWh x -$10/MWh) and a payment of $1,000 (25 MWh x $40/MWh).

Optimal energy will be included in bid cost recovery whereas residual imbalance energy is not. Under the proposed settlement, this resource would receive $625 more ($500 minus -$125) in residual imbalance energy payment.

Figure 6 shows the current settlement of economically bidding variable energy resources when there is no forecast change but the LMP is lower than the current hour bid. The residual imbalance energy is settled based on the bid in the reference hour. There are no proposed changes.

Figure 6
Scenario 3a: Economic bidder and LMP less than bid (no forecast change)

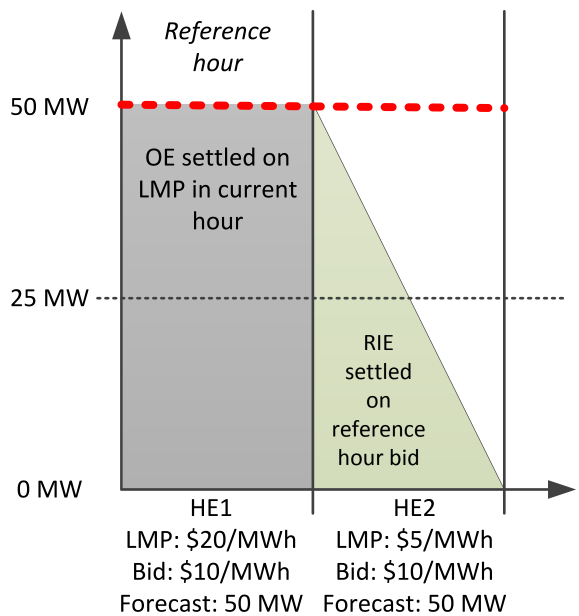
Current	Proposed
	None

Figure 7 shows the current settlement of an economically bidding variable energy resource when there is no forecast change but the LMP is higher than the current hour bid. The optimal energy is settled at the LMP in the current hour. There are no proposed changes.

Figure 7
Scenario 3b: Economic bidder and LMP higher than bid (no forecast change)

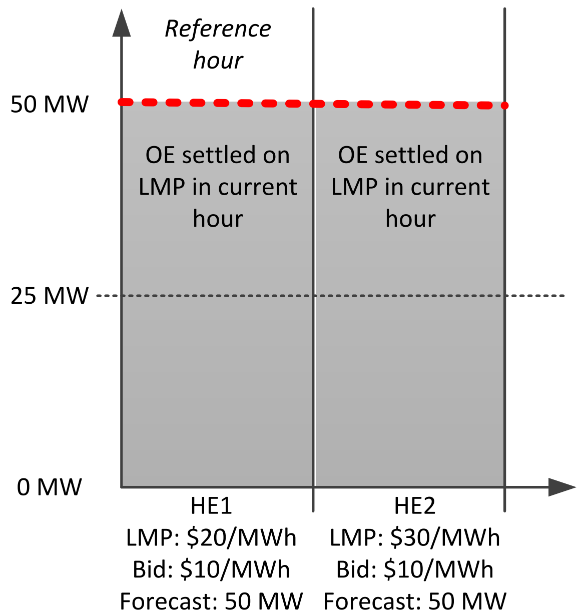
Current	Proposed
 	None

Figure 8 below compares the difference between the current and proposed settlement for an economic bidder dispatched in HE2 pursuant to a decrease in the LMP below the resource's bid and a decrease in the forecast. The LMP in this example is negative $20/MWh in HE2 as compared to a bid of negative $10/MWh. The forecast in this example decreases from 50 MW to 25 MW from the first to second hour (shown by the dotted red line). As mentioned above, the forecast for an economically bidding variable energy resource is analogous to the Pmax of a conventional generator. The ramping energy in HE2 is therefore similar to the ramping energy due to a derate. The current settlement is the negative $10/MWh bid from the reference hour for all residual imbalance energy (shown in green on the left).

