Flexible Ramping Product

Supplemental: Foundational Approach

Lin Xu, Ph.D.

Market Analysis and Development

and

Donald Tretheway

Market and Infrastructure Policy

July 11, 2012

Supplemental – Foundational Approach
Flexible Ramping Product

Table of Contents

1. INTRODUCTION

The ISO is currently in the stakeholder process of designing the flexible ramping product and its cost allocation. While ramping service is not a new concept, the ISO's flexible ramping product introduces a new market mechanism of managing and compensating the ramping capability. The ISO endeavors to design the product in a way that is consistent with market principles, improves market efficiency, and incentivizes market participates to improve dispatch flexibility or reduce the need for ramping service. With the stakeholder process being extended, the ISO wants to take a step back to revisit to the fundamentals of this new product. The ISO hopes that the discussion of the fundamental questions around the product will also guide us to proceed in the right direction of product design and cost allocation.

2. RAMPING NEED: REAL VS UNEXPECTED

The first fundamental question about the flexible ramping product is the purpose of doing it. The ISO wants to have a ramping product to improve the market dispatch flexibility, and reduce the frequency when ramping capability cannot meet the ramping need in the market. The ISO has been considering the ramping need as the unexpected ramping from variability and uncertainties on top of a forecasted net load ramp. However, there may be better ways to define the ramping need as will be discussed hereafter.

Assume the current time is t–7 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 load is certain in the sense that it is not subject to future change in the market. The actual net load may be different from the RTD binding interval load, and the difference is covered by regulation services. However, the RTD net load for the advisory interval t+5 (the 5-minute interval from t+5 to t+10) is still subject to change in the future (from t–7 to t–2). Therefore, we view RTD advisory interval t+5's net load as a random variable, and has a spread from a lower limit to an upper limit. The lower limit and upper limit are illustrated in Figure 1. The purpose of the flexible ramping product is to be able to cover the random net load 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 reflect the ISO's intended coverage of the next interval's net load, and may not necessarily be able to cover all possible net load levels that may be realized when interval t+5 becomes the binding interval.

In Figure 1, there is also a forecasted net load curve. The forecasted net load curve is the ISO's anticipated net load level. For example, the ISO has assumed a certain net load level in the RTUC process, and the assumed RTUC net load can be the forecasted net load curve.

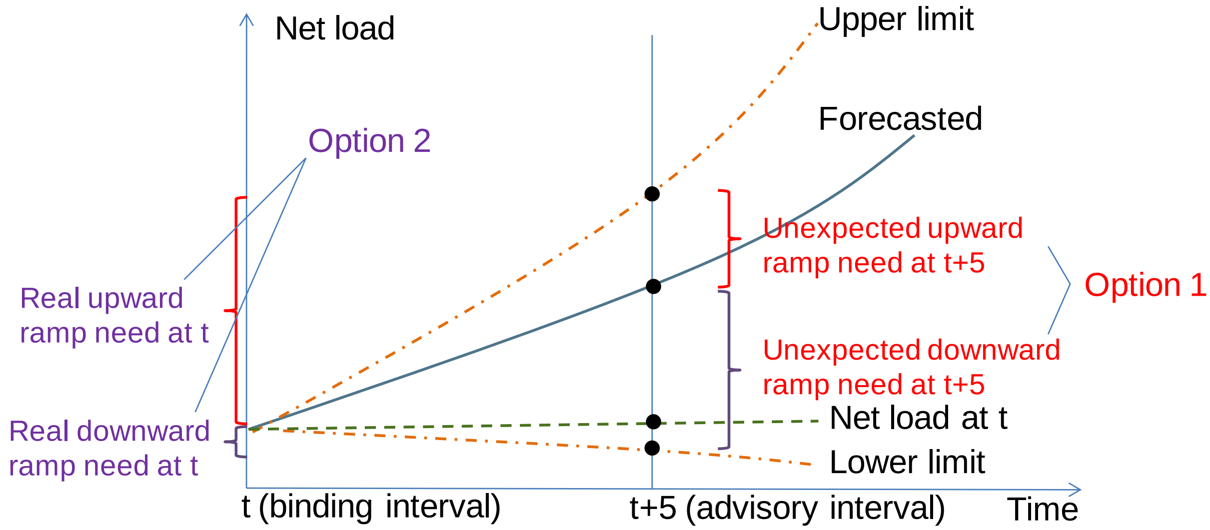

FIGURE 1: RTD UNEXPECTED RAMP NEED VS RTD REAL RAMP NEED

Given the spread from the lower limit to the upper limit and the forecasted net load, there are (at least) two ways to model the ramping capability as listed in Table 1.

Option 1: Unexpected Flex Ramp	Option 2: Real Flex Ramp
RTUC unexpected ramp in interval t+5	RTD real ramp need from interval t to interval t+5
Cover RTD t+5 net load from its RTUC level (net load t+5 – net load RTUC)	Cover next interval net load change (net load t+5 – net load t)

TABLE 1: RTUC UNEXPECTEDRAMP VS RTD REAL RAMP

Option 1 is what the ISO had proposed in the previous draft final proposal. Under this option, the ISO intends to use the flexible ramping product to cover the difference between the RTD net load and RTUC net load in interval t+5. RTUC assumes a flat net load for each 15-minute interval, and when the RTD net load deviates from the RTUC level, it creates a ramp need. Under option 1, the ramp need is

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

Option 2 is another way to quantify flex ramp. Under this option, flex ramp product is to cover the real ramp from RTD interval t to interval t+5, which is the RTD net load at t+5 minus the RTD net load at t. Under option 2, the ramp need is

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

2.1 REAL RAMP NEED VS UNEXPECTED RAMP NEED

Table 2 compares the real ramp need and the unexpected ramp need under three scenarios.

