California ISO

Flexible Ramping Product

Revised Draft Final Proposal

December 17, 2015

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1 Introduction

This paper describes the ISO's market design proposal for the upward and downward flexible ramping products (FRP). This stakeholder effort develops market-based flexible ramping products to address the operational challenges of maintaining power balance in the real-time dispatch. The ISO has observed that the fleet of units determined in the real-time unit commitment process (RTUC), also known as the real-time pre-dispatch (RTPD) process, sometimes is not positioned with sufficient ramping capability and flexibility in real-time dispatch (RTD) to handle the 5-minute to 5-minute system load and supply changes. Insufficient ramping capability sometimes manifests itself in triggering power balance violations, which means the there is no feasible system wide RTD schedule to maintain supply and demand power balance. Here, there are at least three undesirable outcomes:

- The system must rely on regulation services to resolve the issue in real-time after the imbalance has caused frequency deviation or area control error (ACE)
- When power balance is violated, the RTD energy price is not priced by economic bids, but by administrative penalty prices. This would eventually create market inefficiency since the imbalance energy of resources providing regulation services is priced using the administrative penalty prices from RTD.
- Insufficient regulation service results in leaning on the interconnection, which may affect the ability to meet required operational performance criteria.

Since the new nodal market was implemented in 2009, the ISO has had a multi-interval optimization in the unit commitment and dispatch process. The multi-interval optimization can look several intervals ahead to meet forecasted ramping needs. The ISO has observed that the optimization would create the exact amount of ramping capacity according to the imbalance forecast. When the future system conditions materialize, the actual ramping need may differ from the forecast. If the actual ramping need is higher than the forecast, the net supply cannot meet the net demand and a power balance violation is triggered. This develops because there is no margin of error between the interval ramping needs in a multi-interval optimization. A deviation beyond the forecasted ramping need that occurs in a subsequent market run could result in a spurious price spike. FRP creates a ramping margin on top of the forecasted movement between interval ramping need and reduces the frequency of spurious power balance violations. The FRP would compensate resources based on the marginal opportunity cost from out of merit dispatch in the financially binding market interval.

2 Background

With increasing levels of variable energy resources and behind the meter generation, the operational challenge of ramping capability is even more prominent. The variable outputs of the renewable resources may increase the magnitude of the 5-minute to 5-minute net load changes. In Figure 1, the net load equals the load minus the renewable resources' total output. As shown in Figure 1, the 5-minute to 5-minute net load change may triple its magnitude in hour-ending 18 and 19 with renewable generation output moving in the opposite direction of load. It may also reverse the direction of load ramping in hour-ending 7 and 8.

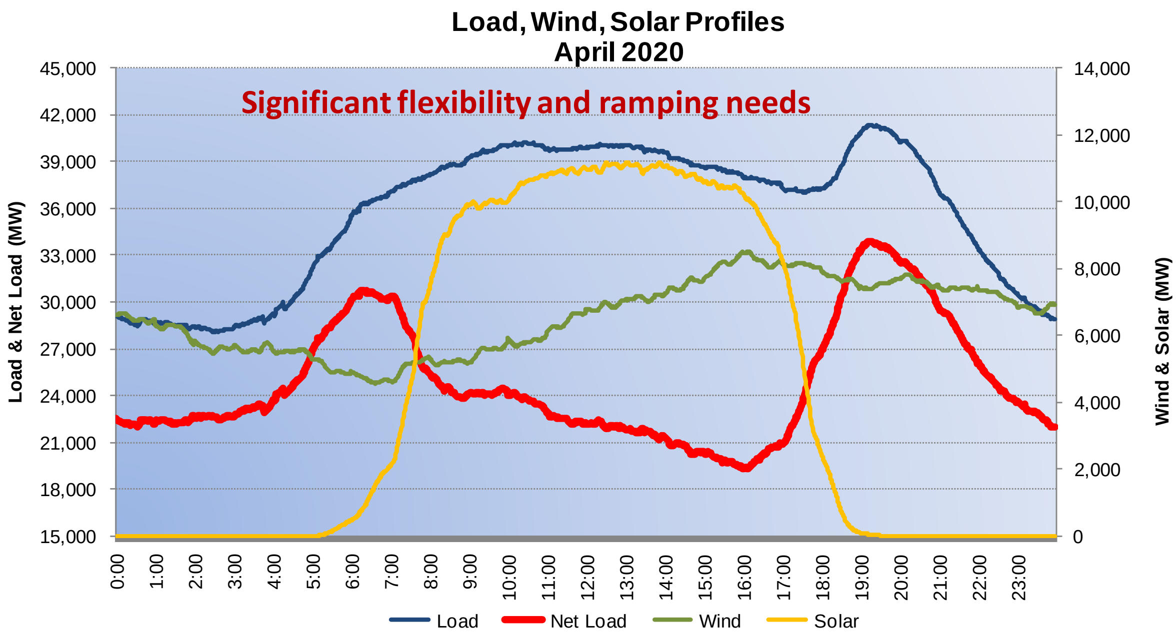

Figure 1: Projected load and Renewable profiles in April 2020[1]