The ISO proposes to settle for the portion of residual imbalance energy above the forecast on the LMP, the same as the ISO's current settlement of ramping energy due to a derate (shown in the blue triangle on the right). However, the ISO proposes to settle the portion within the forecast on the reference hour bid since the energy is driven by the LMP being lower than the bid (shown in the green trapezoid on the right).

Figure 8
Scenario 4a: Economic bidder and LMP less than bid and forecast decrease

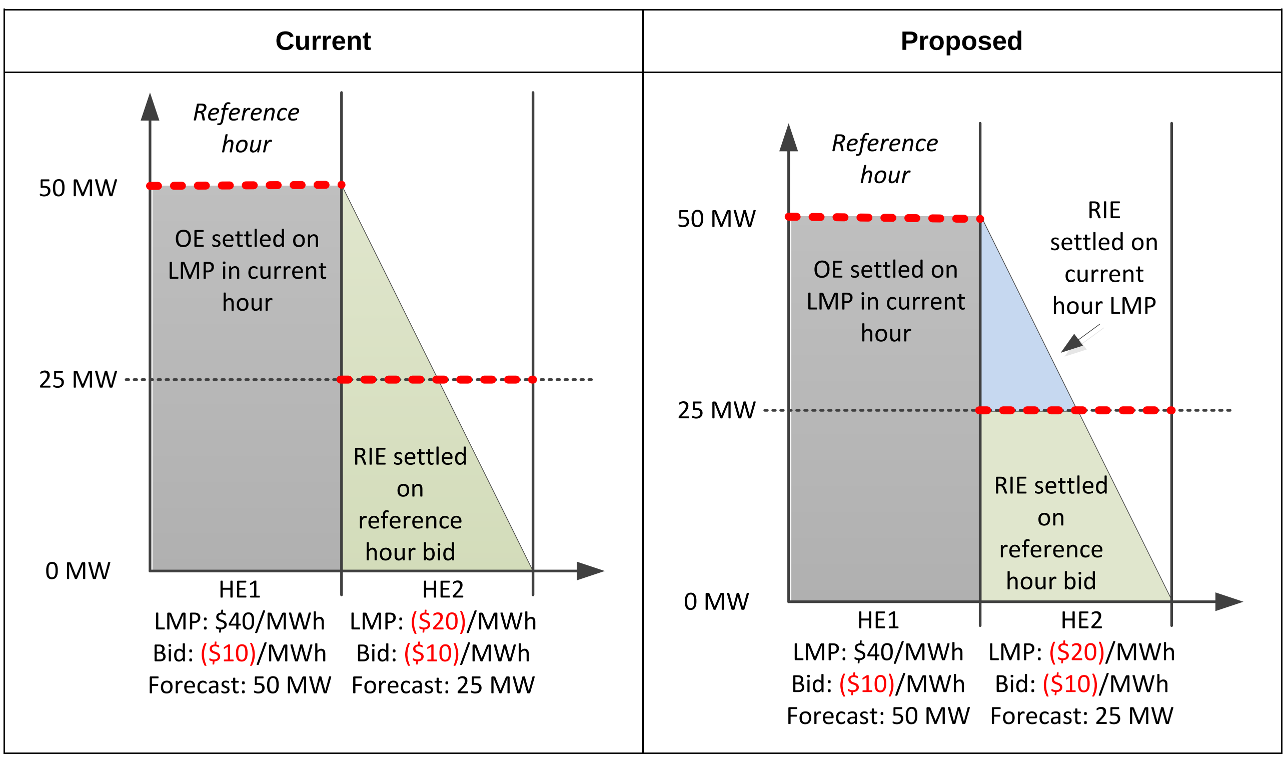


Figure 9 below shows an illustrative settlement example for the first interval of hour ending 2 (HE2) using round numbers.[7]

Figure 9
Calculation for scenario 4a: Economic bidder and forecast decrease (no LMP change)

