California Independent
System Operator Corporation

May 25, 2016

The Honorable Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Re: California Independent System Operator Corporation
Docket No. ER16- ___-000

Tariff Amendment to Improve Settlement of Variable Energy Resources and Bid-Cost Recovery Rules

Dear Secretary Bose:

The California Independent System Operator Corporation (CAISO) submits this tariff amendment to improve its settlement rules regarding the treatment of residual imbalance energy from variable energy resources and its bid-cost recovery provisions for all resources. Specifically, the CAISO proposes to:

- Revise the current settlement rules regarding compensation for residual imbalance energy for economically bidding variable energy resources to ensure that such compensation accounts for changes in output driven by a resource's forecast, as opposed to changes in output driven by submitted bids.
- Revise the CAISO's persistent deviation metric to specify that it will not apply to residual imbalance energy produced by economically bidding variable energy resources in response to forecast changes.
- Revise the day-ahead metered energy adjustment factor to account for situations in which the CAISO instructs a generator to move to its minimum load and its metered energy is less than its minimum load.

The CAISO requests that the Commission accept the tariff revisions contained in this filing effective October 1, 2016. In order to provide sufficient time for the CAISO to complete preparation activities necessary to implement these amendments, however, the CAISO respectfully requests that the Commission issue an order by ten business days prior to the requested effective date, *i.e.,* September 19, 2016.

I. Background, Rationale and Description of Tariff Amendments

A. Settlement of Residual Imbalance Energy for Variable Energy Resources

1. Background and Description of Issue

Residual imbalance energy is a classification of energy used by the CAISO to settle the ramping energy that occurs during an interval or intervals at the start or end of a trading hour when a unit is ramping up or down to or from a dispatch in a previous or upcoming hour (which is defined as the "reference hour"). The CAISO settles residual imbalance energy based on the resource's bid (as mitigated) in the reference hour.[1] The CAISO settles residual imbalance energy in this manner because the bid as cleared in the market in the interval(s) prior or subsequent to the interval in which the generator actually produces the energy is the bid that drove that ramping energy. If the CAISO were to settle the resource based on the LMP for the interval in which the resource is producing this type of residual imbalance energy, the resource could potentially be subject to an LMP that is less than the economic bid that drove the dispatch in the first place. To avoid such bid insufficiencies, the CAISO settles such residual imbalance energy on the bid that drove the dispatch. This is only true, if the resource submitted an economic bid, i.e., a bid with a price in the prior or subsequent intervals. If the resource instead had a self-schedule in those intervals, then the CAISO settles the residual imbalance energy based on the locational marginal price (LMP) in the applicable interval.[2] The CAISO settles residual imbalance energy that is driven by a self-schedule and that driven by an economic bid differently because in the case of self-schedule energy the ramping energy from one interval to another is not driven by a specific bid in the prior or subsequent intervals. Rather it is driven by moving from one interval to another consistent with the resource's self-schedules submitted to the market, which indicate that the resource will be compensated as a price taker. These rules apply to both conventional and variable energy resources.

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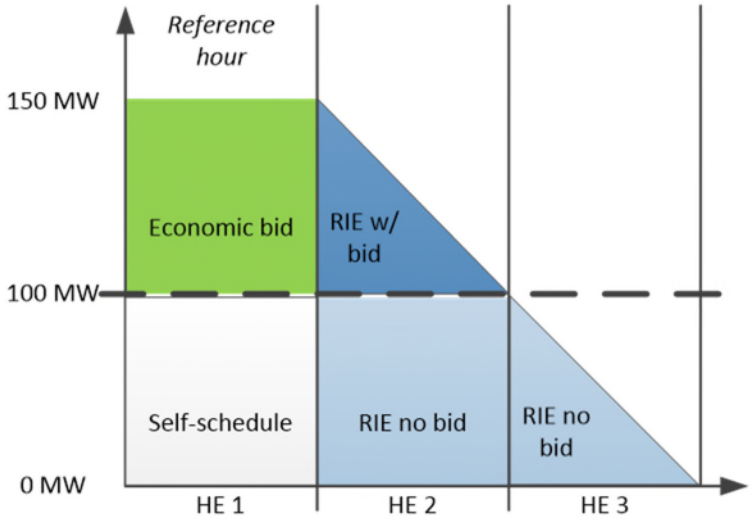
1 *See* CAISO Tariff, Appendix A, definition of "Residual Imbalance Energy," Section 11.5.5.

2 See CAISO Tariff, Section 34.17.5 (specifying that resources without energy bids will be settled based

Figure 1 below demonstrates how these rules operate in practice. This example shows the 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 settled at the bid price in HE 1, and the portion ramping down from a self-schedule portion is classified as residual imbalance energy without a bid, and is settled at the LMP in HE 2 and HE 3.

Figure 1
Residual imbalance energy settlement



On March 20, 2015, the CAISO published a market issues bulletin describing corrections regarding the ramp rates used by the CAISO to calculate the persistent deviation metric. The technical bulletin described an issue the CAISO has detected in how it treated ramp rates for self-scheduled variable energy resources. The CAISO noted that when variable energy resources have not submitted economic bids, the CAISO has dispatched and ramped them based on their energy forecasts, rather than their ramp rate specified in the Master File. However, the CAISO discovered that it had erroneously determined whether a resource had triggered the persistent deviation metric under such circumstances using the ramp rate from the Master File. Therefore, the CAISO stated that it would re-calculate the persistent deviation metric when these circumstances had occurred.[3]

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[3] Available at:

Because these corrections were aimed at ensuring the correct application of the existing persistent deviation metric tariff provisions, no tariff modifications were required. However, during discussions surrounding the release of this bulletin, the CAISO concluded that its current tariff rules governing the settlement of residual imbalance energy should also be modified with respect to the treatment of variable energy resources. Specifically, as explained below, the current provisions do not appropriately treat situations in which a variable energy resource is ramping due to a change in its forecasted energy output[4] versus situations in which a variable energy resource is dispatched based on the resource's bid price. Under the current provisions, whenever a variable energy resource has an economic bid in the reference hour, any residual imbalance energy produced is settled based on that economic bid, even if the residual imbalance energy results from a change in the resource's forecast. The CAISO therefore now proposes to amend the tariff provisions relating to the calculation of residual imbalance energy so that residual imbalance energy produced by a variable energy resource is settled based on its economic bid, when the residual imbalance energy is produced as a result of a dispatch based on that bid, or the LMP, when the resource is dispatched based on a change in its forecasted output.

The need for revisions to the current residual imbalance energy calculation methodology can best be understood by examining the four main scenarios in which the difference between dispatches based on bids versus forecasts can manifest. These scenarios are displayed in Table 1 below. Scenario 1 relates to self-scheduled resources, and scenarios 2 through 4 involve resources that submit economic bids. Scenarios 2 through 4 each involve two variations where one variation shows an increase and the other shows a decrease in the LMP, the forecast, or both. As shown in the "proposed solution" column and discussed below, the CAISO identified two scenario variations in which applying the current residual imbalance energy rules is problematic.

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

[4] The CAISO forecasts the output of variable energy resources that are eligible to participate in the CAISO's market as intermittent resources, which are referred to in the CAISO's tariff as "Eligible Intermittent Resources." *See* CAISO Tariff, Appendix Q, Article 4.

Table 1
Residual imbalance 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 2b involves a variable energy resource with an economic bid that the CAISO dispatches down based on a decrease in the resource's forecasted output, even though the LMP does not change. Under its current settlement rules, the CAISO settles any residual imbalance energy resulting from the dispatch down based on the submitted economic bid. The problem with this result is that the bid did not drive the dispatch down and led to the residual imbalance energy. Rather, the dispatch down, and the resulting residual imbalance energy, was caused by the reduction in the resource's forecasted output. Settling the resulting imbalance energy in this manner is inconsistent with the intended purpose of the residual imbalance energy settlement, which is to price residual imbalance based on the bid that led to the residual imbalance energy from the interval in which the resource was dispatched. Or, if there is no economic bid, based on the LMP.

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

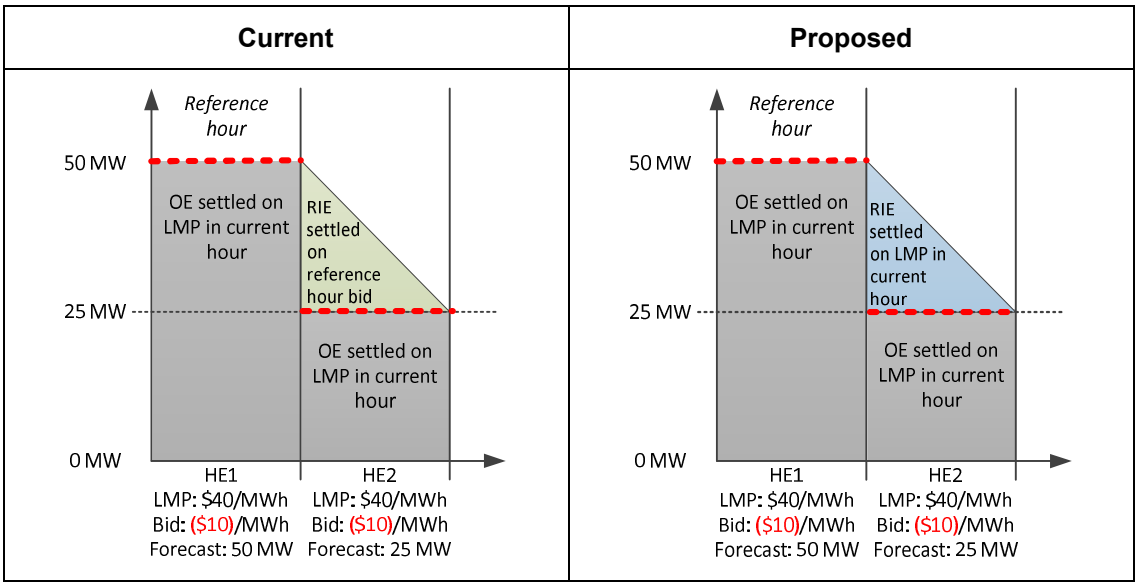
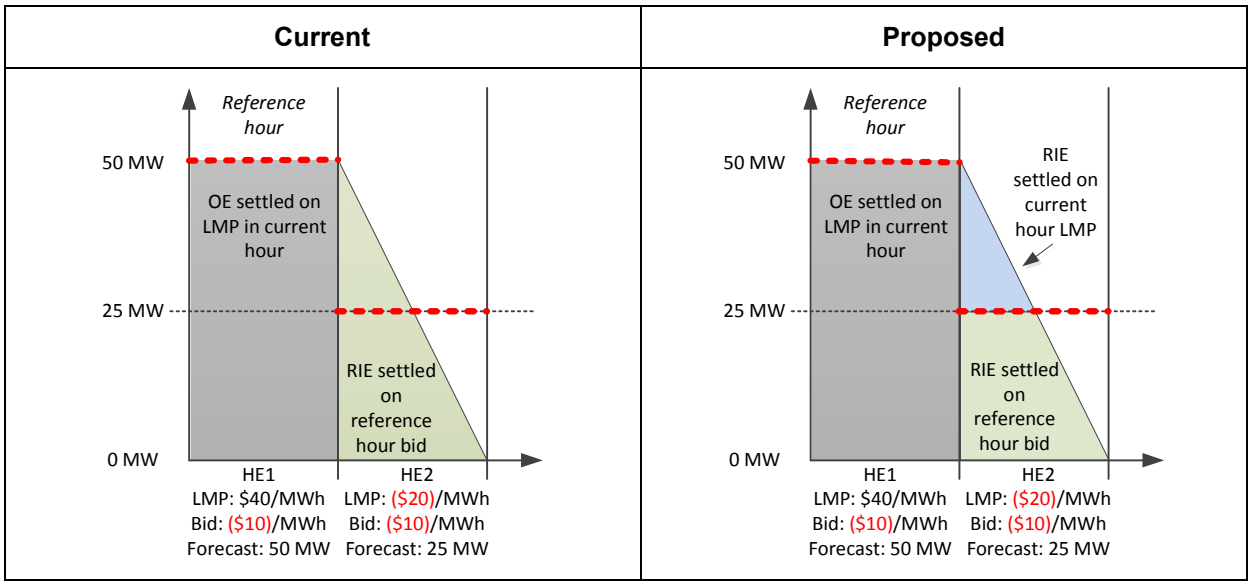