Stakeholders have questioned why the ISO must design a new ramping product while regulation services are standard products to deal with the forecast uncertainties. Two types of uncertainties are accounted for based on timing that uncertainties are realized: one is realized before the binding RTD interval and the other is realized during the binding RTD interval. Uncertainties realized before the binding RTD interval affect the RTD energy price in the binding RTD interval. While uncertainties realized during the binding RTD interval would not impact the RTD energy price. Regulation services are the standard products that address uncertainties that exist during the binding RTD interval. Energy produced by regulation services will be compensated at the corresponding RTD energy price and the resource is also compensated for the provision of the regulation service separately. Procuring more regulation is problematic for uncertainties realized before the binding RTD interval because having additional capacity in an interval locked as regulation service, which cannot be dispatched in RTD as energy, will reduce the resources available to RTD and would lead to more power balance violations, causing prices to be set by the penalty prices related to the bid caps ($1000/MWh and -$155/MWh). In addition, when regulation services are dispatched, they would be paid the RTD prices. If more regulation is procured to handle uncertainties, the additional dispatched energy would be

1 Operating flexibility analysis for R.12-03-014, Mark Rothleder, Shucheng Liu, and Clyde Loutan, CPUC workshop, June 4, 2012.

compensated at the penalty prices. Even when there is no actual operational issue, but just an artificial power balance issue in RTD created by the over-procurement of regulation. That is why it is inappropriate to procure more regulation services to deal with the uncertainties realized before the binding RTD interval. FRP addresses uncertainties realized before the binding RTD interval. While the flexible ramping procurement and deployment would also influence the energy prices, while doing so in a more efficient manner to best reflect the system conditions.

Stakeholders have also questioned whether procuring more non-contingent spinning reserve can achieve what the FRP would achieve. The problem with procuring more non-contingent reserves and dispatching them in RTD is the false opportunity cost payment. When spinning reserve is procured, its price already includes the energy opportunity cost. If the capacity is dispatched in RTD, then the resource will also receive the energy payment. Therefore, the same capacity would be compensated twice for the energy profit. The ramping capacity should be procured and deployed frequently. Using non-contingent spinning reserve for this purpose is problematic from the due to the double compensation.

Prior to these market-based full flexible ramping products, the ISO has implemented a flexible ramping constraint to address certain reliability and operational issues observed in the ISO's operation of the grid.[2] Upon completing the Flexible Ramping Constraint stakeholder process, the ISO Board of Governors agreed with stakeholder and the ISO that greater market efficiency can be gained by developing market-based products that allow for the identification, commoditization, and compensation for the need of flexible capability.

FRP would help the system to maintain and use dispatchable flexibility. FRP is the 5-minute ramping capability, which will be dispatched to meet 5-minute to 5-minute net system demand changes or net system movement in RTD. The net system demand is defined as the load plus export minus all resources' schedules that are not 5-minute dispatchable, which may include renewable resources, imports, and self-schedules. We will refer to the potential 5-minute to 5-minute net system movement in RTD as the Real Ramping Need. The Real Ramping Need is illustrated in Figure 2. Assume the current time is t–7.5 minutes, and the ISO is running RTD for the binding interval t (the 5-minute interval from t to t+5). From the market point of view, RTD interval t's net system demand is certain in the sense it is not subject to future changes in the market. However, the RTD net system demand for the advisory interval t+5 (the 5-minute interval from t+5 to t+10) is still subject to change (from t–7.5 to t–2.5). Consequently, we view RTD advisory interval t+5's net system demand as a random variable with a spread from a lower limit to an upper limit. The lower limit and upper limit are illustrated in Figure 2. FRP is able to cover the random net system demand in interval t+5 with a spread from the lower limit to the upper limit. Note that the spread from the lower limit to the upper limit only reflects the ISO's intended coverage of the next interval's net system demand. It may not be able to cover all

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2 See CAISO Technical Bulletin "Flexible Ramping Constraint" for detailed discussion of the constraint, http://www.caiso.com/Documents/TechnicalBulletin-FlexibleRampingConstraint_UpdatedApr19_2011.pdf, February 2011. See California ISO Tariff Amendment Proposing the Flexible Ramping Constraint and Related Compensation: http://www.caiso.com/Documents/2011-10-07_FlexiRampConstraint_Amend.pdf

possible net system demand levels that may be realized when interval t+5 becomes the binding interval. The flexible ramping capability is met with separate products in the upward and downward directions as the ramp needs may be in both directions. The Real ramping need is:

- Upward: max{ [upper limit at t+5] – [RTD net system demand at t], 0 }
- Downward: max{ [RTD net system demand at t] – [lower limit at t+5], 0 }

Note that the actual net system demand may differ from the RTD energy binding interval load, and the difference is covered by regulation services.