Assumptions						
	Economically bidding VER					
	Settlement is for all of hour ending 2 (HE2)					
	No start-up cost, minimum load cost, CAISO commitment in RTM, no DAM award					
Resource characteristics						
	Pmin	0	MW			
	Pmax	100	MW			
Market inputs						
	RTM LMP (current hour)	($20)	/MWh			
	Bid: reference hour	($10)	/MWh			
	Bid: current hour	($10)	/MWh			
	Forecast	25	MW			
		Current settlement		**Proposed settlement**		
Expected energy types						
	Meter	25	MWh	25	MWh	
	RIE above forecast, current	6.25	MWh	n/a	MWh	
	RIE below forecast, current	18.75	MWh	n/a	MWh	
	RIE above forecast, proposed	n/a	MWh	6.25	MWh	
	RIE below forecast, proposed	n/a	MWh	18.75	MWh	
BD names						
	RTM energy revenue above forecast - RIE	($63)		($125)		
	RTM energy revenue below forecast - RIE	($188)		($188)		
	Total RIE	($250)		($313)		

The current settlement is provided on the left while the proposed settlement is on the right. The example shows that the expected energy types do not change. Both have 6.25 MWh above the forecast categorized as residual imbalance energy (RIE) and both have 18.75 MWh below the forecast categorized as residual imbalance energy.

Under the current settlement, the 6.25 MWh energy above the forecast is settled at the negative $10/MWh bid price for a total of negative $63 (6.25 MWh x -$10/MWh). For the proposed

[7] For example, the ramp rate of the resource has not been calculated and would likely be quite slow compared to actual variable energy resources.

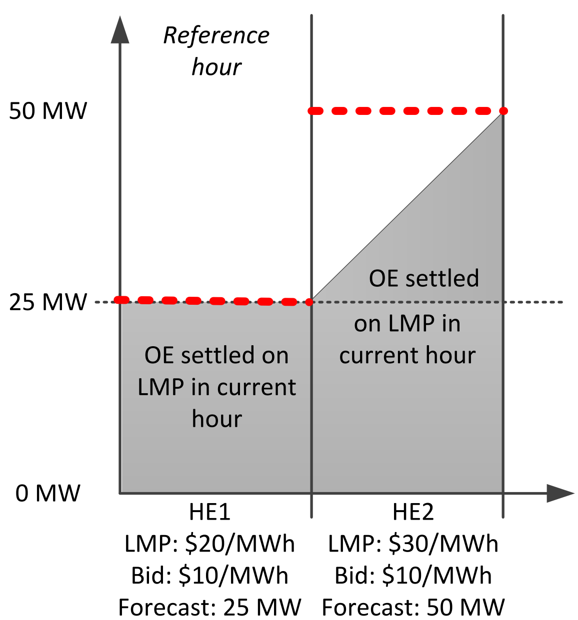
settlement, the LMP is used instead of the reference hour bid resulting in a charge of $125 (6.25 MWh x -$20/MWh).

The residual imbalance energy calculation remains the same under the proposed settlement where the bid is based on the bid cost of the reference hour. This results in a charge of $188 (18.75 MWh x -$10/MWh).

The last line of the calculation adds the residual imbalance energy revenue above and below the forecast for comparison. The resource would be charged $63 more under the proposed settlement (-$313 minus -$250), which is the correct settlement.[8]

Figure 10 below is the same basic concept as presented in Figure 8 except both the LMP and forecast increase in the second hour. The LMP in this example increases from $20/MWh to $30/MWh and the forecast increases from 25 MW to 50 MW in HE2. In this scenario, the energy increase is considered optimal energy and is settled at the LMP in the current hour.