Scenario	Morning load ramp	Middle day	Evening load drop
RTD net load at t	24,000	32,000	28,000
RTUC net load at t+5	24,400	32,000	27,400
Lower limit	24,080	31,800	27,500
Upper limit	24,500	32,300	27,900
RTUC unexpected ramp up	100	300	500
RTUC unexpected ramp down	320	200	0
RTD real ramp up	500	300	0
RTD real ramp down	0	200	500

TABLE 2: REAL RAMP VS UNEXPECTED RAMP UNDER DIFFERENT SCENARIOS

In the morning load ramp scenario, the net load can increase by 80 to 500 MW in 5 minutes. The upward real ramp need is 500 MW. The downward real ramp need is 0 MW because load is not going to decrease in the next interval. In contrast, with RTUC forecasted net load level of 24,400 MW, the upward unexpected ramp need is only 100 MW, but the downward unexpected ramp need is increased to 320 MW. Even the net load is unlikely to drop, and the system is striving to move units up from t to t+5, the system still has to keep 320 MW of downward ramping capability in interval t.

In the middle day scenario, because the RTUC net load at t+5 happens to equal the RTD net load at t, the ramp needs for these two options are also the same. Generally, if the RTUC net load at t+5 is close to the RTD net load at t, the ramp needs for the two options are also close.

Under the evening load drop scenario, the RTUC net load forecast is leading the RTD. In other words, the RTUC net load forecast underestimates the RTD net load. In this case, the unexpected ramp need is in the upward direction despite that the system net load is decreasing.

From the three scenarios, we observe that the real ramp need is always aligned with system condition. In other words, when system net load ramps up, we will have more upward real ramp need and less downward real ramp need, and vice versa. In contrast, the RTUC unexpected net load may not be aligned with system condition. If the RTUC net load underestimates the RTD net load, it can happen that the unexpected ramp need is in the opposite direction of the interval to interval net load change.

2.2 RTD DISPATCH EXAMPLE

The following RTD dispatch example is related to the morning ramp scenario. Assume there are three 500 MW online resources in the system that could provide flexible ramping. The bids and parameters of the three generators are listed in Table 3. G1 and G2 are fast resources with 100 MW/minute ramp rate, and G2 is a slow resource with 10 MW/minute ramp rate. G1 is the most economic resource with lowest energy cost and flex ramp cost. G3 is the least economic resource with highest energy cost and flex ramp cost. There are other resources in the system, which have self scheduled their outputs, and the total self schedule is 23,500 MW. The three generators, G1 and G2 and G3, will also meet the rest of the load beyond 23,500 MW. To simplify the discussion, let's consider only the load beyond 23,500 MW such that the load is 500 MW in interval t, and 900 MW in interval t+5, which will be met by the three generators.

Gen	EN Bid	FRU bid	FRD bid	En init	Ramp rate	Pmin	Pmax
G1	25	2	2	100	100	0	500
G2	30	5	5	400	10	0	500
G3	500	10	10	0	100	0	500

EN – energy FRU – flexible ramping up FRD – flexible ramping

TABLE 3: RESOURCE BIDS, INITIAL CONDITION AND OPERATIONAL PARAMETERS

Consider the binding RTD interval t optimization. Assume in the simultaneous optimization, two RTD intervals, t and t+5, are modeled. We will compare three cases: 1) without flex ramp, 2) with real flex ramp need, and 3) with unexpected ramp need. The real flex ramp requirement is 500 MW upward and 0 MW downward in both intervals. The unexpected flex ramp requirement is 100 MW upward and 320 MW downward in both intervals. There dispatch results are listed in Table 4, Table 5, and Table 6.

	Interval t			Interval t+5		
gen	Energy	Flex-ramp up	Flex-ramp down	Energy	Flex-ramp up	Flex-ramp down
G1	150			500		
G2	350			400		
G3						

TABLE 4: RTD DISPATCH WITHOUT FLEX RAMP

	Interval t			Interval t+5		
gen	Energy	Flex-ramp up	Flex-ramp down	Energy	Flex-ramp up	Flex-ramp down
G1	50	450		450	50	
G2	450	50		450	50	
G3					400	

TABLE 5: RTD DISPATCH WITH REAL FLEX RAMPNEED

	Interval t			Interval t+5		
gen	Energy	Flex-ramp up	Flex-ramp down	Energy	Flex-ramp up	Flex-ramp down
G1	220	100	220	500		320
G2	350		100	400	100	
G3						

TABLE 6: RTD DISPATCH WITH UNEXPECTED FLEX RAMPNEED

In the no flex ramp case, because G1 is the most economic resource, G1 should be used to meet energy as much as possible in both intervals. However, because the two interval optimization sees the 400 MW energy ramp from t to t+5, it tries to make the energy ramp feasible without using the least economic G3, and thus does not dispatch G1 to a level higher than 150 MW in interval t. This is to keep 350 MW ramping capability in interval t from G1 to meet the load ramp from t to t+5.

In the real flex ramp need case, G1 is dispatched even lower in interval t than the no flex ramp case. This is because G1 is needed to meet the upward flex ramp 500 MW, which is greater than the net load ramp 400 MW. This case is more costly than the no flex ramp case. However, in the next RTD run for binding interval t+5, if the t+5 RTD net load is higher than the expected 900 level, say 950 MW, then the no flex ramp case has to rely on the expensive G3, but the real flex ramp need case can still meet the net load without relying on G3. The real benefit of flexible ramping should be evaluated considering the total system cost under the probability distribution of net load.

In the unexpected flex ramp need case, because it has downward unexpected ramp need, the dispatch level of G1 in interval t has to be pushed up compared with the no flex ramp case. However, doing do will cause over generation in interval t. From interval t to t+5, the net load is increasing, so the energy dispatch is at a relatively low level in interval t. If the expected load in interval t+5 is high, and cause the system to keep fair amount of flexible ramping down capability in interval t, the unexpected flex ramp down requirement may fight with the power balance constraint in interval t, and produce undesired results.