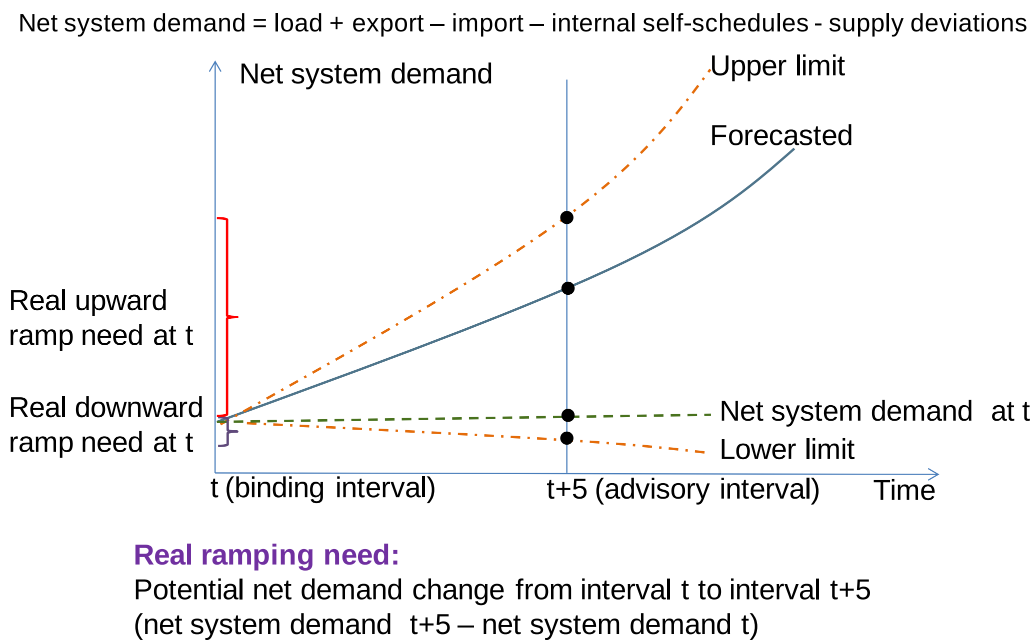

Figure 2: Real ramping need

Stakeholders have questioned why the procurement target is real ramping need, not the unexpected ramping need on top of the expected ramping. Arguing that we should not compensate the resources that meet the expected ramping and should only compensate resources that meet unexpected ramping. As discussed by the Market Surveillance Committee[3], there is no operational difference between resources that meet expected ramping and resources that meet unexpected ramping. There may be resources in either category dispatched out of merit to provide flexible ramping capability. It is inappropriate to treat and compensate the resources under the two categories differently. In addition, there is improved market efficiency. As the opportunity costs for out-of-merit dispatches is compensated in the binding RTD interval. Rather than assumed covered in the advisory RTD intervals, as illustrated in the settlement examples later in the draft final proposal.

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3 Scott Harvey, Flexi Ramp Product Design Issues, http://www.caiso.com/Documents/FlexiRampProductDesignIssues-MSCPresentation.pdf

The latest market design changes separate the settlement of forecasted movement and uncertainty. This change recognizes forecasted movement between intervals would be providers of ramping capability and consumers of ramping capability. Which can be directly settled as energy where forecasted demand and dispatched supply are equal. This improves market efficiency as forecasted movement can be settled in each binding interval which minimizes flexible ramping costs that must be allocated through a monthly uplift. To allocate uncertainty costs, it is appropriate to use monthly data since the need for uncertainty is not based upon a given financially binding interval. Rather, estimates of net load forecast error is used with historical observations.

3 Market Design

This section describes and discusses the FRP design regarding the real-time market. With the introduction of the new fifteen-minute market, the energy schedule from enforcing flexible ramping requirement during RTUC is financially binding. This is beneficial because the opportunity cost of out of merit dispatch is actually realized by resources providing FRP in RTUC.

Two characteristics distinguish FRP from capacity products, such as ancillary services.

> **Capability preserved for between interval changes:** All ancillary services in the ISO's market are "standby" capacity in the sense they are unloaded capacity to meet net system demand deviations from assumed level in the same interval. FRP is the only market product targeting between intervals net system demand changes.
>
> **Regularly dispatched in RTD:** FRP is a 5-minute ramping capability product, which is continuously procured and dispatched in RTD, to meet the net system movement. No similar capacity product currently exists in the ISO's market. Regulation services are dispatched after RTD by automatic generation control (AGC), not through economic bids. Operating reserves are dispatched through the real-time contingency dispatch only after a defined contingency event occurs. FRP can improve the ISO's dispatch flexibility in RTD, while ancillary services awards reduce the RTD flexibility because capacity is held by ancillary service awards.

FRP will be modeled as ramping capability constraints. Modeling flexible ramping in RTUC helps real-time unit commitment make the correct decisions in creating ramping headroom if it is necessary. The real-time unit commitment decisions are binding if such decisions cannot be revisited in later runs due to physical commitment time constraints. With the introduction of the fifteen-minute market, both the flexible ramping headroom and energy schedules in RTUC are financially binding at the FMM price. The ISO will also re-optimize the procurement of flexible ramping capability in RTD and awards will be compensated according to the marginal prices in RTD where the energy awards are also financially binding.

3.1 Bidding Rules

There is no bidding of FRP and the ISO will not procure FRP in the day-ahead market. All resources can provide forecasted movement between market intervals in both the FMM and RTD. Only resources that have an economic bid and are dispatchable in RTD can have a flexible ramping award in excess of its forecasted movement. Flexible ramping awards over the forecasted movement between intervals is procured to meet uncertainty in the 5-minute net load forecast. Resources have no certified flexible ramping capability as done with ancillary services. The ISO will use the internal DOT to evaluate and award the FRP. For instance, if a variable energy resource is using its own 5-minute forecast for settlement of energy. Ramping capability on this resource will be based upon the ISO forecast of the resources. The ISO forecast, not the resource's forecast, is used to clear both FMM and RTD. The FRP price will be based on marginal opportunity cost of meeting the forecasted movement and uncertainty.

Since there is no economic bidding, there is no self-provision of FRP or market power mitigation rules applied to flexible ramping awards.

3.2 Co-optimizing Flexible Ramping Products with Energy and Ancillary Services

This section will cover the stylized optimization model of co-optimizing FRP with energy and ancillary services. The stylized model is for illustration purpose only, and additional information is provided in the technical appendix. The optimization model applies to both RTUC and RTD. RTUC and RTD both optimize over multi-interval horizons. FRP will be modeled by enforcing ramping constraints in each interval of RTUC and RTD. Modeling FRP in advisory intervals enables the optimization to foresee potential problems and take actions accordingly. As is the case for energy dispatches, only the flexible ramping award in the first RTD interval is financially binding. Additional detail is provided in the final technical appendix.

The objective function is modified to ensure sufficient ramping capability is maintained in order to meet both forecasted movement and uncertainty. The changes to the constraints involving flexible ramping are as follows.