Figure 10
Scenario 4b: Economic bidder and LMP higher than bid and forecast increase

Current	Proposed
	None

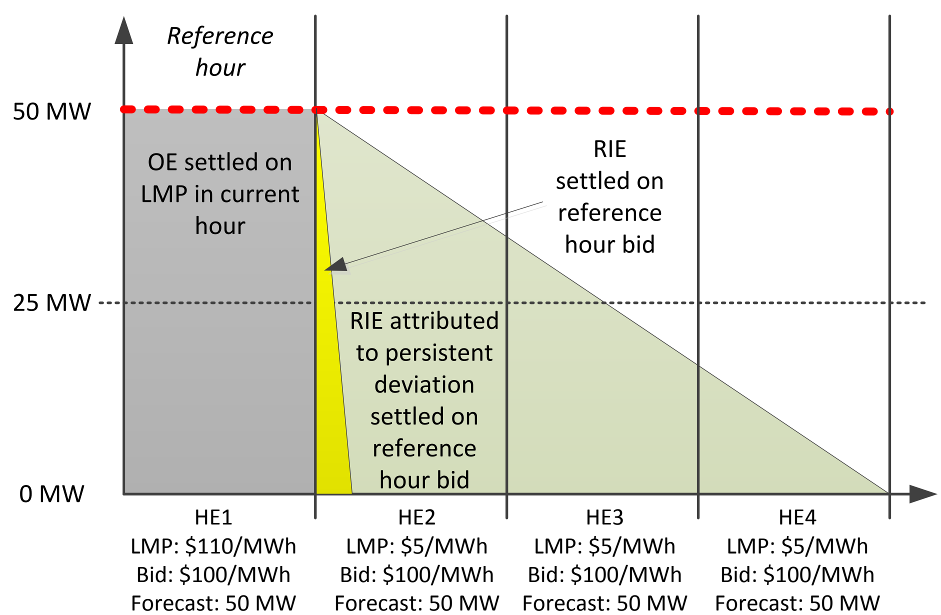
[8] If the settlement is fully on LMP as some stakeholders have questioned, the settlement charge would be even larger as the LMP is lower than the bid price for the portion of the residual imbalance energy below the forecast.

8. Persistent deviation metric

Some stakeholders have advocated for the removal of the persistent deviation metric for all variable energy resources. With the changes proposed in this initiative the ISO will limit the application of the persistent deviation metric to residual imbalance energy where there are still some concerns of a forecast error triggering the metric. For other instances, the metric is still effective for capturing behavior that would seek to inflate bid cost recovery or residual imbalance energy payments.

For example, the current settlement for economically bidding variable energy resources decrementing because of a decrease in LMP rather than the forecast is paid on the bid for the residual imbalance energy from the reference hour. The graphic from Figure 6 is reproduced in Figure 11 below but modified to show a persistent deviation into hour ending 4 and higher bid price.

Figure 11
Scenario 3a with persistent deviation



In this illustrative example, the resource is deviating to capture the higher residual imbalance energy payment based on the bid of $100/MWh rather than the lower LMP of $5/MWh starting in the second hour. The forecast remains unchanged during all four hours. The yellow triangle represents the dispatch of the resource based on its ramp rate while the larger green triangle is the deviation. Without the metric, both the yellow and green triangles will be paid the reference hour bid.

Similarly, a resource may deviate from dispatch to inflate bid cost recovery as shown in the illustrative example in Table 3 below. Assume a resource has a day-ahead schedule of 100 MW at a bid of negative $1/MWh for a total bid cost of negative $100/MWh. The day-ahead LMP is $3/MWh for a total revenue of $300/MWh. Since the revenue minus the cost is a positive number, there is no bid cost recovery (BCR).

In the real-time, the resource deviates from the 100 MW forecast and only provides 10 MW of response even though the dispatch is economic (assuming a negative $1/MWh bid and an LMP of $5/MWh). Therefore, there is a 90 MW buy-back of the day-ahead schedule (reflected as a negative 90 MW quantity multiplied by a negative $1/MWh bid for a bid cost of positive $90/h). For revenue, the same negative 90 MW quantity is multiplied by the real-time LMP of $5/MWh resulting in a negative revenue of $450/h. Under the bid cost recovery calculation the negative $450/h revenue minis the positive cost of $90/h results in negative $540/h, which is eligible for uplift.