The problem exists because the unexpected ramp need is based on interval t+5's net load forecast, while the requirement is in interval t, and being met with ramping capability in interval t. In interval t, being dispatched at 220 MW, G1 can only provides 220 MW of flexible ramping down. However, this is not the right amount of flexible ramping capability given G1 is dispatched up in t+5. G1 should be able to provide more flex ramp down up to 500 MW from the expected dispatch level 500 MW in interval t+5. Therefore, there is gap in attempting to meet the unexpected ramp of interval t+5 with ramping capability in the binding interval t probably, which may produce inadvertent results. It is better to model unexpected flexible ramping in the advisory interval t+5 so that the flex ramp award is based on the expected energy dispatch level in interval t+5. However, giving unexpected flexible ramping award in the advisory energy interval may produce false opportunity cost payment, because the energy dispatch in not binding in the energy advisory interval, and can be changed later.

In summary, there are two correct mathematical models for flex ramp:

- unexpected ramp modeled in the advisory RTD interval, and
- real ramp modeled in the energy binding RTD interval.

However, the advisory interval model may cause false opportunity cost payment. The only option to model flex ramp without incurring false opportunity cost payment is to model flex ramp in the energy binding interval meeting the real ramp need of the next interval.

3. CONSTRUCT THE FLEX RAMP DEMAND CURVE

Another fundamental question is how to set the flexible ramping requirement. The ISO presented two alternative ways to calculate the requirement in the technical workshop, the explicit approach and the implicit approach. The pros and cons are summarized in Table 7. In the technical workshop conference call, stakeholders also suggest a hybrid approach with explicit requirements on both ends and having a demand curve in between. Before exploring further in this direction, the ISO wants to propose another (better) way to construct the demand curve based on the distribution of power balance violations and violation penalties.

	Pros	Cons
Explicit approach	Straightforward.	Different requirements for DA, RTUC and RTD markets. Requirement needs to be tuned frequently to manage cost effectives.
Implicit approach	Same demand curves can be used for DA, RTUC and RTD markets. Can manage cost effectiveness.	Difficult to tune demand curve based system condition.

TABLE 7: THE EXPLICIT APPROACH VS THE IMPLICIT APPROACH

Assume the historical distribution of the power balance violation (PBV) without the flexible ramping product is available as listed in column 1 of Table 8. Column 1 only lists the power balance violation in the direction of power shortage. Power shortage distribution is used to calculate upward flexible ramping demand curve. The downward flexible ramping demand curve can be calculated similarly with the power balance violation distribution in the direction of over generation. Column 2 of **Error! Reference source not found.**~~Table 8~~ is the distribution of the power balance violations with 100 MW of flexible ramping with the assumption that 100 MW of upward flexible ramping would resolve any power balance violations below 100 MW. With 100 MW of flexible ramping, any 100 MW to 200 MW power balance violation, that would occur without flexible ramping, will become 0 MW to 100 MW violation; any 200 to 300 MW power balance violation, that would occur without flexible ramping, will become 100 MW to 200 MW violation; and so on.

We also assume the power balance violation in each category is uniformly distributed, and the average power balance violation in each category is listed in Table 9.

0 MW flex ramp	100 MW flex ramp	200 MW flex ramp	300 MW flex ramp
0-100 MW PBV, 0.3%	0-100 MW PBV, 0.2%	0-100 MW PBV, 0.1%	0-100 MW PBV, 0%
100-200 MW PBV, 0.2%	100-200 MW PBV, 0.1%	100-200 MW PBV, 0%	100-200 MW PBV, 0%
200-300 MW PBV, 0.1%	200-300 MW PBV, 0%	200-300 MW PBV, 0%	200-300 MW PBV, 0%

TABLE 8: POWER BALANCE VIOLATION PROBABILITY DISTRIBUTION WITH AVAILABLE FLEX RAMP

0 MW flex ramp	100 MW flex ramp	200 MW flex ramp	300 MW flex ramp
average(0-100 MW PBV)= 50 MW	average(0-100 MW PBV)= 50 MW	average(0-100 MW PBV)= 50 MW	average(0-100 MW PBV)= 50 MW
average(100-200 MW PBV)= 150 MW	average(100-200 MW PBV)= 150 MW	average(100-200 MW PBV)= 150 MW	average(100-200 MW PBV)= 150 MW
average(200-300 MW PBV)= 250 MW	average(200-300 MW PBV)= 250 MW	average(200-300 MW PBV)= 250 MW	average(200-300 MW PBV)= 250 MW

TABLE 9: AVERAGE POWER BALANCE VIOLATION

Power balance violation may cause the system to lean on regulation, and impose a reliability risk on the grid. Therefore, we should assign penalties for power balance violations to prevent it from happening often. Assume we assign power balance violation penalties as in **Error! Reference source not found.**~~Table 10~~.

Power balance violation	Penalty
0-100 MW	$1000/MWh
100-200 MW	$2000/MWh
200-300 MW	$3000/MWh

TABLE 10: POWER BALANCE VIOLATION PENALTIES

Then we can calculate the value of flexible ramping as follows. The system cost without flexible ramping and with 100 MW of flexible ramping is listed in Table 11. Therefore, the value of the first 100 MW of flex ramp is

(cost0 – cost100)/100 = (2300 – 550)/100 = $17.5/MWh.

Similarly, the value of the second 100 MW of flex ramp is (cost100 – cost200)/100 = (550 – 50)/100 = $5/MWh.

The value of the third 100 MW of flex ramp is

(cost200 – cost300)/100 = (50 – 0)/100 = $0.5/MWh.