Upward ramping capability limit: This constraint ensures that a resource's upward ramping award plus the total amount of upward reserves (regulation-up, spinning, and non-spinning) awards does not exceed its upward ramping capability over the market clearing interval.

Downward ramping capability limit: This constraint ensures that a resource's downward ramping award plus the regulation-down award does not exceed its downward ramping capability over the market clearing interval.

Active power maximum limit: This constraint limits the awards of energy schedule, upward reserves and upward FRP to be less than or equal to the resource's maximum operating capability.

Active power minimum limit: This constraint limits the energy schedule minus the awards of regulation-down and downward FRP to be greater than or equal to the resource's minimum operating level.

Upward flexible ramping requirement: This constraint ensures that the total amount of upward FRP awards at least meets the requirement.

Downward flexible ramping requirement: This constraint ensures that the total amount of downward FRP awards at least meets the requirement.

FRP is a 5-minute ramping capability based on the dispatch level and the resource's ramp rate. The RTUC and RTD have different market clearing interval granularity:

- RTUC has 15-minute market clearing interval, and
- RTD has 5-minute market clearing interval.

In the optimization, the ISO will model the average 5-minute ramping capability over the applicable market clearing interval. The ramping capability over the market clearing interval will be converted to the average 5-minute ramping capability by dividing it by an averaging factor AF (AF = 3 for RTUC, and AF=1 for RTD). If resource A has 60 MW capacity and 1 MW/minute ramp rate, it can be awarded 15 MW ramping capability over in an FMM interval. This can be converted to an average of 5 MW 5-minute ramping capability. The difference between the FMM 5 MW award will be settled at the RTD flexible ramping price. If the resource is awarded 4 MW 5-minute ramping capability in RTD, the resource must pay back the 1 MW at the RTD flexible ramping price.

4 Demand Curve to Meet Uncertainty

Besides procuring FRP to meet net forecast demand within the respective interval, the ISO will procure additional flexible ramping capability using the demand curve which is based on the net demand forecast uncertainty of the next interval. If the price of supply is lower, more FRP will be procured to cover the ramping requirement uncertainty. If the price of supply is higher, less FRP will be procured to cover the ramping requirement uncertainty.

Figure 3 illustrates an interval where the maximum expected downward forecast error (max is greater than the FRU minimum requirement. The ISO will procure the portion between the maximum expected forecast error and net load forecast at time t using a demand curve. This is illustrated as the difference between the dashed green line and the dashed orange line.

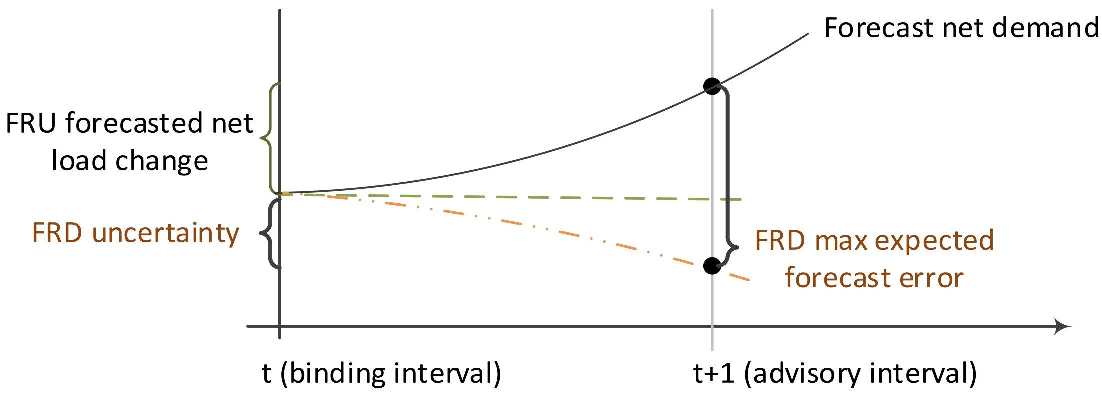

Figure 3 Flexible Ramping Product Requirement due to uncertainty

Figure 4, below, illustrates an interval where the maximum expected downward forecast error is less than the FRU minimum requirement. In this situation the ISO will not need additional FRD capacity.

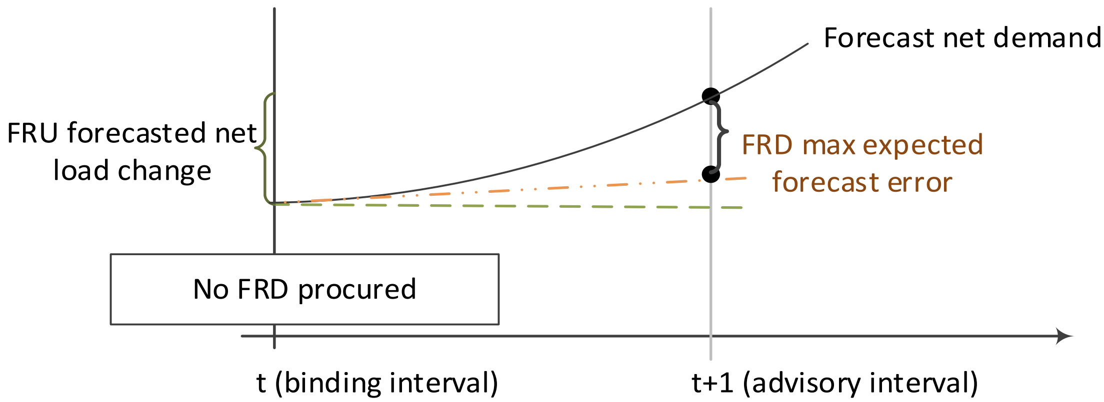

Figure 4 Flexible Ramping product with no flexible ramping down minimum or demand requirement

The ISO will construct histograms as an approximation of the probability distribution of net demand forecast errors to be used to procure for uncertainty. It will construct separate histograms for FRU and FRD for each hour, separately for RTD and FMM.