Figure 2 above shows this scenario and compares the difference between applying the CAISO's current settlement rules for residual imbalance energy and the amended rules proposed in this filing (as described in Section I.A.2 below). In this example, although the resource has submitted an economic bid of negative $10/MWh in HE1, the CAISO dispatches it in HE2 not as a result of that bid, but rather because of a decrease in the resource's forecasted output from 50 MW to 25 MW (shown by the dotted red line). The forecast output for an economically bidding variable energy resource constitutes its upper operational and economic limit, analogous to the full operational range (Pmin to Pmax) of a conventional resource. Therefore, the CAISO market optimization will not dispatch a variable resource above its forecasted output, and when the resource's forecasted output decreases, the CAISO treats that decrease similar to a Pmax derate of a conventional resource.

Under the CAISO's current rules, the residual imbalance energy resulting from the ramping down from HE1 to HE2 would be paid based on the negative $10/MWh, even though the residual imbalance energy resulted from a change in the resource's forecasted output, rather than its bid being selected by the market clearing process. In other words, even though the unit is dispatched due to a change in its forecast rather than its economic bid, it will be effectively charged (-$250/MWh) for the residual imbalance energy produced as a result of that dispatch. The CAISO believes that this outcome is inappropriate. As explained above, under the CAISO tariff, when a unit without a bid is dispatched up or down, such as a conventional generator that has been derated from its PMax, any resulting residual imbalance energy is settled based on the LMP in the

reference hour. For a conventional generator, ramping energy associated with a derate is classified as derate energy and is paid at the applicable LMP in the given interval and does not receive bid cost recovery.[5] Because a variable energy resource dispatched as a result of its forecast, rather than its economic bid, is analogous to a derated conventional unit the CAISO proposes to settle the portion of residual imbalance energy above the forecasted amount in the same manner as it settles ramping energy resulting from the derate of a conventional generator: based on the LMP in the applicable hour ($40/MWh). This is shown in the illustration on the right of Figure 2.[6] The CAISO proposes to treat ramping energy resulting from a downward forecast change the same as the derated energy because in both instances the ramping energy across the optimal hour is driven by the derate or forecast change and not a bid in the prior or subsequent interval cleared in the market.

Figure 3
Scenario 4a: Economic bidder and LMP less than bid and forecast decrease



The other scenario involving a problematic outcome is Scenario 4a from Table 1. This scenario involves a variable energy resource with an economic bid in which the LMP is lower than the bid in the relevant hour *and* a decrease in its forecasted output. In this scenario, the residual imbalance energy results from both the decrease in LMP (below that of the bid) and the forecast, but under the

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5 *See* CAISO Tariff Sections 11.5.1.1, 11.8.4.1.5, definitions for FMM Derate Energy and RTD Derate Energy.

6 A mathematical accounting showing the difference in revenue in this example between application of the current and amended settlement rules is set forth in Figure 5 on page 13 of the CAISO's final proposal, included as Attachment C to this filing.

CAISO's current rules the entire amount of residual imbalance energy is settled based on the economic bid in the reference hour, *i.e.,* as if the change in LMP relative to the bid price was the only driver. As with scenario 2b above, the CAISO proposes to settle the amount of residual imbalance energy resulting from the change in forecasted output based on the LMP, similar to energy resulting from the derate of a conventional resource. As explained above, this is appropriate because the residual imbalance energy resulting from a change in forecast of a variable energy resource is analogous to residual imbalance energy produced as a result of a derate of a conventional generator, which is settled based on the LMP. However, the CAISO proposes to continue to settle the portion of the residual imbalance energy that is less than or equal to the forecasted energy based on the submitted bid price, because this portion of the residual imbalance energy results not from the change in forecasted output, but rather due to the difference between the LMP and the unit's economic bid.

This scenario is illustrated in Figure 3 above, which compares the difference between the current and proposed settlement methodologies for an economic bid dispatched in HE2 pursuant to both a decrease in the LMP below the resource's bid price and a decrease in the forecast. The LMP in this example is negative $20/MWh in HE2, compared to a bid of negative $10/MWh. The forecast in this example decreases from 50 MW to 25 MW from HE1 to HE2 (shown by the dotted red line). As with scenario 2b above, the CAISO's current rules provide that the CAISO will settle all of the residual imbalance energy produced in HE2 based on the bid price of negative $10/MWh bid (shown in green on the left). For the reasons described above, the ISO proposes to settle the portion of residual imbalance energy above the resource's forecasted output based on the LMP in HE2. The CAISO will continue to settle the portion of residual imbalance energy that is less than or equal to the resource's forecasted output for HE2 (25 MW), shown in the green trapezoid on the right, based on the resource's bid in the reference hour (HE1) of negative $10/MWh. This is the appropriate result because that portion of the residual imbalance energy does not result from a change in forecast, but rather because the resource's bid is less than the LMP. Therefore, it is just and reasonable to settle that portion of the residual imbalance energy based on the resource's bid price (as would be the case today with respect to all of the residual imbalance energy in HE2).[7]

In summary, changing the settlement rules related to imbalance energy for variable energy resources as proposed is just and reasonable because it will ensure that the compensation for residual imbalance energy is aligned with the driver of residual imbalance energy, whether it is a change in the resource's

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[7] A mathematical accounting showing the difference in revenue in this example between application of the current and amended settlement rules is set forth in Figure 5 on page 13 of the CAISO's final proposal, included as Attachment C to this filing.

forecasted output (which is analogous to the derate of a conventional resource) or a change in the LMP relative to the resource's bid price. The residual imbalance energy design is based on the principle that a resource should not be compensated less than its bid while it is ramping through or from a schedule or instruction across the trading hour, when ramping is required to achieve the CAISO's schedule or dispatch.[8]

2. Implementing Tariff Modifications

To correlate the cause of residual imbalance energy and the basis of payment, as discussed above, the CAISO proposes to modify section 11.5.5 of the Tariff (Settlement Amount for Residual Imbalance Energy). Specifically, the CAISO proposes to add language as part of a new subsection stating that any portion of the resource's residual imbalance energy that is greater than its forecasted output for a particular settlement interval will be the product of the MWh of residual imbalance energy above the resource's forecasted output for that Settlement Interval and the applicable LMP (or MSS price, for resources settled as metered subsystems). This addition will ensure that residual imbalance energy that is the product of a change in a resource's forecasted output will be correctly settled based on the LMP, rather than the unit's bid.

Also, to improve the clarity of section 11.5.5, the CAISO proposes to divide it into three separate subsections, with the new language just discussed residing in section 11.5.5.2.

B. Application of Persistent Deviation Metric to Variable Energy Resources

1. Background and Description of Issue

As part of its bid cost recovery mitigation initiative,[9] the CAISO developed various measures to eliminate incentives to inflate bid cost recovery payments

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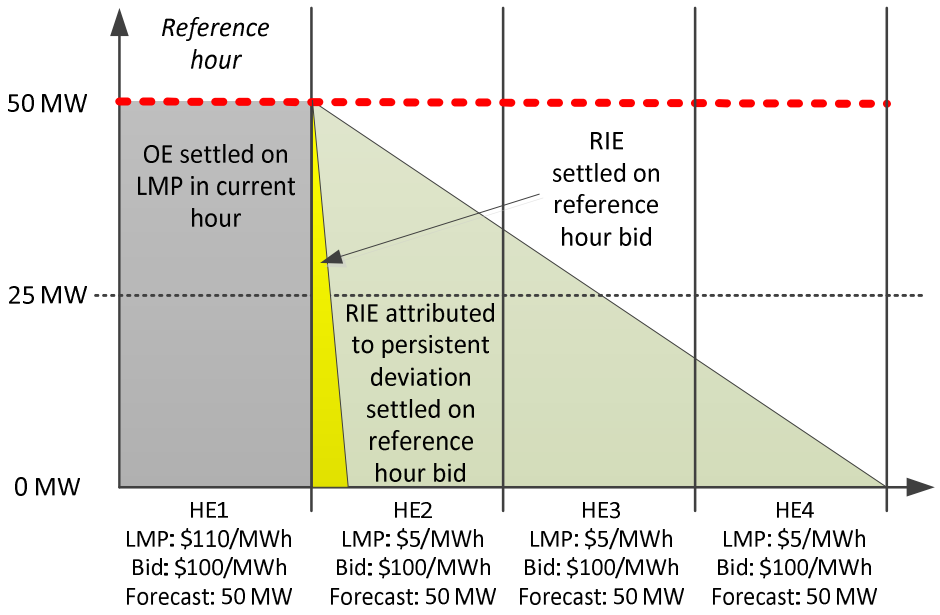
[8] Section 11.5.5 of the CAISO Tariff containing the residual imbalance energy settlement provisions was accepted by the Commission on September 21, 2006. *California Indep. Sys. Operator Corp*., 116 FERC ¶ 61,274 (2006). Subsequently, in response to a compliance filing unrelated to the payment of residual imbalance energy, an intervenor challenged the ISO's exclusion of residual imbalance energy from the bid cost recovery process. The ISO explained that the exclusion was appropriate given that the ISO paid a resource based on its bid, which obviated the need for bid cost recovery. *California Indep. Sys. Operator Corp*., 123 FERC ¶ 61,285 (2008). See also *California Indep. Sys. Operator Corp*., 145 FERC ¶ 61,254 (2013) (noting the principle that resources should receive bid cost recovery only "for energy delivered in response to a CAISO dispatch instruction" including residual imbalance energy).