Table 3
Illustrative deviation from day-ahead schedule

Market	Bid cost	Revenue	Rev minus Cost	BCR?
Day-ahead	100 MW x -$1/MWh = -$100/h	100 MW x $3/MWh = $300/h	$300 – (-$100) = $400	No
Real-time	-90 MW x -$1/MWh = $90/h	-90 MW x $5/MWh = -$450/h	-$450 - $90 = -$540	Yes

This example is not limited to differences between the day-ahead and real-time. This example is the same if this is a deviation between the fifteen and five minute markets.

These are two illustrative examples and there may be others. Therefore, the ISO proposes to retain the metric with the following caveats below and monitor its impacts on all variable energy resources.

The ISO agrees with stakeholder comments that there is a concern the persistent deviation metric may still trigger pursuant to a forecasting error. Though there are still some manipulation concerns, overall the ISO finds it appropriate to remove the application of the metric to variable energy resource residual imbalance energy when responding to a forecast change. A difference between the forecast and actual resource availability may arise due to several factors such as averaging between a forecast over a wide footprint and individual resource movement, poor quality forecasts, intentional manipulation of forecasts, and the time difference between the forecasts consumed by the fifteen minute and five minute markets. The ISO has not conducted an analysis separating the impacts of each of these factors (and potentially others) in order to fine tune the persistent deviation metric. As the ISO gains more experience with economically bidding variable energy resources, we may be able to conduct this analysis.

In the meantime, the ISO proposes to no longer apply the metric to variable energy resource residual imbalance energy when responding to a forecast change. Table 4 below shows the current and proposed application of the metric to variable energy resources. Currently, the metric applies to both residual imbalance energy and optimal energy for all variable energy resources. The ISO proposes to remove the metric for residual imbalance energy for economically bidding variable energy resources when responding to a forecast change only (see scenario 2b above) and a simultaneous forecast and LMP change (see blue triangle in scenario 4a). Since the forecast is driving the change in both scenarios and the resource is already proposed to be settled on LMP, the ISO believes the metric may be removed. However, the metric will continue to apply to optimal energy (and is applied to the bid cost if triggered).

On the other hand, if the economically bidding variable energy resource is only responding to a LMP change and is economically dispatched (see scenario 3a and the green trapezoid in scenario 4a), the ISO proposes no change to the current policy to continue to apply the metric to both residual imbalance energy and optimal energy. This treats the economically bidding variable energy resource similarly to an economically bidding conventional generator.

Self-scheduled variable energy resources are similarly situated to economically bidding variable energy resources responding to a forecast change. Therefore, the ISO proposes to also remove the metric for residual imbalance energy but retain it for optimal energy (applied to the bid cost).

Table 4
Application of the persistent deviation metric for variable energy resources

VER type	Current	Proposed
Economically bidding – responding to forecast only (see RIE in scenario 2b) and simultaneous forecast and LMP change (see RIE in blue triangle in scenario 4a)	Apply PDM to OE and RIE	RIE – remove PDM OE – continue to apply
Economically bidding – responding to LMP change only (see RIE in scenario 3a and RIE in green trapezoid in scenario 4a)		Continue to apply PDM to OE and RIE
Self-schedule (see RIE in scenario 1)		RIE – remove PDM OE – continue to apply

The ISO does not propose any change to the actual persistent deviation metric calculation. This may be a later initiative to consider whether the current 10 percent bandwidth should be increased for variable energy resources. For now, the metric will be calculated in the same manner. For example, the ramp rate used for a self-scheduled resource will still be the implied ramp rate from forecasts. For an economically bidding resource, the ramp rate will be the ramp rate registered in the Master File.

The ISO will develop additional details during implementation. Generally, the ISO may "flag" the residual imbalance energy so that the persistent deviation metric will only be applied to economically bidding residual imbalance energy when responding to an LMP change. For example, this type of residual imbalance energy may be flagged as "economic responding" whereas response to a forecast change may be flagged as "forecast change." Such a system can be useful to market participants to track settlements.

When there is both types of residual imbalance energy within the same interval, the persistent deviation metric will be calculated for the entire interval but if triggered, will only be applied to the energy flagged as "economic responding." The ISO believes that this will appropriately account for the ramp rates.