The histogram for RTD will be constructed by comparing the net demand for the first advisory RTD interval to the net load in the same time interval for the next financially binding RTD run. Figure 5 shows two consecutive RTD 5-minute market runs, RTD_1 and RTD_2. The ISO will construct the histograms by subtracting the net demand from the first market run used for the first advisory interval (A1) from the net demand the second market run used for the binding interval (B_2).

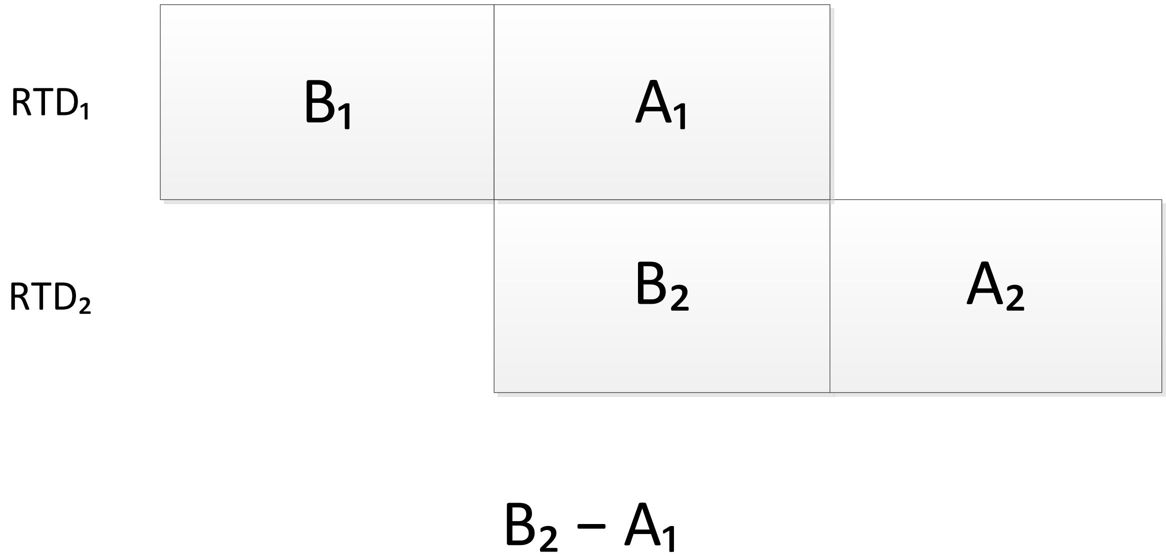

Figure 5: RTD Histogram Construction

For FMM, the ISO will construct separate histograms for FRU and FRD.

- For FRU, the histograms will be constructed based on the difference of the net demand the market used in the FMM for the first advisory RTUC interval and the maximum net demand the market used for the three corresponding RTD intervals.
- For FRD, the histograms will be constructed based on the difference of the net demand the market used in the FMM for the first advisory RTUC interval and the minimum net demand the market used for the three corresponding RTD intervals.

Figure 6 shows two RTUC intervals: the FMM (i.e. the RTUC binding interval) and the first advisory interval (labeled “A”). It illustrates how the FRU histogram will be constructed by comparing the net demand the FMM used for first advisory RTUC interval to the maximum net demand the market used for the corresponding three RTD binding intervals (b_1,b_2,b_3).

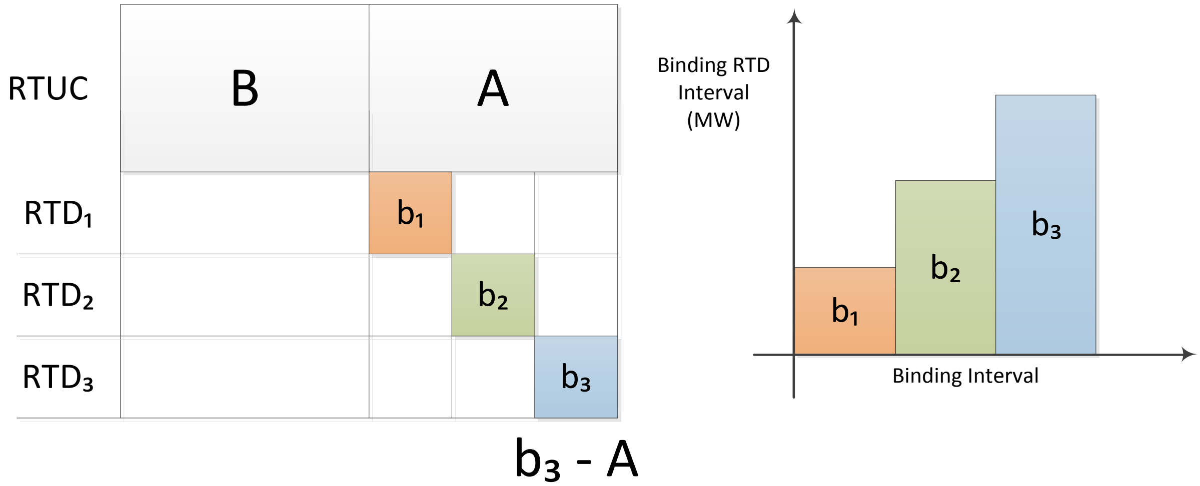

Figure 6: Histogram construction in FMM

The FRU histogram will use the observation b_3 – A. This represents the maximum ramping need. The variable b_3, represents the maximum net load in the three RTD intervals. The FRD histogram will use observation b_1 – A as this is the minimum ramping need. Ultimately in this example, the FRD observation is positive and therefore will not be used directly in the demand curve creation. It will however be used to calculate the 95th percentile load forecast error and therefore needs to be captured in the histogram.