Cost0 = system penalty cost associated with 0 MW flex ramp =	Cost100 = system penalty cost associated with 100 MW flex ramp =
Average(0-100 MW PBV)*0.3%*1000+ average(100-200 MW PBV)*0.2%*3000+ average(200-300 MW PBV)*0.1%*5000	Average(0-100 MW PBV)*0.2%*1000+ average(100-200 MW PBV)*0.1%*3000+ average(200-300 MW PBV)*0%*5000
= 50*0.3%*1000+ 150*0.2%*3000+ 250*0.1%*5000	= 50*0.2%*1000+ 150*0.1%*3000+ 250*0%*5000
= $2300/h	= $550/h

TABLE 11: SYSTEM COST COMPARISON OF NO FLEX RAMP AND 100 MW FLEX RAMP

Cost200 = system penalty cost associated with 200 MW flex ramp =	Cost300 = system penalty cost associated with 300 MW flex ramp =
Average(0-100 MW PBV)*0.1%*1000+ average(100-200 MW PBV)*0%*3000+ average(200-300 MW PBV)*0%*5000	Average(0-100 MW PBV)*0%*1000+ average(100-200 MW PBV)*0%*3000+ average(200-300 MW PBV)*0%*5000
= 50*0.1%*1000+ 150*0%*3000+ 250*0%*5000	= 50*0%*1000+ 150*0.1%*3000+ 250*0%*5000
= $50/h	= $0/h

TABLE 12: SYSTEM COST COMPARISON OF 200 MW FLEX RAMP AND 300 MW FLEX RAMP

The complete demand curve is as follows

MW	Price
0-100 MW	$17.5/MWh
100-200 MW	$5/MWh
200-300 MW	$0.5/MWh

TABLE 13: UPWARD FLEXIBLE RAMPING DEMAND CURVE

This method only relies on the following inputs:

- the distribution of power balance violations
- the penalties of power balance violations

The distribution of power balance violations can be analyzed with historical data. The penalties of power balance violations will need to be assigned based on the risk of lost load or over gen. This method provides a simple and transparent way to construct the demand curve for flex ramp.

4. COST ALLOCATION

The ISO has applied the cost allocation guiding principles in developing the cost allocation proposal for the flexible ramping product. The ISO briefed the Board of Governors on the guiding principles at the May board meeting. The ISO will finalize the cost allocation guiding principles after completion of this initiative. The ISO will then commence a stakeholder initiative to review other cost allocations to ensure consistency with the guiding principles. Based upon stakeholder comments to the draft final proposal and at the Board of Governors meeting, the ISO has renamed guiding principle three to better reflect the intent of the guiding principle. The cost allocation guiding principles have seven elements: (1) Causation, (2) Comparable Treatment, (3) Efficient Policy Achievement, (4) Incentivize Behavior, (5) Manageable, (6) Synchronized, and (7) Rational.

Based upon comments at the technical workshop and on the draft final proposal, the ISO has made the following changes:

- First allocate the costs for the flexible ramping product based upon movement of production of energy for netted supply, production of energy for netted fixed ramps, or consumption of energy for netted load that require changes in real-time dispatch of resources;
- For the load category, allocate costs based upon gross uninstructed imbalance energy;
- For the supply category, allocate costs based upon changes in uninstructed energy that is outside a 3% threshold based upon the resource's instruction;
- For the fixed ramp category, allocate costs based upon the net SC movement;
- Allow variable energy resources to utilize the 15 minute forecast as the baseline to measure uninstructed energy to calculate the billing determinant in the supply category;
- Allocate costs on an hourly basis and maintain monthly resettlement.

4.1 PROPOSED MOVEMENT BASELINE FOR FLEXIBLE RAMPING PRODUCT

The ISO proposes to initially allocate the costs for the flexible ramping product based upon movement that requires changes in real-time dispatch of resources. Movement for load is defined as changes in observed load every ten minutes. Movement for generation is defined as changes in uninstructed imbalance energy every ten minutes. Movement for static intertie ramps and internal self-schedules is calculated based upon the change in MWhs deemed delivered every 10 minutes. The ISO believes that movement is better aligned with the procurement decisions of the flexible ramping product because the movement represents the changes in RTD dispatch necessary to manage the system. This is more aligned with the Causation cost allocation guiding principle than the previous proposal of gross deviations.

The expectation of potential movement across all market participants results in the procurement of the flexible ramping product. When flexible ramping products are procured at the system level, the total system variability and uncertainty that may be realized as movement in RTD is the driver of the procurement target. There may be instances where on average two market participants offset each other's movement which decreases the overall system requirement. This offsetting impact decreases the quantity of the flexible ramping product the ISO must procure and is reflected in a lower system procurement target.

The flexible ramping cost is the product of the procurement target and the respective market clearing price paid to suppliers of the flexible ramping product. The costs include capacity procured in both the day-ahead and real-time market. The flexible ramping product costs are represented by the blue (Up) and green (Down) pies in Figure 2.

The upward flexible ramping product is procured to address variability and uncertainty that is observed as negative movement. The downward flexible ramping product is procured to address variability and uncertainty that is observed as positive movement.

All resources in a given category will be netted prior determining the initial division of system wide costs. By netting across all supply resources and scheduling coordinators with fixed ramps, the movement will be comparable with the load category which nets deviations across all load serving entities. The ISO will then determine an appropriate billing determinant for each category to allocate the costs to individual resources.