Stakeholders have also requested that the actual reference hour that residual imbalance energy is driven by be made known. The ISO will endeavor to publish this information in the appropriate system (*e.g.,* CMRI*).*

9. Default energy bids

The ISO requires default energy bids for resources in case of local market power mitigation. In addition the persistent deviation metric will evaluate a resource's default energy bid in case it is triggered. The ISO adjusts the bid basis for real-time bid cost recovery and residual imbalance energy as follows:

Incremental energy: the minimum of the (a) default energy bid cost, (b) the bid price, or (c) the LMP

Decremental energy: the maximum of the (a) default energy bid cost, (b) the bid price, or (c) the LMP

The ISO has found that many variable energy resources have not supplied default energy bids. The ISO tariff Section 39.7.1 allows for three methodologies: 1) variable cost option, 2) negotiated rate option, or 3) LMP option. If no cost is submitted and approved then the variable cost option will be the default.

For resources that select the LMP option, the current tariff rules provided in Section 39.7.1.2 require that the ISO calculate the weighted average of the lowest quartile of LMPs at the generating unit PNode in periods when the unit was dispatched during the preceding ninety (90) day period for which LMPs that have passed the price validation and correction process. This is further subject to a feasibility test to determine whether there are a sufficient number of data points to allow for the calculation of an LMP-based default energy bid.

The ISO proposes to use the variable cost option for variable energy resources applying for an LMP-based default energy bid until such a bid can be calculated.

10. Day-ahead metered energy adjustment factor

This issue was not discussed in the market issues technical bulletin and is applicable to all generators, not just variable energy resources.

This section describes two scenarios that were not considered when developing the day-ahead metered energy adjustment factor scenarios. The formula for the factor is calculated as the minimum of: (1) the number one (1); or (2) the absolute value of the ratio of the resource's (a) Metered Energy less the Day-Ahead Minimum Load Energy and less the Regulation Energy, and (b) the minimum of (i) the Expected Energy and (ii) the Day-Ahead Scheduled Energy, less the Day-Ahead Minimum Load Energy. In cases where both the denominator and numerator produced by this calculation equal zero (0), the Day-Ahead Metered Energy Adjustment Factor is set to one (1). If the denominator produced from this calculation equals zero (0), but the numerator is a non-zero number, the Day-Ahead Metered Energy Adjustment Factor is set to zero (0).

Scenario 1: Metered energy is below Pmim

When the metered energy is below Pmin, the resource is not considered "On" and eligible for bid cost recovery. However, the formula for the day-ahead metered energy adjustment factor will allow for some ratio of bid cost recovery between 0 and 1. Aside from circumstances in which the real-time market shut-down a resource, this was an oversight in the MEAF design because resources dispatched to be operating by the real-time market but that do not operate should not receive bid cost recovery for day-ahead scheduled energy not delivered

Scenario 2: Meter or total expected energy is equal to or greater than Pmin

The factor was revised to incentivize resources to follow ISO dispatch, even if this differs from the day-ahead schedule. However, when a resource is instructed to decrement to Pmin and follows dispatch (*i.e.*, the metered energy is equal or close to expected energy, which in turn equals the day-ahead minimum load energy), the current rule in the business practice manual states that any denominator of zero with a non-zero numerator will result in a day-ahead factor of zero. The policy did not contemplate the boundary scenario when dispatch equals Pmin in which the day-ahead scheduled energy is equal to the day-ahead minimum load. This results in a denominator equal to zero but potentially a non-zero numerator. The day-ahead factor is inadvertently penalizing resources for following dispatch.

CAISO proposal to address both scenarios

The CAISO proposal will address both issues by adding in additional conditions either in lieu of or before applying the main day-ahead metered adjustment factor formula. Each step of the new conditions is outlined in the table below.

The calculation proceeds only if the resource is not decommitted in real-time as the day-ahead metered energy adjustment factor is not relevant upon being shut down.