The ISO proposes to use a rolling 30 days, with a separate histogram for weekends and holidays, to evaluate the historical advisory RTUC imbalance energy requirement error pattern for each RTUC hour. The ISO will also evaluate if hours with similar ramping patterns could be combined to increase the sample size used in the historical analysis. The ISO expects that the estimate of uncertainty will improve over time. Therefore, the actual method of calculating the demand curve will be included in the business practice manual versus including these details in the tariff.

5 Settlement of Forecasted Movement

Forecasted movement will be settled in FMM at the FMM price. Any difference between FRP procured for the FMM forecasted movement and the RTD forecasted movement will be settled at the RTD FRP price. Note that the granularity difference between FMM and RTD can cause differences between the FMM awards and RTD awards. The same issue exists with energy settlements today.

For dispatchable and non-dispatchable supply, the settlement is calculated by resource for each 15-minute FMM and 5-minute RTD settlement interval. The ISO uses its forecast[4] for variable energy resources' output to clear the market but provides the option for variable energy resources to use their own forecast to schedule energy. The ISO will only use the ISO's forecast to calculate ramping awards for variable energy resources. This is to mitigate against variable energy resources adjusting the forecast of the advisory interval to receive payment for ramp. VERs could do this without financial cost because the advisory energy schedules are not financially binding.

For interties, the settlement is calculated for each schedule for each 15-minute and 5-minute settlement interval based upon the prescribed ramps. Hourly schedule changes have a 20 minute ramp. 15-minute schedule changes have a 10 minute ramp. The granularity differences between FMM and RTD will result in ramp settlement even if though a static intertie schedule cannot be changed in RTD. In addition, operational adjustments should be reflected prior to the start of the RTD optimization covering the relevant FMM interval; therefore, this change can be reflected in the forecasted movement of RTD is not a cause of uncertainty.

Unlike supply and interties, load cannot be settled directly for forecasted movement with a Scheduling Coordinator (SC) because the ISO load forecast used to clear the market is aggregated for each balancing authority area. Therefore, all payments and charges to load based upon the ISO market forecast will be charged/paid based on load ratio share for each 5-minute settlement interval for each balancing authority area.

6 Monthly Settlement and Allocation of Uncertainty

Unlike forecasted movement, there is no counterparty to directly charge in the financially binding interval for FRP procured for uncertainty. Uncertainty is procured to address the potential for differences in net load when the advisory interval becomes financially binding in the subsequent market run. This difference occurs when uncertainty is realized in a future interval. Since the additional ramping capability is similar to insurance, it is appropriate to not allocate cost for a given realization of uncertainty, but over a period of time. Therefore, the cost (payment to dispatchable resources) will be allocated at the end of the month through an uplift.

The FRP for uncertainty awards will be settled with dispatchable resources at the applicable binding interval FMM or RTD price at the end of the month. By not paying the uncertainty awards immediately, there is no need to perform a monthly resettlement because the payment to a resource and the cost allocation will occur in the same settlement period. This is a significant simplification of the settlements implementation.

In addition, payment rescissions to dispatchable resources for uninstructed imbalance energy that would provide a double payment as discussed in the subsequent section will be charged at

[4] In the energy imbalance market, the EIM entity must provide an independent third party forecast. This forecast is then used in the market. If the EIM entity does not have an independent third party forecast, the ISO will use its forecast provider.

the end of the month. The payment rescission will be settled at applicable binding interval RTD price in which the payment rescission occurred.

If the settlement amounts for Flexible Ramp Up Uncertainty Settlement Amount, Flexible Ramp Down Uncertainty Settlement Amount, Flexible Ramp Up Uncertainty Rescission Amount, Flexible Ramp Down Uncertainty Rescission Amount, Flexible Ramp Up Uncertainty Allocation Amount, and Flexible Ramp Down Uncertainty Allocation Amount does not equal zero, the ISO will assess the resulting differences to all SCs with metered demand within the balancing authority area.

The ISO proposes settling the uncertainty for two groups of trade hours. In the assessment of grid management charge (GMC) prior to the 2010 GMC redesign, the ISO identified a GMC bucket for charging load based upon Non-Coincident Peak hours and Non-Coincident Off Peak Hours. Non-Coincident Peak Hours is defined as trading hours ending 7 through 22 for all trading days within a trading month, whereas Non-Coincident Off Peak Hours is defined as trading hours ending 1 through 6 and trading hours 23 through 25 for all trading days within a trading month. For each group of the hour, the FRP for uncertainty uplift cost is the sum of the monthly payments to dispatchable resources less monthly payment rescissions charges to dispatchable resources in the each bucket of trading hours. The total FRP for uncertainty uplift cost is first allocated between the load, supply, and intertie categories. The respective uplift costs allocated to the load, supply, and intertie categories are then allocated to individual resources or loads using a different billing determinate method for each category.

The initial allocation of FRP uncertainty uplift costs between the load, supply, and intertie categories is determined by calculating the "vertical" binding – advisory as shown in figure 7. This difference will be calculated for all non-dispatchable[5] changes in supply resources, interties[6] and load for each 5-minute interval. There is no netting between 5-minute intervals, so in each 5-minute interval there will be either a FRU value or an FRD value. Table 2 below illustrates whether the observed net load error will split FRU or FRD costs. "A" is the advisory interval in the first RTD run and "B" is the binding interval from the second RTD run.