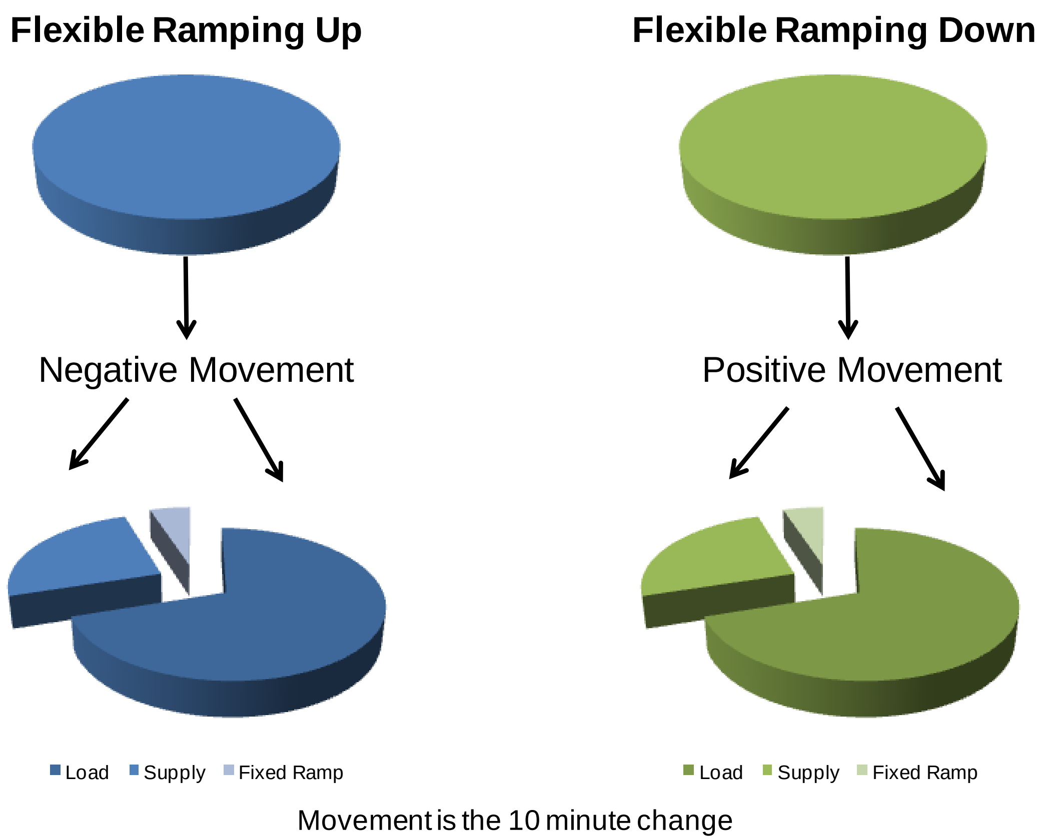

FIGURE 2 - FLEXIBLE RAMPING PRODUCT COST ALLOCATION

The ISO has analyzed data from January 1, 2012 through March 31, 2012. The following two graphs show the initial cost allocation to each of the categories by percentage on an hourly basis. It should be noted that the fixed ramp category does not include internal self-schedules.

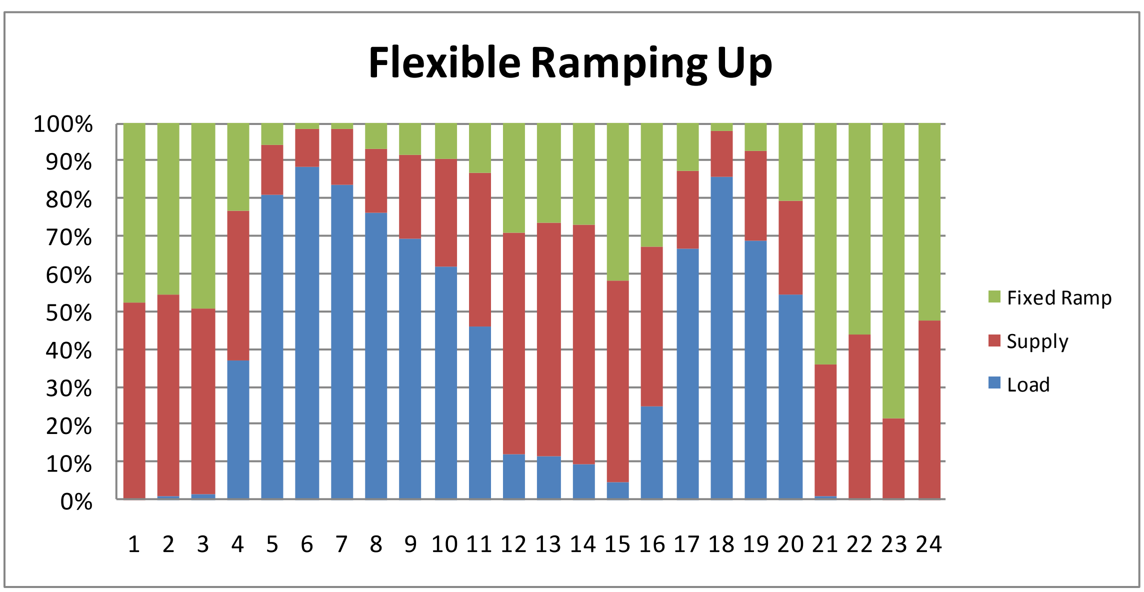

FIGURE 3 - % FRU MOVEMENT BY CATEORY

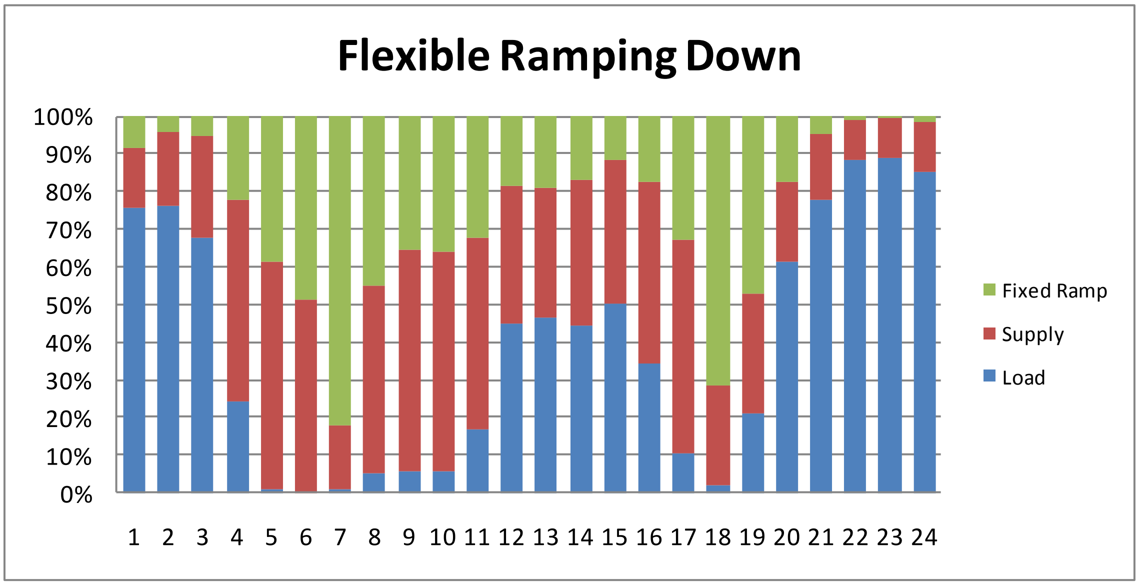

FIGURE 4 - % FRD MOVEMENT BY CATEGORY

The following two figures estimate the 5 minute average deviations in each hour by category.