[9] *See* Tariff Amendment, Docket No. ER13-2452-000 (filed September 25, 2013).

through adverse strategic market behavior. A key element of this initiative was the persistent deviation metric, which evaluates whether a resource is deviating from its dispatch in order to inflate real-time bid cost recovery or residual imbalance energy payments. Bid cost recovery is the mechanism by which the CAISO ensures resources recover at least their start-up, minimum load, and bid costs when scheduled or dispatched through the CAISO markets, to the extent such costs are not recovered through their market revenues.[10] There is no bid cost recovery for a resource's self-schedule because such resources do not have a bid. If triggered, the persistent deviation metric mitigates a resource's bid energy bid costs that are used for bid cost recovery purposes or settlement of residual imbalance energy for that resource. The persistent deviation metric evaluates each 5-minute interval based on threshold criterion described in tariff section 11.17.1.1.

Figure 4 provides an example of applying the persistent deviation metric to a variable energy resource:

Figure 4



In this example, the resource is dispatched down based on the decrease in the LMP, rather than due to a change in the resource's forecast, which remains constant. However, the resource deviates to capture the higher residual imbalance energy payment based on its bid of $100/MWh rather than the lower LMP of $5/MWh starting in the second hour. The yellow triangle represents the

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10 *See* Section 11.8 of the CAISO Tariff.

dispatch of the resource based on its ramp rate, and the larger green triangle is the deviation based on the resource's actual output. Absent the persistent deviation metric, the output represented by both the yellow and green triangles would be paid based on the resource's bid during the reference hour (HE1).

Similarly, a resource may deviate from a dispatch to inflate bid cost recovery. 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 resulting in a total revenue of $300/MWh. Because the revenue minus the cost is a positive number, the resource receives no bid cost recovery.

In the real-time, the resource deviates from the 100 MW forecast and only generates 10 MW 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 per hour). 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 per hour. Under the bid cost recovery calculation, the negative $450 per hour revenue minus the positive cost of $90 per hour results in a total negative revenue of $540 per hour, which is then eligible for a bid cost recovery uplift because the resource failed to recover its costs.

Some CAISO stakeholders expressed a concern that for variable energy resources, forecast errors may inadvertently trigger the persistent deviation metric. 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 utilized by the fifteen minute and five minute markets.

The CAISO anticipates that as it gains experience with economically bidding variable energy resources, it will be able to understand better the relative impacts of each of these factors (and potentially others). In the meantime, some stakeholders proposed that the CAISO exempt variable energy resources from the persistent deviation metric under all circumstances. However, because resources, including variable resources, can inflate their bid cost recovery and residual imbalance payments, it is inappropriate to adopt an across the board exemption. A more targeted and reasonable approach is to not apply the persistent deviation metric to residual imbalance energy produced by variable energy resources in response to changes in their forecasted output. This strikes a reasonable balance between addressing the potential for inflating bid cost recovery and residual imbalance energy payments, as illustrated in the examples above, and minimizing the possibility of over-applying the persistent deviation metric when a resource produces residual imbalance energy as a result of a

forecast change.[11] This would apply both to situations in which the residual imbalance energy is solely the product of a forecast change, as well as to situations in which residual imbalance energy is the product of both a change in forecast as well as a change in the LMP relative to the resource's bid (as in Figure 3 above). Because the resource's forecast is driving the change in both situations and because the CAISO is proposing herein to settle the resulting residual imbalance energy based on the LMP, exempting these situations from application of the persistent deviation metric carries a relatively low risk of resources receiving overinflated residual imbalance energy payments.

On the other hand, if a variable energy resource that has submitted a bid is economically dispatched based solely on a change in the LMP relative to its bid, the CAISO proposes no change to its current policy and will continue to apply the persistent deviation metric to the resulting residual imbalance energy. Under these circumstances, a variable energy resource's dispatch is functionally no different than a conventional resource's dispatch, and therefore, it is just and reasonable to continue to treat both types of resources similarly with respect to application of the persistent deviation metric. This ensures there is no unduly preferential or discriminatory treatment among resources.[12]

An economically bidding variable energy resource responding to changes to its forecast are similarly situated to a self-scheduled resource responding to a forecast change. Therefore, the CAISO also proposes to no longer apply the persistent deviation metric for residual imbalance energy produced variable energy resources in response to changes in its forecasted output, regardless of whether the resource is economically bid-in or self-scheduled.

Finally, it is important to note that the CAISO does not propose any change to the underlying persistent deviation metric calculation. The current proposal only affects how the CAISO applies the persistent deviation metric.

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[11] The CAISO does not propose any change with respect to the application of the persistent deviation metric to optimal energy produced by variable energy resources under these circumstances.

[12] The Commission has recognized the need for measures to protect against the ability of resources to inflate residual imbalance energy payments by persistently deviating from CAISO dispatches. See *California Indep. Sys. Operator Corp*., 141 FERC ¶ 61,069 (2012) (finding that the opportunity for resources to inflate residual imbalance energy payments justified the CAISO settling such payments at a price similar to the mitigated exceptional dispatch payment); *California Indep. Sys. Operator Corp*., 145 FERC ¶ 61,254 (2013) (finding a need for a measure to reduce opportunities to earn inflated residual imbalance energy payments through persistent deviation from CAISO dispatches, and concluding that the CAISO's proposed persistent deviation metric is a just and reasonable measure to discourage such opportunities).

2. Implementing Tariff Modifications

To implement this proposal, the CAISO has added a new tariff section, 11.17.3, entitled "Application of Persistent Deviation Metric to Eligible Intermittent Resources Residual Imbalance Energy." This section specifies that the persistent deviation metric will not apply to settlement amounts defined in Section 11.5.5.2, which as explained in the prior section, consist of any portion of an eligible intermittent resource's residual imbalance energy that is greater than its forecasted output during a particular settlement interval. In other words, to the extent that residual imbalance energy is the product of a resource's change in forecasted output, that residual imbalance energy will not be subject to the persistent deviation metric.

C. Metered Energy Adjustment Factor

1. Background and Description of Issue

The CAISO's bid cost recovery provisions include a metered energy adjustment factor to align day-ahead bid cost recovery payments with actual energy produced by a resource. Applying this factor scales a resource's bid cost recovery payments to the extent the resource operates below its day-ahead schedule. The formula for the factor is calculated as the minimum of: (1) the number one; or (2) the absolute value of the ratio of the resource's (a) metered energy less any day-ahead minimum load energy[13] and regulation energy and (b) the minimum of (i) the expected energy[14] and (ii) day-ahead scheduled energy, less the day-ahead minimum load energy. Where both the denominator and numerator produced by this calculation equal zero, the adjustment factor is set to one, meaning that the resource receives its full bid cost recovery uplift for the relevant interval. If the calculation produces a denominator of zero, but the numerator is a non-zero number, the adjustment factor is set to zero, meaning that the resource will not receive any uplift for that interval.

The CAISO has determined that there are two scenarios where applying the current formula leads to inappropriate results. The first scenario involves situations where a resource's metered energy is less than its minimum load.

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[13] Day-ahead minimum load energy is any day-ahead scheduled energy less than a resource's registered minimum load, which applies to generating units with non-zero minimum load. Day-ahead scheduled energy is energy produced in an hour that corresponds to the flat portions of a resource's hourly day-ahead schedule. It includes day-ahead minimum load energy as well as energy self-scheduled in the day-ahead market and energy that is awarded a bid in the day-ahead market.

[14] Expected energy is energy that is expected to be generated or consumed by a resource, based on the dispatch of that resource, as calculated by the CAISO's real-time market.

Under these circumstances, the resource is not considered "On" and therefore is not eligible for bid cost recovery. However, the current formula for the day-ahead metered energy adjustment factor will nevertheless allow for some ratio of bid cost recovery between 0 and 1. For instance, assume a resource's expected energy is 20MW, its day-ahead scheduled energy is 25 MW and its day-ahead minimum load energy is 10 MW while its metered energy is 5 MW and its regulation energy is zero. Under the existing formula, the metered energy adjustment factor would be calculated as:

> absolute value of the minimum of {(1, (5 MW – 10 MW) } / (minimum of {20 MW, 25 MW } – 10 MW) = absolute value of (-5 MW / 10 MW) = .5

Aside from circumstances in which the real-time market shut-down a resource that was scheduled in the day-ahead market, this result represents an oversight in the design of the adjustment factor because resources dispatched by the real-time market that do not operate should not receive bid cost recovery for energy they did not deliver.

The second scenario is where metered or expected energy is equal to or greater than a resource's minimum load. In the bid cost recovery mitigation initiative, the CAISO revised the metered energy adjustment factor in order to incentivize resources to follow CAISO dispatches, even if they differ from the day-ahead schedule.[15] However, when the CAISO instructs a resource to decrement to its minimum load and the resource follows this dispatch, the CAISO's current rule results in a metered energy adjustment factor of zero (*i.e*. no uplift) because any denominator of zero with a non-zero numerator automatically results in a day-ahead factor of zero. The policy did not contemplate a scenario in which the CAISO dispatches a resource at its minimum load and the resource's day-ahead scheduled energy is equal to its day-ahead minimum load.