5 Only non-dispatchable resources can have forecast errors between the two market runs. A dispatchable resource could have differences between the two market runs, but this is in response to market instructions not a result a forecast error of that resources.

6 Only operational adjustments that occur after RTD initializes will result in a forecast error. Once the operational adjustment is reflected in RTD, it is settled as part of the forecasted movement.

Figure 7: Binding and advisory interval representation

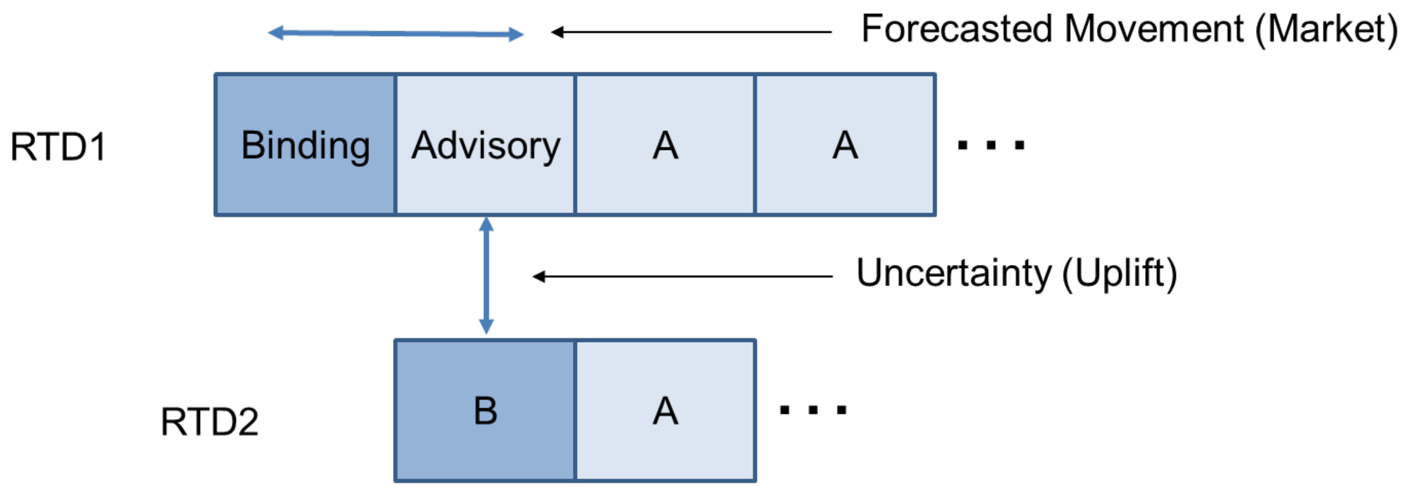

Table 1 Allocation of uncertainty uplift costs between FRU and FRD

	FRU	FRD
Load	A-B > 0	A-B < 0
Supply	A-B < 0	A-B > 0
Interties (Net import in B)	A-B < 0	A-B > 0
Interties (Net export in B)	A-B > 0	A-B < 0

*For load and exports the values of A and B are negative

The load forecast is a single value for each balancing authority area, therefore the forecast error nets errors resulting from individual load serving entities. The load will have a single FRU or FRD value for each settlement interval per balancing authority area based on the ISO forecast between "vertical" advisory – binding interval shown in Figure 7. When splitting the costs into each category, supply and interties must also have a single FRU or FRD value for each settlement interval per balancing authority area. This is accomplished by netting all resources within the supply category and separately netting all intertie schedules within the intertie category to then calculate a single value for each of the categories.

There will be 4 monthly costs that will be allocated: FRU Peak, FRD Peak, FRU Off Peak, and FRD Off Peak. The FRU and FRD values in each 5-minute interval for each category are summed for the month over each range of trading hours. Then each category is allocated its pro-rata share of the monthly FRP costs. The each category allocates its four costs according to its own billing determinant.

1. Load is allocated to each SC based on the pro-rata share of gross UIE over the month. There is no netting between settlement intervals. Negative (increased consumption) UIE is allocated FRU and positive (decreased consumption) UIE is allocated FRD. If a load

uses five minute metering, such as load following metered sub-systems, then the load would be included within the supply category.

2. Supply is allocated by calculating the observed forecast error (the vertical advisory – binding) plus any uninstructed imbalance energy. Each resource is allocated its pro-rata share of gross (A-B-UIE) for over the month for each cost bucket. There is no netting between settlement intervals. Positive (A-B-UIE) is allocated FRU and negative (A-B-UIE) is allocated FRD. Uninstructed imbalance energy was included to provide an additional incentive for dispatchable resources to follow their dispatch instruction. If UIE persists, this can increase the need for ramping capability.
3. Intertie category is allocated to each SC based upon the pro-rata share of gross operational adjustment in each cost bucket over the month. Uncertainty costs for interties will be small. The uncertainty is realized only if an operational adjustment occurs after the binding RTD interval prior to the start of the next RTD interval. Otherwise, the operational adjustment will be resettled as a forecasted movement in RTD. Most operational adjustments occur prior to the start of the operating hour and will be settled through the forecasted movement deviation between FMM and RTD.