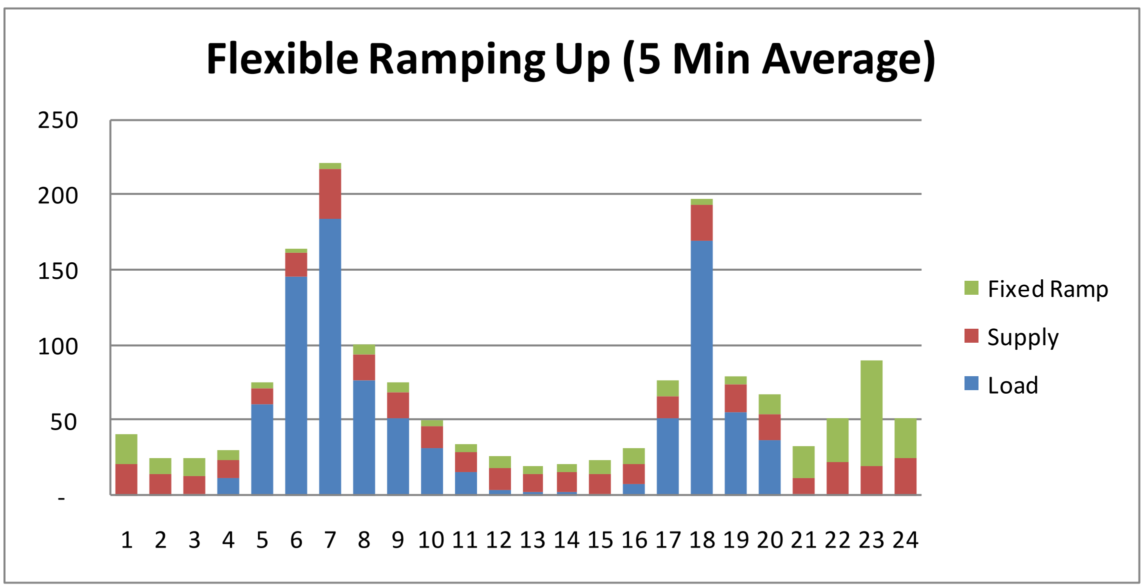

FIGURE 5 - AVERAGE FRU USING ESTIMATED 5 MINUTE MOVEMENT

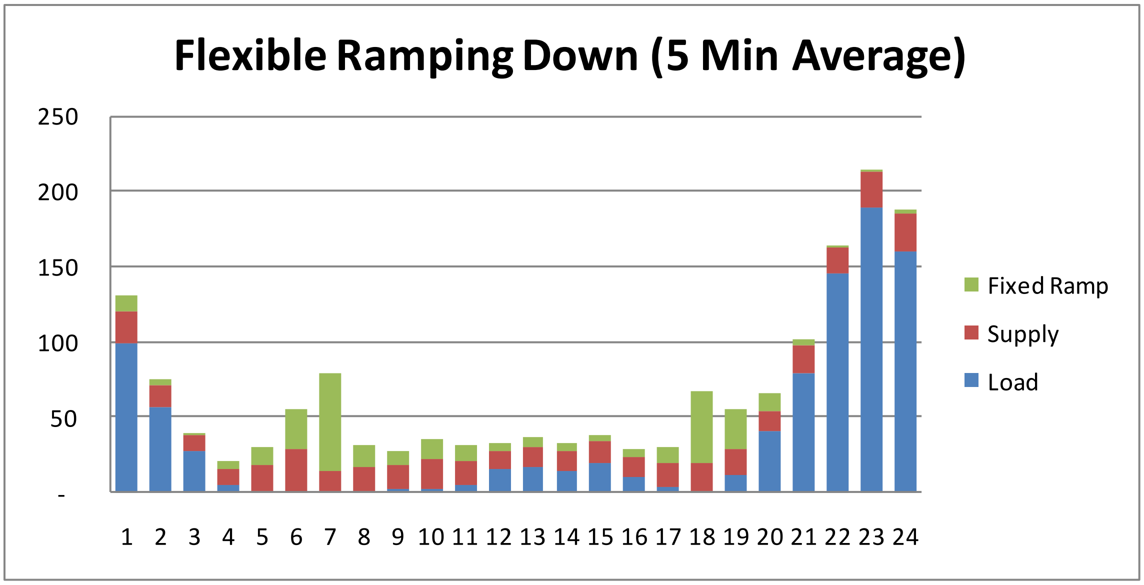

FIGURE 6 - AVERAGE FRD USING ESTIMATED 5 MINUTE MOVEMENT

The ISO has also posted a spreadsheet on the website which includes the movement and deviation data used to calculate Figures 3-6.

4.2 BILLING DETERMINANT OF LOAD CATEGORY

In the real-time market, Load does not submit economic bids or schedules. The ISO commits resources in RTUC to meet the CAISO forecast of CAISO demand (CFCD) and dispatches resource in RTD to meet the 5 minute load forecast. While metering of Load for energy settlement purposes is done on an hourly basis, the ISO can measure system demand with 10 minute granularly based upon actual observations. Ten minute granularity aligns with the metering of supply resources.

The ISO previously proposed to use the ISO RTPD demand forecast as the hourly profile to calculate the baseline for measuring Load deviations. However, the use of observed load movement removes any biasing that was embedded within the RTPD forecast which provides a better measure for the initial allocation.

The ISO is not requiring more granular metering of load by load serving entities. The ISO proposes to use gross uninstructed imbalance energy to determine the share of flexible ramping costs attributable to each load serving entity. While uninstructed imbalance energy is based upon day-ahead scheduled load, the ISO believes that if load serving entities more accurately predict hour to hour load ramp in the day-ahead market, the ISO should be able to reduce the amount of flexible ramping procured to meet variability and uncertainty that results from hourly ramps.