For example, assume a resource's expected energy is 10 MW, its day-ahead scheduled energy is 25 MW, and its day-ahead minimum load energy is 10 MW while its metered energy is 20 MW and its regulation energy is zero. Under the existing formula the metered energy adjustment factor would be calculated as zero, because (as stated earlier) the numerator of the metered energy adjustment factor would be nonzero, while the associated denominator would equal zero. As a result, the current rule inadvertently penalizes this resource, and other resources in this type of scenario, for following the CAISO's dispatches.

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15 *See supra* note 7.

2. Proposed Tariff Changes

The CAISO proposes to address both issues identified above by including additional conditions either in lieu of or before applying the main day-ahead metered adjustment factor formula. To improve readability and add clarity, the CAISO proposes to remove the description of the formula from the definition of metered energy adjustment factor in Appendix A and instead reflect it in a new tariff subsection (11.8.2.5.1). With these changes, section 11.8.2.5 will now reflect rules for both calculating and applying the metered energy adjustment factor.

The CAISO proposes to structure section 11.8.2.5.1 as a series of discrete calculation steps, reflecting both new steps to address the scenarios described in this section and steps that reflect the existing formula. Specifically, steps 1 and 2 address the first scenario by ensuring that the adjustment factor will be set to zero if the resource's metered energy is less than its minimum load or it is in an "off" state.[16] Step 4 addresses the second scenario, *i.e*., when the minimum of a resource's expected energy or day-ahead scheduled energy is equal to its day-ahead minimum load and the resultant factor was automatically set to zero. Step 4 assumes that a resource is outside of the relevant performance tolerance band (per step 3) while checking whether or not the expected energy equals the day-ahead minimum load energy (within a very small tolerance of 10^{-9}). If the resource delivers energy in excess of this amount, the adjustment factor remains set at one because the resource has at least delivered its effective day-ahead scheduled energy.

The CAISO also proposes to add language to the last step of the formula (step 7) to account for the fact that participating load pumped-storage hydro units and pumping load scheduled to pump in the day-ahead market may, under certain circumstances, have negative day-ahead energy and still be eligible to receive a bid cost recovery uplift. These rules are necessary to account for scenarios in which the CAISO's real-time dispatches switch such resource between pumping and generating modes relative to the mode scheduled in the day-ahead.

Finally, the CAISO is proposing to add language to Section 11.8.2.5 to clarify that it will not apply the metered energy adjustment factor to non-generator

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16 The CAISO is proposing to add a new defined term "Effective Day-Ahead Scheduled Energy" which is the minimum of Expected Energy and Day-Ahead Scheduled Energy. This avoids the need to repeat this formula in each step of this calculation, thereby making the tariff section more easily readable.

resources.[17] The origin of this clarification is a request made by a stakeholder to add language relating to the calculation of metered energy adjustment factor for non-generator resources. In order to do so, the CAISO would need to develop new rules and implementing tariff language, which goes beyond the scope of this filing. The CAISO, however, does plan to consider this issue in a subsequent stakeholder process relating to the treatment of non-generator resources. Alternatively, the stakeholder asked that in the event that the CAISO does not agree to make its requested changes that the CAISO state explicitly that the non-generator day-ahead metered energy adjustment factor does not apply to non-generator resources. After further consideration, the CAISO agrees that it would be helpful to clarify that the metered energy adjustment factor will not apply to non-generator resources.[18]

II. Stakeholder Process

The CAISO conducted a stakeholder process that involved issuing both straw and final proposals and providing stakeholders with an opportunity for comment on each. The feedback on the CAISO's proposal was generally supportive. No stakeholders opposed the changes to the metered energy adjustment factor. Also, most stakeholders supported the changes relating to settling residual imbalance energy from variable energy resources. One stakeholder recommended that instead of revising the existing rules, the CAISO should develop new energy types specifically for variable energy resources due to their unique operating characteristics. The CAISO believes that the approach proposed herein is the most suitable because it allows the CAISO to utilize its existing settlement design and promptly, cost-effectively, and adequately address the concerns identified with respect to settling variable energy resources. It is not necessary nor reasonable to require a wholesale change of the CAISO's settlement rules in order to adopt this enhancement.

The CAISO also provided draft tariff language for stakeholder review and comment, and based on feedback from stakeholders made several improvements to the tariff language.

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[17] Non-Generator Resources are defined in the CAISO tariff as resources that operate as either generation or load and that can be dispatched to any operating level within their entire capacity range but are also constrained by a MWh limit to (1) generate energy, (2) curtail the consumption of energy in the case of demand response, or (3) consume energy. CAISO Tariff, Appendix A.

[18] The CAISO will implement this in its software by simply setting the metered energy adjustment factor to "1" for all non-generator resources.

III. Effective Date and Request for Waiver of Notice Requirement

Pursuant to section 35.11 of the Commission's regulations,[19] the CAISO respectfully requests waiver of the notice requirement set forth in section 35.3(a)(1) of the regulations[20] so that the Commission will accept the tariff revisions contained in this filing effective October 1, 2016. Good cause exists to grant this waiver because the requested October 1 effective date coincides with the date of the CAISO's fall software release. In order to provide sufficient time for the CAISO to complete preparation activities necessary to implement these amendments, however, the CAISO respectfully requests that the Commission issue an order by ten business days prior to the requested effective date, *i.e.*, September 19, 2016.

IV. Communications

Correspondence and other communications regarding this filing should be directed to:

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V. Service

The CAISO has served copies of this filing on the California Public Utilities Commission, the California Energy Commission, and all parties with scheduling coordinator agreements under the CAISO tariff. In addition, the CAISO has posted a copy of the filing on the CAISO website.

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19 18 C.F.R. § 35.11.

20 18 C.F.R. § 35.3(a)(1).

VI. Contents of Filing

In addition to this transmittal letter, this filing includes the following attachments:

Attachment A	Clean CAISO tariff sheets incorporating this tariff amendment
Attachment B	Red-lined document showing the revisions contained in this tariff amendment
Attachment C	Draft Final Proposal
Attachment D	Board Memorandum (including matrix of stakeholder comments)

VII. Conclusion

For the reasons set forth in this filing, the CAISO respectfully requests that the Commission accept the tariff revisions proposed in the filing effective as of October 1, 2016, in an order issued no later than September 19, 2016.

Respectfully submitted,

/s/ Michael Kunselman

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Attachment A – Clean Tariff Records

Tariff Amendment to Improve Settlement of Variable Energy Resources and Bid-Cost Recovery Rules

California Independent System Operator Corporation

May 25, 2016

11.5.5 Settlement Amount for Residual Imbalance Energy

11.5.5.1 In General

For each Settlement Interval, Residual Imbalance Energy settlement amounts shall be the product of the MWh of Residual Imbalance Energy for that Settlement Interval and the Bid, as mitigated pursuant to Section 39.7 that led to the Residual Imbalance Energy from the relevant Dispatch Interval in which the resource was dispatched, subject to additional rules specified in this section below and in Section 11.17. The relevant Dispatch Interval and Bid that led to the Residual Imbalance Energy may occur prior or subsequent to the interval in which the relevant Residual Imbalance Energy occurs and can be contiguous, or not, with the applicable Trading Hour in which the relevant Residual Imbalance Energy Settlement Interval occurs.

11.5.5.2 Eligible Intermittent Resources

For Eligible Intermittent Resources, the Settlement Amount for any portion of the resource's Residual Imbalance Energy that is greater than its forecasted output for a particular Settlement Interval will be the product of the MWh of Residual Imbalance Energy above the resource's forecasted output for that Settlement Interval and the applicable RTD Locational Marginal Price or RTD MSS Price if the resource is MSS Net settled.

11.5.5.3 Metered Sub-Systems

For MSS Operators the Settlement for Residual Imbalance Energy is conducted in the same manner, regardless of any MSS elections (net/gross Settlement, Load following or opt-in/opt-out of RUC), except in the case of Eligible Intermittent Resources which are settled as specified in Section 11.5.5.2.

11.5.5.4 Rerated Minimum Load

When a Scheduling Coordinator increases the Minimum Load pursuant to Section 9.3.3, for the Settlement Interval(s) during which the affected resource is ramping up towards or ramping down from such a Minimum Load change, the Residual Imbalance Energy for the applicable Settlement Interval(s) will be re-classified as Derate Energy and will be paid at the applicable RTD Locational Marginal Price.

* * * *

11.8.2.5 Calculation and Application of the Day-Ahead Metered Energy Adjustment Factor to IFM Bid Costs and Market Revenues

The CAISO will adjust for each Bid Cost Recovery Eligible Resource the IFM Energy Bid Cost and IFM Market Revenue calculations by multiplying the Day-Ahead Metered Energy Adjustment Factor with the amounts derived as specified in Sections 11.8.2.1.5 and 11.8.2.2, respectively. In addition, the CAISO will apply the Real-Time Performance Metric to the IFM Energy Bid Costs, IFM Minimum Load Costs IFM Pumping Costs and IFM Market Revenues, as described in 11.8.4.4. The CAISO will not apply the Day-Ahead Metered Energy Adjustment Factor to Non-Generator Resources.

11.8.2.5.1 Calculation of Day-Ahead Metered Energy Adjustment Factor

The CAISO will calculate the Day-Ahead Metered Energy Adjustment Factor for each BCR Eligible Resource through the following steps:

a) For Generation Unit and Resource Specific System Resource scheduled by CAISO in the Day-Ahead Market

Step 1: If the resource's Effective Day-Ahead Scheduled Energy is greater than or equal to its Day-Ahead Minimum Load Energy, and is greater than zero, then the calculation will proceed to step two. Otherwise, the calculation will proceed to step six.

Step 2: If (1) the resource's Metered Energy less Regulation Energy is less than its Day-Ahead Minimum Load Energy less the Tolerance Band; or (2) the resource's Metered Energy less Regulation Energy is less than or equal to zero, then the Day-Ahead Metered Energy Adjustment Factor will be set to zero (0). Otherwise, the calculation will proceed to step three.