Step [1] ensures that the expected energy is at least equal to minimum load, which means there is no shut-down instruction from the CAISO. In the absence of a shut-down instruction, the formula will set the factor to zero if the meter is below Pmin (minus the tolerance band) or is Off. This addresses the inadvertent application of a factor greater than zero when the resource deviates below Pmin.

Step [2] will reset the factor to one if the difference between the metered energy and expected energy are within the tolerance band. This is not a change to the existing rules.

Step [3] will set the factor to one if the minimum of the expected energy or the day-ahead scheduled energy is equal to the day-ahead minimum load energy (within a zero tolerance, as newly defined in this process). This formula addresses the boundary condition when the minimum of the expected energy or the day-ahead scheduled energy is equal to day-ahead minimum load and the resultant factor was automatically set to zero. Note that in step [2] we already checked to see if the resource delivered at least within the performance metric tolerance band. Thus, step [3] assumes the resource is outside of this band while checking for whether or not the expected energy equals the day-ahead minimum load energy (within a small tolerance of 10^{-9}). If the resource over-delivers, the DA MEAF remains 1 because the resource has delivered at least its total expected energy. However, over-delivered amounts will be subject to the real-time performance metric, which may disqualify bid cost recovery on energy in excess of the expected energy quantity.

Step [4] will be calculated when the minimum of the metered energy or day-ahead scheduled energy is greater than the day-ahead minimum load energy outside of the zero tolerance.

Step [5] addresses participating load, which may have negative day-ahead energy.

Step	Conditions and Actions

[1]	If (Expected Energy[i] >= DA Minimum Load Energy) and Expected Energy > 0
	
	Then
	
	If ((Metered Energy – Regulation Energy < DA Minimum Load Energy –Tolerance Band) Or (Metered Energy – Regulation Energy <= 0))
	
	Then
	DA MEAF = 0

[2]	Else
	
	If (Abs (Metered Energy – Regulation Energy - Expected Energy) <= Performance Metric Tolerance)
	
	Then
	DA MEAF = 1

[3]	Else *(noting from Step 1 that Expected Energy should be >= DA Minimum Load Energy here, first test to determine if Expected Energy = DA Minimum Load Energy to avoid a divide by zero condition in the next "Else" statement below…)* If (min(Expected Energy, DA Scheduled Energy) – DA Minimum Load Energy <= Zero

	Tolerance[ii]) Then DA MEAF = 1

[4]	Else
	
	DA MEAF =
	
	$Min\left[1, Max\left(0, \left(\frac{Metered\ Energy - DA\ Minimum\ Load\ Energy - Regulation\ Energy}{\min(Expected\ Energy,\ DA\ Scheduled\ Energy) - DA\ Minimum\ Load\ Energy}\right)\right)\right]$
	
	End if
	
	End if
	
	End if

[5]	*This condition occurs after all of the other IF, Else statements from above*
	
	Else
	
	If Expected Energy >= 0
	
	Then
	
	DA MEAF = 1
	
	Else
	
	(for the case of a BCR-Eligible Resource such as a pump-storage device from which negative DA energy is expected)
	
	$DA\ MEAF\ =$
	
	$Min\left[1, Max\left(0, \frac{Metered\ \ Energy}{Expected\ \ Energy}\right)\right]$
	
	End if
	
	End if

i. The term Expected Energy, for purpose of the calculations within the above table, is defined to be the minimum of the real-time expected energy and the day-ahead expected energy.
ii. The term Zero Tolerance is a constant that equals the (very small) number 1 x 10^{-10}.

The ISO has provided a series of examples discussed during the stakeholder process and in the working group session. These examples, along with the settlement examples from scenario 2b and 4a, will be provided as active cell calculations in a separate excel spreadsheet.

11. Tariff clarifications on residual imbalance energy

Based on discussions with stakeholders during the market issues bulletin, there are certain tariff sections that were written before MRTU that could be clarified. The ISO will present the specific tariff sections during the tariff stakeholder process.

12. Next Steps

The ISO will discuss this draft final proposal with stakeholders on a conference call on May 27, 2015. Stakeholders should submit written comments by June 10, 2015 to initiativecomments@caiso.com.