If a load serving entity uses 10 minute metering, such as load following metered sub-systems, then the load serving entity would be considered within the supply category discussed in the next section.

4.3 BILLING DETERMINANT OF SUPPLY CATEGORY

The supply category will be allocated based upon the 10 minute change in uninstructed deviations. Conventional generation deviations will be measured based upon changes in uninstructed imbalance energy. Variable energy resources can elect to be measured based upon changes in their deviation to their 15 minute real-time forecast made 37.5 minutes prior to the RTPD interval.

The use of the change in uninstructed deviations recognizes that the ramp requirement only occurs once. For example, assume a resource negatively deviates 10 MW for the entire hour. Once the deviation occurs, another resource must be dispatched up 10 MW to make up the shortfall; however, no additional ramp is required to address the subsequent uninstructed deviations.

The implementation of the cost allocation based upon changes in uninstructed deviations is more complex than utilizing gross uninstructed deviations as previously proposed to allocate the supply category. Given the added complexity, the ISO seeks stakeholder comments on the advantages of using changes in UIE versus gross UIE.

4.3.1 BASELINE TO MEASURE DEVIATIONS FOR CONVENTIONAL RESOURCES

The ISO has two types of uninstructed imbalance energy. Uninstructed imbalance energy 1 (UIE1) measures a resource's deviations up to its five minute dispatch over the 10 minute settlement interval. If a resource deviates greater than the 5 minute dispatch, the remaining deviation is measured as uninstructed imbalance energy 2 (UIE2). The flexible ramping products are procured for generation which has deviated from both its hourly schedule and ISO dispatch. If a resource deviates from the ISO dispatch, the subsequent RTD interval will dispatch other internal generation to make up the shortfall. As a result, the 10 minute change in UIE1 and UIE2 will be counted towards the allocation of flexible ramping costs because other resources will have to be dispatched to address those deviations.

Conventional resources that are dynamically transferred will also be allocated based upon UIE1 and UIE2 changes.

4.3.2 BASELINE TO MEASURE DEVIATIONS FOR VARIABLE ENERGY RESOURCES

Currently the participating intermittent resource program (PIRP) requires resources to submit the ISO provided hourly forecast as a real-time self schedule in order to be eligible for monthly netting of imbalance energy. The ISO proposes to use the real-time forecast of variable energy resources (both PIRP and non-PIRP) if the resource elects this option. If a variable energy resource does not select this option, the measurement on uninstructed energy will be the same as conventional generation which is based upon schedule and dispatch. The real-time forecast will be used from 37.5 minutes prior to the "binding" RTPD interval. Every 15 minutes, the resource forecast will be updated and used as the baseline for the next "binding" RTPD interval.

In order to be consistent with the Comparable Treatment guiding principle, the use of the real-time forecast is similar to conventional generation reporting of an outage. For conventional resources, once an outage is entered through SLIC, the imbalance energy is considered instructed imbalance energy even though it is settled at the real-time LMP.

Previously, the ISO proposed to allow variable energy resources to submit their own expected energy output. Several stakeholders expressed concerns of potential gaming. For example, in periods where the cost of flexible ramping up is high, the resource could avoid the allocation by always ensuring that they have positive uninstructed imbalance energy. In addition, CalWEA expressed concerns regarding additional complexity for variable energy resources and that resources could incur additional costs in order to provide the expected energy output. As a result, the ISO now proposes to use the third party ISO forecast for the baseline for measuring changes in uninstructed energy.

The deviations will be calculated for each 10 minute settlement interval based upon the rolling 15 minute real-time forecasts. The 15 minute baselines will be converted to 10 minute intervals to align with the metering of internal generation. For example, assume two RTPD intervals. Interval 1 the real-time forecast is 15 MWh and interval 2 the forecast is 30 MWh. The baseline for the 10 minute settlement interval 1 is 10 MWh, settlement interval 2 is 15 MWh, and settlement interval 3 is 20 MWh.

4.3.3 THRESHOLD FOR ALLOCATION

Several stakeholders have commented that a threshold, similar to the uninstructed deviation penalty threshold, should be considered for allocating the supply category. The threshold would not be used for the initial splitting of the flexible ramping costs in to the three categories, but would recognize that perfect adherence to dispatch is not realistic based upon resource operational characteristics. However, if a threshold was implemented the cost allocation should be more manageable and resources would be incentivized to make investments that could improve their performance to dispatch to stay within the threshold. This is consistent with the Management and Incentive Behavior cost allocation guiding principles.

The ISO proposes to allow a 3% threshold for allocation of the supply category. Unlike the uninstructed deviation penalty, the threshold will be based upon the resource's instructed energy. For example, assume a resource has instructed energy of 10 MWh in a given settlement interval, if the resource's actual metered output was less than 9.7 MWh, the resource's deviation would be allocated flexible ramping up costs. If the resource's actual metered output was greater than 10.3 MWh, the resource would be allocated flexible ramping down costs. State differently, if the change in uninstructed deviations exceeds 3% of the instructed energy, the resource will be allocated a portion of the supply category costs. Preliminary analysis by the ISO shows that using a threshold will not result in the need to consider a two-tiered allocation for the supply category. The threshold is only applied after the costs are split in to each of the three categories. The threshold is only proposed for the allocation of costs from the supply category.

4.4 BILLING DETERMINANT OF FIXED RAMP CATEGORY

The fixed ramp category allocates cost based upon the net movement within a SC for imports, exports, operational adjustments and self-schedules. Static hourly schedules for Imports and Exports require the ISO to manage dispatchable resources to honor the twenty minute ramp for hourly schedule changes. Internal self schedules require the ISO to manage dispatchable resources to honor the resource's ramp rate between hourly schedules. Internal generation can avoid the fixed ramp allocation by submitting a real-time economic bid. The submission of the economic bid allows the ISO to dispatch the resource if the modeled ramp between hourly schedules is not aligned with system conditions.