Step 3: If the absolute value of the result of the resource's Metered Energy less its Regulation Energy less the Effective Day-Ahead Scheduled Energy, is less than or equal to the Performance Metric Tolerance Band, then the Day-Ahead Metered Energy Adjustment Factor will be set to one (1). Otherwise, the calculation will proceed to step four.

Step 4: If the resource's Effective Day-Ahead Scheduled Energy less its Day-Ahead Minimum Load Energy is equal to zero, then the Day-Ahead Metered Energy Adjustment Factor will be set to one (1). Otherwise, the calculation will proceed to step five.

Step 5: The resource's Day-Ahead Metered Energy Adjustment Factor will be the minimum of: (A) the number one (1); or (B) the maximum of (i) the number zero (0), and (ii) the ratio of the resource's (a) Metered Energy less the Day-Ahead Minimum Load Energy and less the Regulation Energy, and (b) the Effective Day-Ahead Scheduled Energy, less the Day-Ahead Minimum Load Energy.

Step 6: If the resource's Effective Day-Ahead Scheduled Energy is less than its Day-Ahead Minimum Load Energy and if the resource's Effective Day-Ahead Scheduled Energy is greater than zero (0), then its Day-Ahead Metered Energy Adjustment Factor will be set to one (1). Otherwise, the calculation will proceed to step seven.

Step 7: If the Day-Ahead Scheduled Energy is positive and the resource's Expected Energy is less than or equal to zero, and its Metered Energy is less than or equal to zero, then its Day-Ahead Metered Energy Adjustment Factor will be set to one (1). Otherwise, its Day-Ahead Metered Energy Adjustment Factor will be set to zero (0).

b) Participating Load Pumped-Storage Hydro Units and Pumping Load scheduled by CAISO to pump in the Day-Ahead Market

Step 1: If the Day-Ahead Pumping Energy is negative and its Expected Energy is negative, then its Day-Ahead Metered Energy Adjustment Factor will be the minimum of: (A) the number one (1); or (B) the maximum of (i) the number zero (0) and (ii) the ratio of the resource's Metered Energy and its Expected Energy. Otherwise, proceed to step two.

Step 2: If the Day-Ahead Pumping Energy is negative and the resource's Expected Energy is greater than or equal to zero, and its Metered Energy is greater than or equal to zero, then its Day-Ahead Metered

Energy Adjustment Factor will be (1). Otherwise, its Day-Ahead Metered Energy Adjustment Factor will be set to zero (0).

11.8.2.5.2 Application of Day-Ahead Metered Energy Adjustment Factor

The CAISO will apply the Day-Ahead Metered Energy Adjustment Factor to the IFM Pumping Bid Costs in the same manner in which the CAISO applies the Day-ahead Metered Energy Adjustment Factor to the IFM Energy Bid Costs as specified in this Section 11.8.2.5.2 and its subsections.

11.8.2.5.2.1 If the IFM Energy Bid Costs and the IFM Market Revenues for the amounts of Day-Ahead Scheduled Energy above the Bid Cost Recovery Eligible Resource's Minimum Load are greater than or equal to zero (0), the CAISO will apply the Day-Ahead Metered Energy Adjustment Factor to the IFM Energy Bid Costs, but not the IFM Market Revenue.

11.8.2.5.2.2 If the IFM Energy Bid Costs are greater than or equal to zero (0) and the IFM Market Revenues are negative, the CAISO will apply the Day-Ahead Metered Energy Adjustment Factor to both the IFM Energy Bid Costs and IFM Market Revenues.

11.8.2.5.2.3 If the IFM Energy Bid Costs are negative and IFM Market Revenues are greater or equal to zero, the CAISO will not apply the Day-Ahead Metered Energy Adjustment Factor to IFM Energy Bid Costs or IFM Market Revenues.

11.8.2.5.2.4 If the IFM Energy Bid Costs and the IFM Market Revenues are both negative, the CAISO will apply the Day-Ahead Metered Energy Adjustment Factor to the IFM Market Revenues, but it will not apply it to the IFM Energy Bid Costs.

* * * *

11.17.3 Application of Persistent Deviation Metric to Eligible Intermittent Resources' Residual Imbalance Energy

For a Settlement Interval, the Persistent Deviation Metric does not apply to the Settlement amounts defined in Section 11.5.5.2.

* * * *

Appendix A

Master Definition Supplement

* * * *

- Day-Ahead Metered Energy Adjustment Factor

A factor calculated for the purposes of determining the portions of a Scheduling Coordinator's resource's relevant Day-Ahead Schedule to be included in the Bid Cost Recovery calculations as further specified in the CAISO Tariff based on the resource's actual performance reflected in the Metered Energy, which is calculated as set forth in Section 11.8.2.5.

* * * *

- Effective Day-Ahead Scheduled Energy

The minimum of the Expected Energy and the Day-Ahead Scheduled Energy.

* * * *

- Residual Imbalance Energy

Extra-marginal IIE produced or consumed at the start or end of a Trading Hour outside the hourly schedule-change band and not attributed to Exceptional Dispatch. Residual Imbalance Energy is due to a Dispatch Instruction in the previous Trading Hour or a Dispatch Instruction in the next Trading Hour. Residual Imbalance Energy may overlap only with Day-Ahead Scheduled Energy. Residual Imbalance Energy does not apply to Non-Dynamic System Resources (including Resource-Specific System Resources). Residual Imbalance Energy is settled as described in Section 11.5.5 and it is not included in BCR as described in Section 11.8.4.

Attachment B – Marked Tariff Records

Tariff Amendment to Improve Settlement of Variable Energy Resources and Bid-Cost Recovery Rules

California Independent System Operator Corporation

May 25, 2016

11.5.5 Settlement Amount for Residual Imbalance Energy

11.5.5.1 In General

For each Settlement Interval, Residual Imbalance Energy settlement amounts shall be the product of the MWh of Residual Imbalance Energy for that Settlement Interval and the Bid, as mitigated pursuant to Section 39.7 that led to the Residual Imbalance Energy from the relevant Dispatch Interval in which the resource was dispatched, subject to additional rules specified in this section below and in Section 11.17. The relevant Dispatch Interval and Bid that led to the Residual Imbalance Energy may occur prior or subsequent to the interval in which the relevant Residual Imbalance Energy occurs and can be contiguous, or not, with the applicable Trading Hour in which the relevant Residual Imbalance Energy Settlement Interval occurs.

11.5.5.2 Eligible Intermittent Resources

For Eligible Intermittent Resources, the Settlement Amount for any portion of the resource's Residual Imbalance Energy that is greater than its forecasted output for a particular Settlement Interval will be the product of the MWh of Residual Imbalance Energy above the resource's forecasted output for that Settlement Interval and the applicable RTD Locational Marginal Price or RTD MSS Price if the resource is MSS Net settled.

11.5.5.3 Metered Sub-Systems

For MSS Operators the Settlement for Residual Imbalance Energy is conducted in the same manner, regardless of any MSS elections (net/gross Settlement, Load following or opt-in/opt-out of RUC), except in the case of Eligible Intermittent Resources which are settled as specified in Section 11.5.5.2.

11.5.5.4 Rerated Minimum Load

When a Scheduling Coordinator increases the Minimum Load pursuant to Section 9.3.3, for the Settlement Interval(s) during which the affected resource is ramping up towards or ramping down from such a Minimum Load change, the Residual Imbalance Energy for the applicable Settlement Interval(s) will be re-classified as Derate Energy and will be paid at the applicable RTD Locational Marginal Price.

* * * *

11.8.2.5 Calculation and Application of the Day-Ahead Metered Energy Adjustment Factor to IFM Bid Costs and Market Revenues

The CAISO will adjust for each Bid Cost Recovery Eligible Resource the IFM Energy Bid Cost and IFM Market Revenue calculations by multiplying the Day-Ahead Metered Energy Adjustment Factor with the amounts derived as specified in Sections 11.8.2.1.5 and 11.8.2.2, respectively. In addition, the CAISO will apply the Real-Time Performance Metric to the IFM Energy Bid Costs, IFM Minimum Load Costs IFM Pumping Costs and IFM Market Revenues, as described in 11.8.4.4. The CAISO will not apply the Day-Ahead Metered Energy Adjustment Factor to Non-Generator Resources.

11.8.2.5.1 Calculation of Day-Ahead Metered Energy Adjustment Factor

The CAISO will calculate the Day-Ahead Metered Energy Adjustment Factor for each BCR Eligible Resource through the following steps:

a) For Generation Unit and Resource Specific System Resource scheduled by CAISO in the Day-Ahead Market

Step 1: If the resource's Effective Day-Ahead Scheduled Energy is greater than or equal to its Day-Ahead Minimum Load Energy, and is greater than zero, then the calculation will proceed to step two. Otherwise, the calculation will proceed to step six.

Step 2: If (1) the resource's Metered Energy less Regulation Energy is less than its Day-Ahead Minimum Load Energy less the Tolerance Band; or (2) the resource's Metered Energy less Regulation Energy is less than or equal to zero, then the Day-Ahead Metered Energy Adjustment Factor will be set to zero (0). Otherwise, the calculation will proceed to step three.

Step 3: If the absolute value of the result of the resource's Metered Energy less its Regulation Energy less the Effective Day-Ahead Scheduled Energy, is less than or equal to the Performance Metric Tolerance Band, then the Day-Ahead Metered Energy Adjustment Factor will be set to one (1). Otherwise, the calculation will proceed to step four.

Step 4: If the resource's Effective Day-Ahead Scheduled Energy less its Day-Ahead Minimum Load Energy is equal to zero, then the Day-Ahead Metered Energy Adjustment Factor will be set to one (1). Otherwise, the calculation will proceed to step five.

Step 5: The resource's Day-Ahead Metered Energy Adjustment Factor will be the minimum of: (A) the number one (1); or (B) the maximum of (i) the number zero (0), and (ii) the ratio of the resource's (a) Metered Energy less the Day-Ahead Minimum Load Energy and less the Regulation Energy, and (b) the Effective Day-Ahead Scheduled Energy, less the Day-Ahead Minimum Load Energy.

Step 6: If the resource's Effective Day-Ahead Scheduled Energy is less than its Day-Ahead Minimum Load Energy and ~~i~~If the resource's Effective Day-Ahead Scheduled Energy is greater than zero (0), then its Day-Ahead Metered Energy Adjustment Factor will be set to one (1). Otherwise, the calculation will proceed to step seven.