7 Rule to Address Double Payment

Since dispatchable resources, non-dispatchable resources, interties, and load will all be awarded and compensated for FRP, the ISO is proposing a consistent approach to address the potential double payment of opportunity costs. The double payment arises when a resource is awarded FRP and is then subsequently settled for uninstructed imbalance energy. Assume a resource's energy bid is $30/MWh and the market clearing LMP was $40. If the resource was awarded FRU, it would be paid no less than $10 for the FRU award. If the resource then deviated above its binding dispatch, the resource would incur positive uninstructed imbalance energy and be paid at the 5-minute LMP of $40. This would cause a profit of $10 which would be the same as the opportunity cost used to compensate the FRU award which assumed the resource would be at it dispatch operating target.

For each settlement interval in which a resource is awarded FRP, the ISO will determine if the resource was double paid by comparing uninstructed imbalance energy (UIE) to the FRP award. If the resource's final meter indicates that the resource has uninstructed imbalance energy deviation or operational adjustment that overlaps with the reserved FRP awarded capacity, the ISO will rescind this portion of the FRP award. The FRP rescission quantity will be charged at the five-minute market FRP price. The FRP rescission quantity will be first assessed against the resource's FRP uncertainty awards and then against the FRP movement awards.

The rescinded FRP amount for forecasted movement will be charged in each settlement interval with the same settlement timing as energy imbalances. The rescinded FRP amount for uncertainty will be charged at the end of the month to eliminate the need for a monthly resettlement since uncertainty costs are allocated monthly.

The rescinded FRP amounts for forecasted movement will be paid to the resources directly charged in proration to their forecasted movement in the binding RTD interval. The rescinded

FRP amounts for uncertainty will be netted against the FRP uncertainty payments prior to monthly allocation to load, supply, and interties as discussed in the next section.

8 EIM Resource Sufficiency Evaluation

With introducing FRP, the ISO will introduce a downward ramping sufficiency evaluation to address real-time leaning due to over-supply in the energy imbalance market (EIM). If the EIM entity balancing authority area (BAA) fails the flexible ramping down sufficiency incremental EIM transfers out of that BAA will not be allowed. The test is symmetrical to the upward ramping sufficiency test currently implemented in the EIM and applied to all BAAs in the EIM[7].

In addition, the settlement to both EIM participating resources and EIM non-participating resources will be settled as any resource in the ISO BAA. The base schedules of non-participating resources will be considered self-schedules when calculating forecasted movement and for allocating the monthly uncertainty cots. The EIM entity scheduling coordinator will be allocated flexible ramping costs for changes in base schedules from non-participating resources because the ramps between hourly base schedules must be honored by RTD.

The ISO will calculate the flexible ramping down requirement for each BAA individually and for the EIM footprint, which recognizes the diversity benefits of the EIM. The diversity benefit will then be allocated pro rata to individual EIM entity BAA for the flexible ramping down sufficiency test. The total system requirement will not exceed the sum of the individual BAA flexible ramping requirements, since in this case the requirement can be met with no transfers between BAAs.

If an EIM entity BAA has a net incoming EIM transfer (net imbalance energy import with reference to the base net schedule interchange) before the operating hour, then it has partially fulfilled its flexible ramping down requirement for that hour because it can retract that EIM transfer during the hour as needed. Here, the ISO will apply a flexible ramping down requirement credit in the flexible ramping down sufficiency test for that EIM entity BAA equal to the net incoming EIM transfer before the operating hour. There will be no such credit for an EIM Entity BAA with a net outgoing EIM transfer (net imbalance energy export with reference to the base net schedule interchange) before the operating hour; the flexible ramping down requirement for that EIM entity BAA in the flexible ramping down sufficiency test will not be affected by the net outgoing EIM transfer. That EIM entity BAA will be sufficient if it meets its own flexible ramping down requirement, with any EIM diversity benefit, irrespective of the outgoing EIM transfer, which results from optimal dispatch in the EIM.

The ISO will perform a series of flexible ramping down sufficiency tests prior to commencing the EIM. The sufficiency test is cumulative. The EIM Entity BAA must meet flexible ramping down requirements for each 15 minute interval of the hour:

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[7] See section 3.4.3 of the EIM draft final proposal at http://www.caiso.com/Documents/EnergyImbalanceMarket-DraftFinalProposal092313.pdf

- Interval 1: 15-minute ramp from T−7.5 to T+7.5
- Interval 2: 30-minute ramp from T−7.5 to T+22.5
- Interval 3: 45-minute ramp from T−7.5 to T+37.5
- Interval 4: 60-minute ramp from T−7.5 to T+52.5

Upon completion of the flexible ramping down sufficiency test, the ISO will enforce separate flexible ramping down constraints in the market optimization for each BAA in EIM and the entire EIM footprint. EIM entity BAAs that fail the flexible ramping down sufficiency test will not be included in EIM footprint constraint. The only constraint to be formulated for these EIM entity BAAs will be for their individual flexible ramping down requirements.

The ISO will calculate a total BAA uncertainty cost before performing the monthly cost allocation to the three categories. The uncertainty costs will include the BAA specific constraint uncertainty costs and the pro-rata share, based upon the individual BAA requirements, of the EIM footprint constraint when the BAA has passed the resource sufficiency evaluations.

9 Next Steps

The ISO plans to discuss this revised draft final proposal and updated technical appendix with stakeholders during a stakeholder conference call to be held on January 5th. The ISO requests comments from stakeholders on the proposed market design changes described in this revised draft final proposal. Stakeholders should submit written comments by January 12th to initiativecomments@caiso.com.

Table 2 - Schedule for Flexible Ramping Product Stakeholder Initiative

Item	Date
Post Revised Draft Final Proposal and Technical Appendix	December 17, 2015
Stakeholder Conference Call	January 5, 2015
Stakeholder Comments Due	January 12, 2015
Board of Governors Decision	February 11-12, 2015