The ISO must honor the modeled ramps even if the ramp is counter to existing system conditions. By using movement for fixed ramps, when the fixed ramp movement is aligned with the load change, the allocation will be for the flexible ramping product in the opposite direction of load movement. For example, in the morning load pull, the ISO will require more flexible ramping up. If in this hour, net imports are increasing, the fixed ramp movement will be positive which results in an allocation towards flexible ramping down. The requirement for flexible ramping down will be significantly smaller than flexible ramping up requirement during the load pull.

4.5 COST ALLOCATION GRANULARITY WITHIN THE DAY

Several stakeholders commented that the costs of flexible ramping products may be different by hour. Therefore resources which deviate in specific hours with high flexible ramping product procurement costs should receive a higher relative cost allocation. For example, a solar resource will not deviate during the night as its output will be zero, but using daily granularity this is not reflected in its flexible ramping product cost allocation. The ISO is proposing hourly level granularity. Previously, the ISO was concerned that this may lead to the need to implement a two-tiered allocation due to insufficient deviations. However, the ISO believes that the monthly re-settlement of flexible ramping costs at the resource level is sufficient to mitigate the need for a second tier. As Figure 5 illustrated below the flexible ramping constraint has seen sufficient hourly differences.

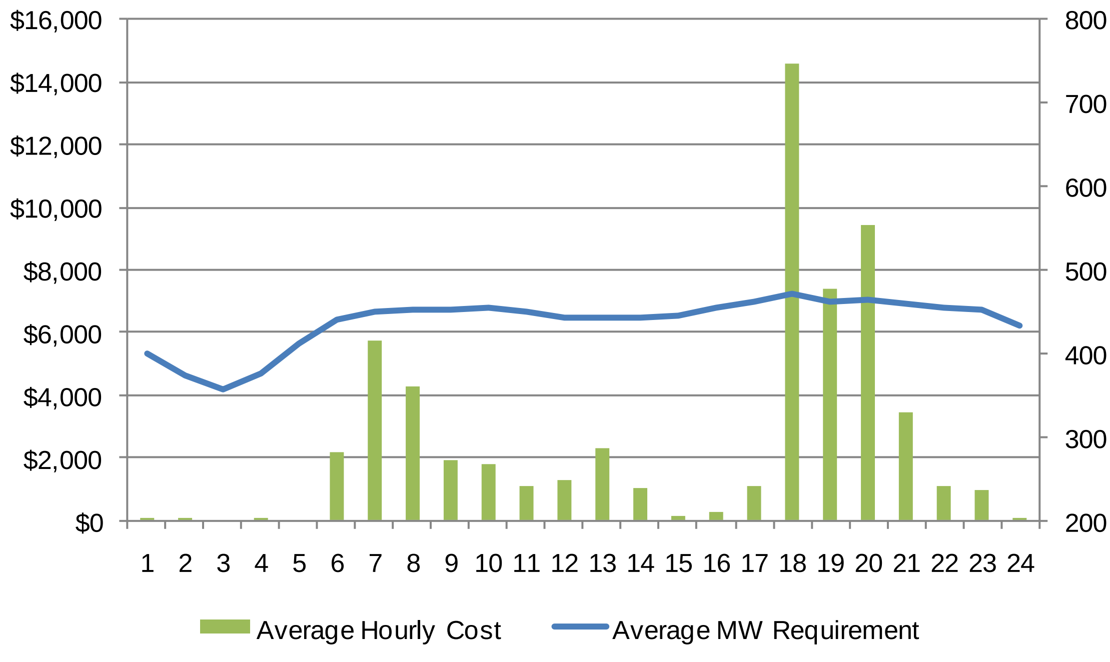

FIGURE 7 - HOURLY FLEXIBLE RAMPING CONSTRAINT COSTS JANUARY TO MARCH 2012

Utilizing the hourly cost of the flexible ramping constraint, the ISO can estimate the cost allocation by category for flexible ramping up. The ISO is currently not enforcing a constraint for flexible ramping down. The total cost of the flexible ramping constraint from January 1, 2012 through March 31, 2012 was $5.7 million. Using the percentage splits from Figure 5, the allocation to the load category would be $3.4 million (62%), the supply category would be $1.3 million (24%), and fixed ramps would be $0.8 million (15%). Note that the data of the fixed ramp category only includes static intertie ramps and does not include internal self-schedules.

4.6 MONTHLY RE-SETTLEMENT

Since the flexible ramping products are procured based upon forecasted variability and uncertainties, when a resource deviates in a specific settlement interval, it cannot be concluded that the resource's actual deviation caused the flexible ramping product to be procured for that settlement interval. Consistent with the Synchronization guiding principle, the ISO proposes to re-settle costs based upon the monthly rate per deviation for each operating hour. The monthly rate will be determined by the total costs incurred during the month divided by the sum of positive (or negative for flexible ramping product up) deviations across all resources for each operating hour. On an hourly basis, scheduling coordinators will be allocated flexible ramping product costs as a share of their resources deviations. At the end of the month, these hourly charges will be reversed, and the resource will be charge the monthly rate for each of its deviations for each hour of the day.

4.7 ASSIGNMENT OF FLEXIBLE RAMPING COST ALLOCATION

The flexible ramping costs will be allocated to scheduling coordinators. In order to facilitate implementation of bilateral contracts, the ISO will implement functionality to allow assigning of the flexible ramping product cost allocation at the resource level between scheduling coordinators.

5. PLAN FOR STAKEHOLDER ENGAGEMENT

Item	Date
Post Supplemental Paper and Data	July 11, 2012
Stakeholder Meeting	July 17, 2012
Stakeholder Comments Due	July 24, 2012
Post Revised Draft Final Proposal	August 9, 2012
Stakeholder Meeting	August 16, 2012
Stakeholder Comments Due	August 23, 2012
Post 2nd Revised Draft Final Proposal	September 11, 2012
Stakeholder Meeting	September 18, 2012
Stakeholder Comments Due	September 25, 2012
Board of Governors Meeting	November 1-2, 2012

6. NEXT STEPS

The ISO will discuss the special edition with stakeholders at a meeting to be held on July 17, 2012. The ISO is seeking written comments on the revised straw proposal by July 24, 2011. Stakeholder comments should be sent to FRP@caiso.com.