Step 7: If the Day-Ahead Scheduled Energy is positive and the resource's Expected Energy is less than or equal to zero, and its Metered Energy is less than or equal to zero, then its Day-Ahead Metered Energy Adjustment Factor will be set to one (1). Otherwise, its Day-Ahead Metered Energy Adjustment Factor will be set to zero (0).

b) Participating Load Pumped-Storage Hydro Units and Pumping Load scheduled by CAISO to pump in the Day-Ahead Market

Step 1: If the Day-Ahead Pumping Energy is negative and its Expected Energy is negative, then its Day-Ahead Metered Energy Adjustment Factor will be the minimum of: (A) the number one (1); or (B) the maximum of (i) the number zero (0) and (ii) the ratio of the resource's Metered Energy and its Expected Energy. Otherwise, proceed to step two.

Step 2: If the Day-Ahead Pumping Energy is negative and the resource's Expected Energy is greater than or equal to zero, and its Metered Energy is greater than or equal to zero, then its Day-Ahead Metered

Energy Adjustment Factor will be (1). Otherwise, its Day-Ahead Metered Energy Adjustment Factor will be set to zero (0).

11.8.2.5.2 Application of Day-Ahead Metered Energy Adjustment Factor

The CAISO will apply the Day-Ahead Metered Energy Adjustment Factor to the IFM Pumping Bid Costs in the same manner in which the CAISO applies the Day-ahead Metered Energy Adjustment Factor to the IFM Energy Bid Costs as specified in this Section 11.8.2.5.2 and its subsections.

11.8.2.5.2.1 If the IFM Energy Bid Costs and the IFM Market Revenues for the amounts of Day-Ahead Scheduled Energy above the Bid Cost Recovery Eligible Resource's Minimum Load are greater than or equal to zero (0), the CAISO will apply the Day-Ahead Metered Energy Adjustment Factor to the IFM Energy Bid Costs, but not the IFM Market Revenue.

11.8.2.5.2.2 If the IFM Energy Bid Costs are greater than or equal to zero (0) and the IFM Market Revenues are negative, the CAISO will apply the Day-Ahead Metered Energy Adjustment Factor to both the IFM Energy Bid Costs and IFM Market Revenues.

11.8.2.5.2.3 If the IFM Energy Bid Costs are negative and IFM Market Revenues are greater or equal to zero, the CAISO will not apply the Day-Ahead Metered Energy Adjustment Factor to IFM Energy Bid Costs or IFM Market Revenues.

11.8.2.5.2.4 If the IFM Energy Bid Costs and the IFM Market Revenues are both negative, the CAISO will apply the Day-Ahead Metered Energy Adjustment Factor to the IFM Market Revenues, but it will not apply it to the IFM Energy Bid Costs.

~~**11.8.2.5.5** If for any given Settlement Interval, the absolute value of the resource's Metered Energy less its Regulation Energy less the minimum of the Day-Ahead Schedule Energy and Expected Energy, is less than or equal to the Performance Metric Tolerance Band, then the CAISO will not apply the Day-Ahead Metered Energy Adjustment Factor to the IFM Energy Bid Cost or the IFM Market Revenue.~~

* * * *

11.17.3 Application of Persistent Deviation Metric to Eligible Intermittent Resources' Residual Imbalance Energy

For a Settlement Interval, the Persistent Deviation Metric does not apply to the Settlement amounts defined in Section 11.5.5.2.

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Appendix A

Master Definition Supplement

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- Day-Ahead Metered Energy Adjustment Factor

A factor calculated for the purposes of determining the portions of a Scheduling Coordinator's resource's relevant Day-Ahead Schedule to be included in the Bid Cost Recovery calculations as further specified in the CAISO Tariff based on the resource's actual performance reflected in the Metered Energy, which is calculated as set forth in Section 11.8.2.5. ~~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 will be 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 will be set to zero (0).~~

* * * *

- Effective Day-Ahead Scheduled Energy

The minimum of the Expected Energy and the Day-Ahead Scheduled Energy.

* * * *

- Residual Imbalance Energy

Extra-marginal IIE produced or consumed at the start or end of a Trading Hour outside the hourly schedule-change band and not attributed to Exceptional Dispatch. Residual Imbalance Energy is due to a Dispatch Instruction in the previous Trading Hour or a Dispatch Instruction in the next Trading Hour. Residual Imbalance Energy may overlap only with Day-Ahead Scheduled Energy. Residual Imbalance Energy does not apply to Non-Dynamic System Resources (including Resource-Specific System Resources). Residual Imbalance Energy is settled ~~as bid, based on the Real-Time Energy Bid of the reference hour,~~ as described in Section 11.5.5 and it is not included in BCR as described in Section 11.8.4.

Attachment C – Draft Final Proposal

Tariff Amendment to Improve Settlement of Variable Energy Resources and Bid-Cost Recovery Rules

California Independent System Operator Corporation

May 25, 2016

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.

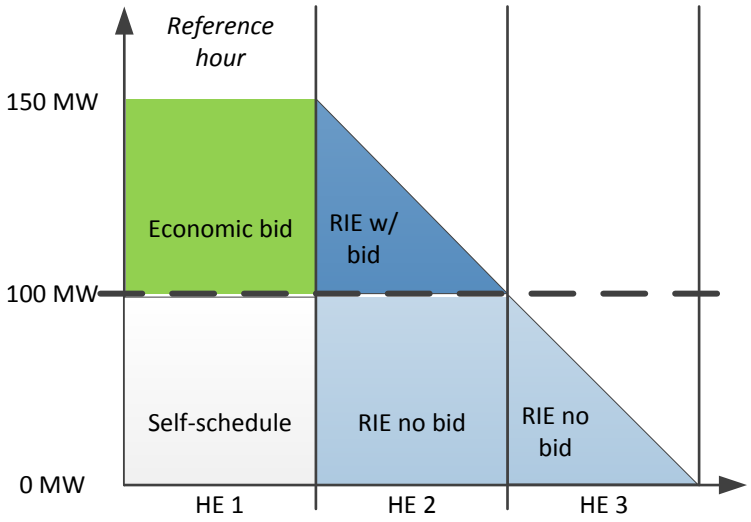
On the other hand, the ISO market will consider the best operational ramp rate of resources with an economic energy bid, whether the resource is a conventional resource or variable energy resource. The ISO market considers the best operational ramp rate as listed in the Master File when it economically 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

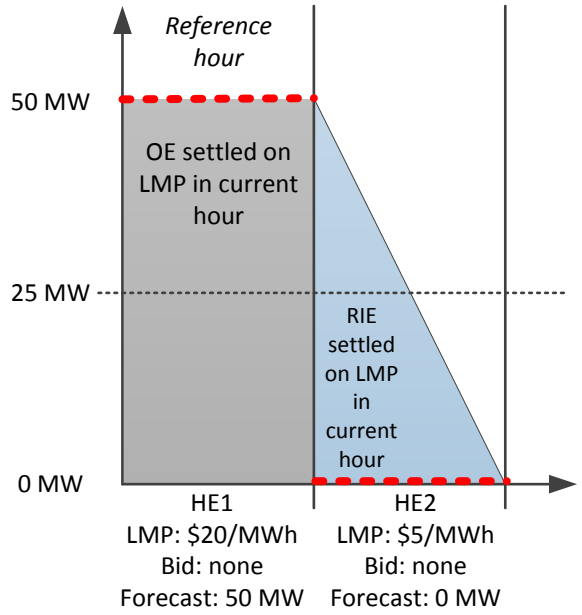
Current	Proposed
	None

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)

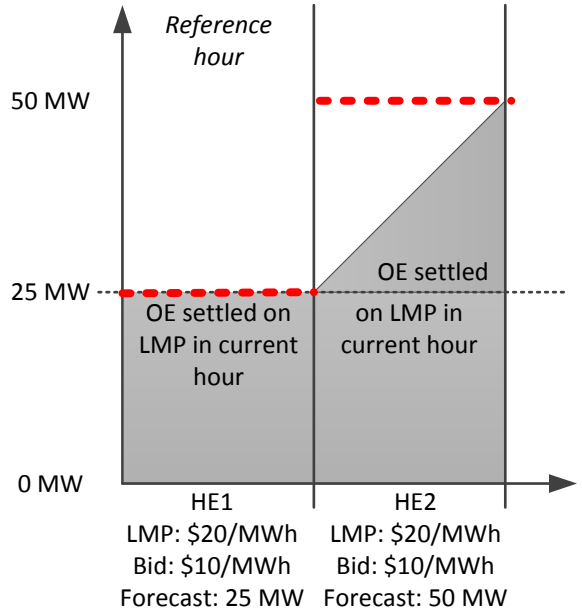
Current	Proposed
	None

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)

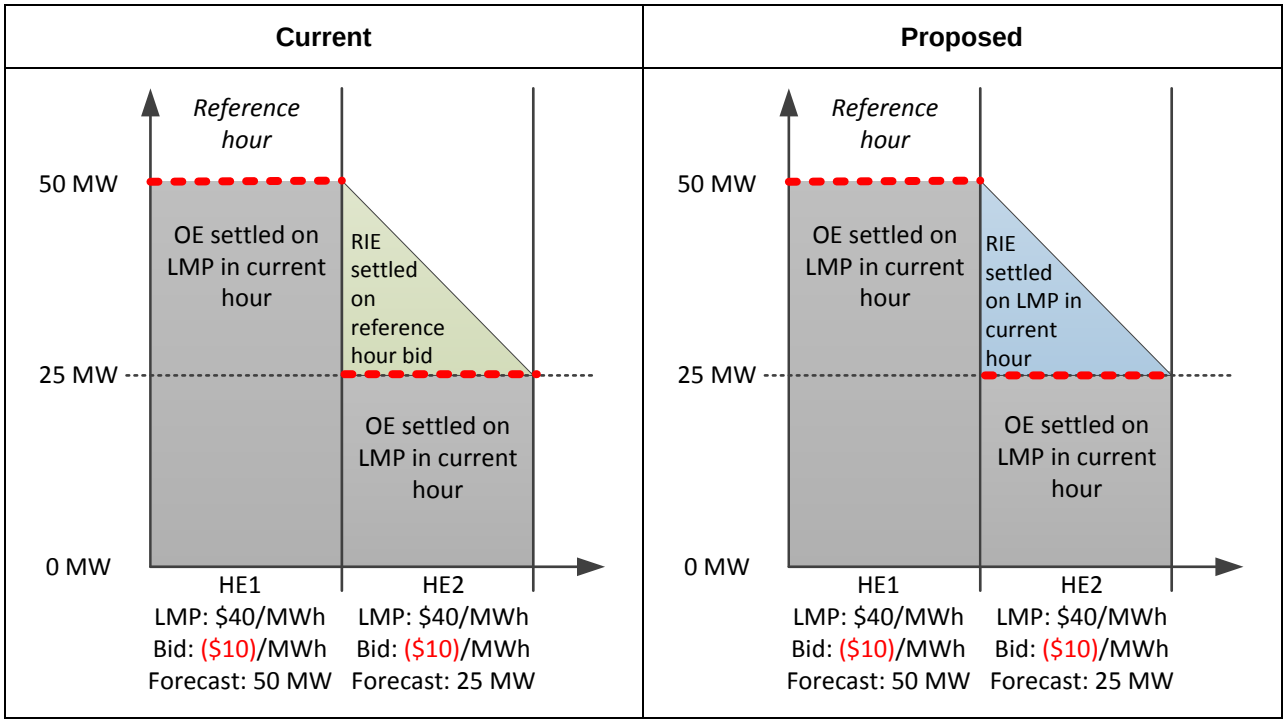


Figure 5 below shows an illustrative settlement example for hour ending 2 (HE2) for the full hour using round numbers.[5]

[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)

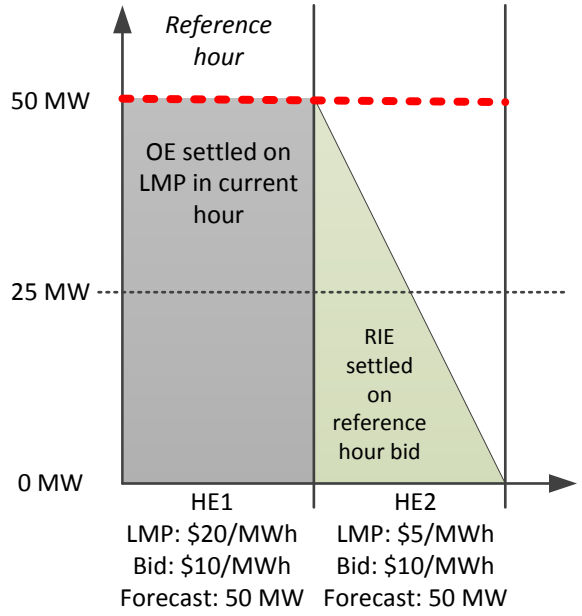
Current	Proposed
	None

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)

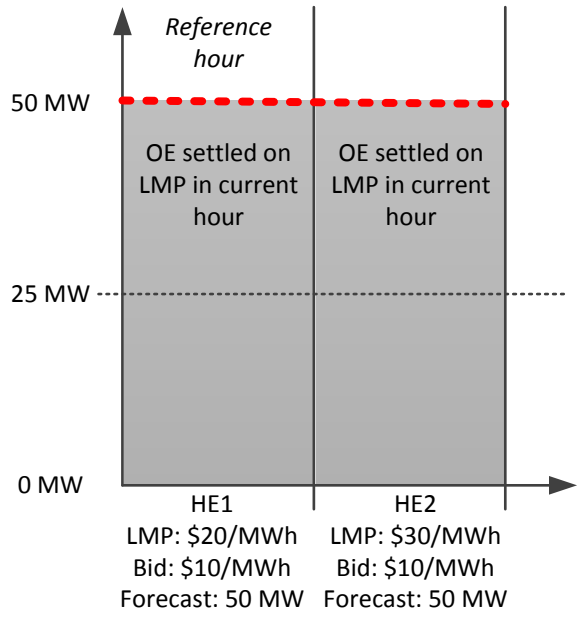
Current	Proposed
	None

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

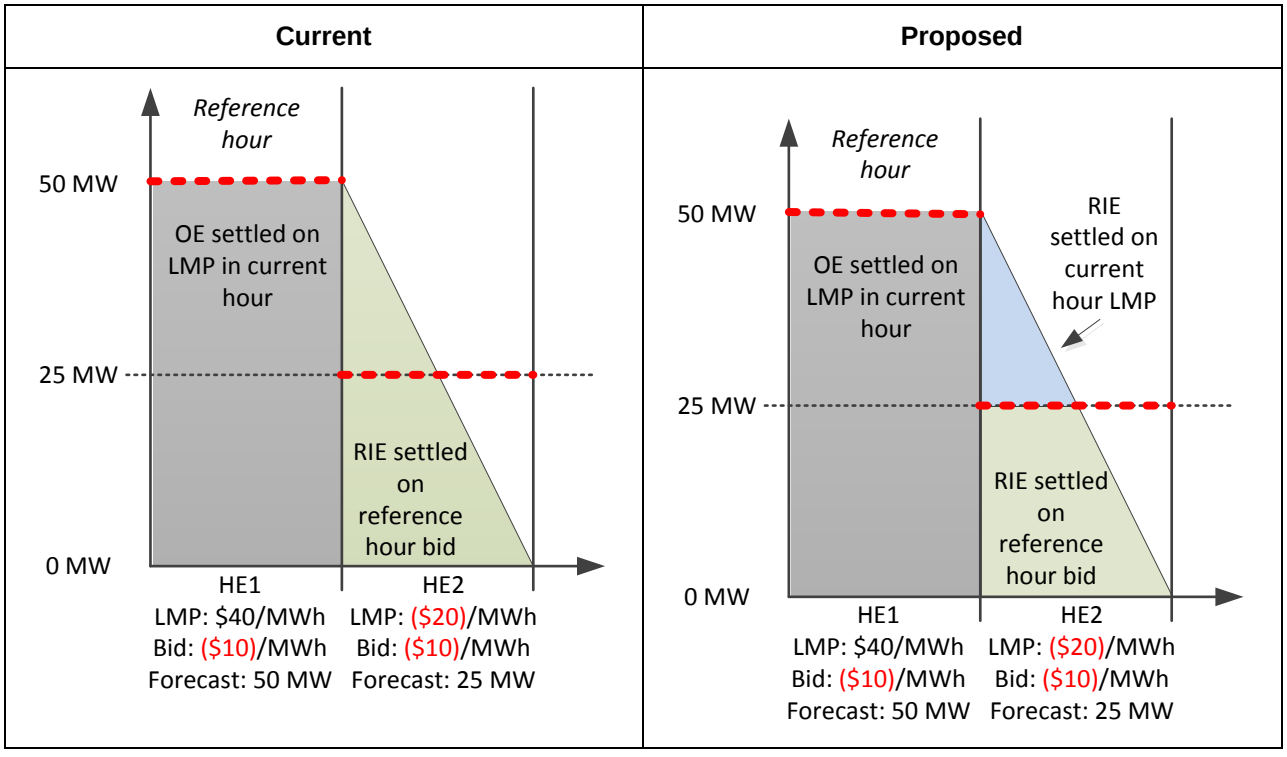


Figure 9 below shows an illustrative settlement example for the first interval of hour ending 2 (HE2) using round numbers.[7]

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.

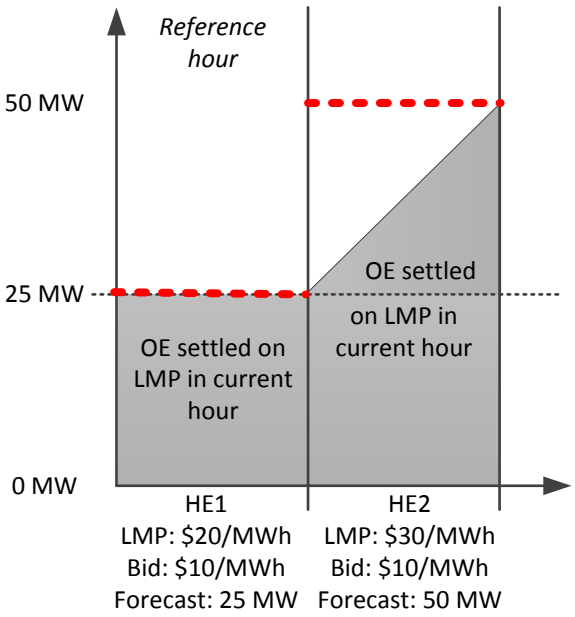
settlement, the LMP is used instead of the reference hour bid resulting in a charge of $125 (6.25 MWh x -$20/MWh).

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

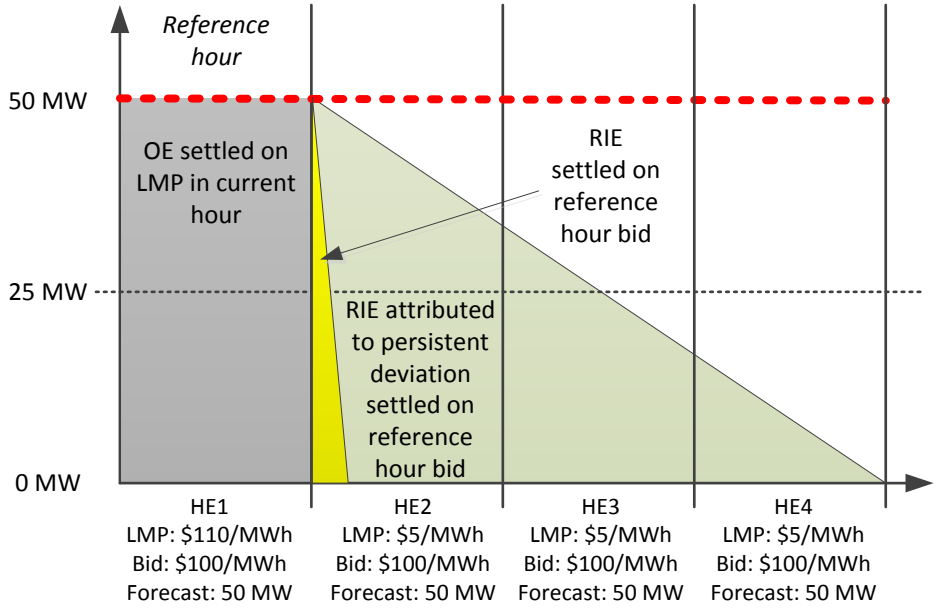
[8] If the settlement is fully on LMP as some stakeholders have questioned, the settlement charge would be even larger as the LMP is lower than the bid price for the portion of the residual imbalance energy below the forecast.

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 1×10^{-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.

Attachment D – Board Memorandum (including Matrix of Stakeholder Comments)

Tariff Amendment to Improve Settlement of Variable Energy Resources and Bid-Cost Recovery Rules

California Independent System Operator Corporation

May 25, 2016

Memorandum

To: ISO Board of Governors

From: Keith Casey, Vice President, Market and Infrastructure Development

Date: July 9, 2015

Re: **Decision on bid cost recovery and variable energy resource settlement**

This memorandum requires Board action.

EXECUTIVE SUMMARY

Management seeks Board approval to modify existing financial settlement rules to ensure fair treatment of variable energy resources that provide economic bids to the ISO market. Economic bids from variable energy resources are an important tool to efficiently integrate these resources into the operation of the grid. The proposal recognizes the operational characteristics of variable energy resources that are dispatched to a forecast in the ISO market.

Additionally, applicable to all resource types, Management proposes some minor enhancements to the calculation of the bid cost recovery mitigation measures that are used to ensure a resource's bid cost recovery payment is only based on costs for energy that it actually delivered.

These two items are further refinements to the fifteen-minute market changes and the bid cost recovery changes that went into place in May 2014.

Management proposes the following motion:

> ***Moved, that the ISO Board of Governors approves the bid cost recovery and variable energy resource settlement proposal, as described in the memorandum dated July 9, 2015; and***
>
> ***Moved, that the ISO Board of Governors authorizes Management to make all necessary and appropriate filings with the Federal Energy Regulatory Commission to implement the proposed tariff change.***

DISCUSSION AND ANALYSIS

Management's proposal consists of two items:

- **Item 1** – Financial settlement modifications for economically-bidding variable energy resources.

- **Item 2** - Enhancement of a bid cost recovery metric calculation used in settlement of all resources.

The following sections discuss these two items.

Item 1 - Settlement modifications for economically-bidding variable energy resources

Management's proposal for this item solves an issue in which the ISO currently settles energy from economically-bidding variable energy resources during certain periods at a resource's bid price rather than its locational marginal price. Without this proposed change, variable energy resources would have a disincentive to submit economic bids because they typically bid a low, or even a negative dollar amount that reflects their marginal opportunity cost, which is usually lower than the locational marginal price. This settlement outcome occurs because the ISO market classifies certain ramping energy as "residual imbalance energy," which it settles at a resource's bid price rather than the locational marginal price.

Management's proposal for this item also solves another issue in which normal error in the forecast output of variable energy resources currently triggers the "persistent deviation metric," which mitigates the price paid for residual imbalance energy.

To address these issues, Management proposes to:

- Pay residual imbalance energy resulting from variations in a resource's intermittent energy source at the locational marginal price, rather than at the resource's bid price. Under this circumstance, the residual imbalance energy will <u>not</u> be subject to mitigation measures that apply to uninstructed deviations.

- Continue to pay the resource's bid price for residual imbalance energy resulting from the ISO dispatching a variable energy resource down based on its economic bid. Under this circumstance, the residual imbalance energy will be subject to mitigation measures.

A supply resource uses its energy bids for two main purposes: first, to specify the minimum price at which it is willing to provide energy to the market; and second, to specify the maximum price it is willing to pay to "buy back" in real time energy it sold in the day-ahead market. Energy bids for the latter purpose are commonly called decremental bids because they are bids by a supplier to reduce or decrement a resource's real time output relative to its accepted energy schedule. Economically bidding variable energy resources typically bid zero or negative dollar amounts as compared to positive amounts from conventional

generators. The negative bids reflect payments such as production tax credits variable energy resources may receive outside of the ISO markets. Integrating large quantities of variable energy resources into the supply fleet creates an increased need for a liquid supply of economic bids from variable energy resources to integrate them into the ISO market and the operation of the grid.

Economically bidding variable energy resources are unique because their energy output may be driven by a change in their intermittent energy source or a change in the locational marginal price. Variable energy resources only behave like conventional generators and control their output when their energy output is driven by a price change.

Despite this difference, the ISO market's energy settlement in some aspects currently treats the energy from variable energy resources as if the output is always controllable. Economically bidding variable energy resources are treated somewhat like a conventional generator even when they are only responding to an intermittent energy source change and are not being economically dispatched by the ISO. This creates a discrepancy when paying the resource for residual imbalance energy.

"Residual imbalance energy" is energy dispatched in the real-time market attributable to ramping down from a dispatch in a previous hour, or ramping up to a dispatch in a subsequent hour. This energy type is paid based on a generator submitted bid in the previous or subsequent hour that drove the dispatch, referred to as the "reference hour bid."

Residual imbalance energy can occur from either a change in a resource's intermittent energy source or an economic dispatch. When a resource moves pursuant to an intermittent energy source change, the current settlement rules will pay the resource based on the reference hour bid even when the locational marginal price is higher. However, the current settlement rule does not recognize that the resource is not controlling its dispatch like a conventional generator.

Management proposes to differentiate when the residual imbalance energy is driven by an intermittent energy source change versus an economic dispatch for economically bidding variable energy resources. When driven by an intermittent energy source change, the settlement will be based on the locational marginal price in recognition that the resource is a price taker. When driven by an economic dispatch, the settlement will continue to be based on the reference hour bid that drove the dispatch, consistent with a conventional generator's settlement. In this circumstance, this residual imbalance energy settlement is an important safeguard to ensure resources are not able to unjustly increase their residual energy settlement payments.

For self-scheduled variable energy resources, the residual imbalance energy is always driven by an intermittent energy supply change and is settled at the locational marginal price.

Along with these changes, Management also proposes to no longer apply bid cost recovery mitigation measures to the residual imbalance energy settlement when variable energy resources are responding to changes in their intermittent energy source. These mitigation

measures will continue to apply when variable energy resources are responding to a dispatch due to an economic bid, consistent with the settlement of conventional resources.

Item 2 - Enhancement of bid cost recovery calculation

Management's proposal for this second item solves an issue with the "day-ahead metered energy adjustment factor." The day-ahead metered energy adjustment factor is a metric applied to all resources to ensure that a resource's bid cost recovery payment is only based on costs for energy that it actually delivered. Should the resource under-deliver, the factor will reduce the amount of eligible bid cost recovery. Bid cost recovery is the process by which the ISO ensures that scheduling coordinators are able to recover start up, minimum load and energy bid costs for supply resources. The bid cost recovery calculations compare bid costs and market revenues for each resource to ascertain whether or not there is a net revenue shortfall over the course of the day-ahead and real-time markets. If so, the resource receives an uplift payment for that shortfall.

Management proposes minor enhancements to the adjustment factor so that it accurately calculates whether mitigation is appropriate. The enhancements will avoid mitigation in instances when a resource producing energy above minimum operating capacity and when a resource is fully responding to ISO dispatch. These enhancements will ensure that the mitigation is applied consistent with the original policy intent that was implemented last year.

POSITION OF THE PARTIES

Stakeholders unanimously support the modifications to the day-ahead metered energy adjustment factor.

Stakeholders support the proposed settlement changes for variable energy resources with regard to the residual imbalance energy and the application of the persistent deviation metric. Stakeholders had two additional positions described below. A detailed stakeholder matrix is attached.

Position 1: One stakeholder proposed developing new energy types specifically for variable energy resources to account for their unique operating characteristics.

Response: Management appreciates the potential merits of such an approach but believes, for now, that there is benefit to leveraging the existing settlement constructs until a plan to use differentiated settlement codes is agreed upon. The ISO may address this through a follow-on stakeholder initiative. For now, the changes provided in the proposal largely addresses the stakeholder's concerns about treatment of variable energy resources. In the meantime, the ISO can learn from the resources operating in the market to inform such an initiative.

Position 2: Stakeholders would like more implementation details during the stakeholder process.

Response: Through this initiative, the ISO has provided additional settlement examples and technical walk-throughs to bridge the gap between high-level policy development and implementation. The ISO has also coordinated with its implementation teams to clarify how the policy will be implemented.

CONCLUSION

Management recommends the Board approve the bid cost recovery and variable energy resource settlement proposal described in this memorandum. The change in settlement for residual imbalance energy recognizes the unique operating characteristics of intermittent resources and appropriately aligns the application of mitigation measures between variable energy and conventional resources. Moreover, the enhancements to the bid cost recovery calculation will appropriately consider additional conditions to ensure that bid cost recovery is provided when resources follow ISO dispatch instructions.

Attachment A

Stakeholder Process: Bid cost recovery and variable energy resource settlement

Summary of Submitted Comments

Stakeholders submitted two rounds of written comments to the ISO on the following dates:

- Round One, 4/30/15
- Round Two, 6/10/15

Stakeholder comments were received from: Pacific Gas & Electric Company, San Diego Gas and Electric, and Southern California Edison.

Stakeholder comments are posted at:
http://www.caiso.com/informed/Pages/StakeholderProcesses/BidCostRecovery_VariableEnergyResourceSettlements.aspx

Other stakeholder efforts include:

- Stakeholder call, 4/15/15
- Working group session, 5/8/15
- Stakeholder call, 5/27/15
- Numerous outreach calls

Stakeholder	Management proposal: Pay residual imbalance energy resulting from a variable energy resource's intermittent energy source change at the locational marginal price. For this energy, do not apply the persistent deviation metric.	Management response
Pacific Gas & Electric Company	Supports.	The ISO appreciates the out-of-the-box thinking but believes, for now, that there is benefit to leveraging the existing settlement constructs until a plan to use differentiated settlement codes is agreed upon. This may be a follow-on stakeholder initiative. For now, the changes provided in the proposal largely addresses the stakeholder's concerns about treatment of variable energy resources. In the meantime, the ISO can learn from the resources operating in the market to inform such an initiative.
San Diego Gas and Electric	Develop new energy type specifically for variable energy resources.	
Southern California Edison	Supports.	

Stakeholder	Management proposal: DA MEAF	Management response
Pacific Gas & Electric Company	Supports.	No comment.
San Diego Gas and Electric	Supports.	
Southern California Edison	Supports.	