Resource Adequacy Availability Incentive Mechanism Modification: Draft Final Proposal

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Table of Contents

1. Executive summary

The ISO conducted a review of its Resource Adequacy Availability Incentive Mechanism (RAAIM), including its implementation, performance, and the RAAIM tariff language. Based on this review, the ISO concluded that:

1) Following go-live on April 1, 2017, the ISO and market participants detected minor errors in implementing the RAAIM policy. The ISO will correct these defects and issue revised settlement statements effective April 1, 2017. The ISO has posted a list of these errors on its website.[1]
2) The availability calculation methodology approved in RAAIM allows a resource to reduce its exposure to RAAIM charges by merely adding flexible capacity to its showing. This reduces the incentive for a resource to follow its must offer obligations and to provide replacement capacity in the event of an outage.

In this white paper, the ISO describes the current RAAIM calculation, including its basis in the Reliability Services Initiative – Phase 1 (RSI1) policy development, how the availability calculation methodology can lead to the outcome described in item (2), above, and how the ISO is seeking to modify the availability calculation methodology in this initiative. After assessing RAAIM performance and settlement following implementation, the ISO, with the help of stakeholders, recognized the problematic outcomes and potential manipulation opportunity associated with the RAAIM calculation methodology. To address the problem, the ISO determined that modifications to the RAAIM availability assessment calculation are needed, and the ISO intends to implement such modifications on a prospective basis.

The goal of RAAIM was to improve incentives for Generic resource adequacy[2] capacity to be available consistent with the must-offer obligation and to create comparable incentives for flexible capacity. The intent was not to create incentives that favored or more-heavily weighted one type of capacity over the other (or at the expense of the other). However, the current RAAIM calculations allows a resource providing a significant quantity of Generic RA to reduce its RAAIM exposure by providing only a single MW of flexible capacity. This degrades these resources' incentive to provide replacement capacity, which can result in the need for backstop procurement and impact the ISO's ability to reliably operate the grid during peak load conditions.

The root of the problem with the current calculation can be described, at a high level, as an issue with how the current formula accounts for must offer obligation hours and MWs. The current formula drastically overweights flexible RA performance, which in turn drastically skews the performance incentives. The current RAAIM formula essentially assesses resource availability based on an hourly MW availability basis and then averages the resources' hourly MW availability for all RA products into a single monthly availability percentage (%) value. This approach does not properly account for both the overlap and variation in Generic and Flexible RA availability assessment hours and the associated assessment hours that are utilized in these calculations. This approach values flexible RA capacity much greater than system and local capacity and can essentially "discount" the performance of system

[1] https://bpmcm.caiso.com/Pages/ViewPRR.aspx?PRRID=1012&IsDlg=0
[2] Generic RA resources include both system and local RA.

and local capacity. This also creates the potential for manipulation of RAAIM assessments and associated penalties or payments. Specific examples of how this "discounting" impacts availability calculations are provided in section 3.1.

In this White Paper, the ISO also describes its proposed solution to modify the RAAIM availability assessment calculation to more appropriately assess resource availability based on the daily availability of a resource and properly align the objective of RAAIM and the availability calculations used. The ISO's proposed solution is a modified approach that evaluates resources on a daily MW availability basis for Generic and Flexible RA separately and then calculate a separate, average monthly availability for both Generic and Flexible RA. This modification will calculate daily availability values for system and flexible RA capacity separately to determine a charge or payment for each of the two RA products provided by resources. Calculating the availability of Generic RA and Flexible RA separately ensures that each one has comparable incentives and eliminates the potential interactions that could impact the incentives for each product. Given the identified shortcomings reflected in the performance of the current RAAIM formula and the potential that the Flexible RA product and associated must offer obligations could change in the future, the ISO believes this modified approach is a more appropriate, straightforward, and pragmatic approach that can be adapted to future flexible RA capacity requirements.

2. Background

The ISO's Standard Capacity Product (SCP) was the first tool the ISO developed to incentivize resource availability and encourage resources to provide replacement capacity for resource adequacy (RA) resources. The SCP charged resources with low availability measures and provided a payment to those with high availability measures. The SCP assessed availability based on forced outages. After completing the Flexible Resources Adequacy Criteria and Must Offer Obligation (FRACMOO) stakeholder process, the ISO sought to ensure there was a process to incentivize the availability of flexible RA capacity comparable to Generic RA capacity subject to SCP. As part of the RSI1 stakeholder process, "[t]he CAISO and stakeholders determined… that, although the existing [SCP] mechanism is creating incentives for local and system resource adequacy capacity to be available for service, the incentives are not sufficient, and an enhanced mechanism is necessary."[3] Further, with the introduction of flexible capacity, there was additional need to ensure that similar incentives were made available for flexible capacity. The objective was to ensure both generic and flexible RA capacity had comparable incentives to ensure their availability.

In the RSI1 initiative, the ISO developed the RAAIM tool with a goal of ensuring resources had the proper incentives to (1) be available to the ISO consistent with the must-offer obligation for the type of RA which a resource provided and (2) provide replacement capacity if the resource went on a forced outage. FERC accepted tariff revisions to implement this policy on October 1, 2015.[4] The ISO implemented the RAAIM provisions on April 1, 2017. Based on initial questions from stakeholders

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3 http://www.caiso.com/Documents/May29_2015_TariffAmendment_Implement_Phase1A_ReliabilityServicesInitiative_ER15-1825.pdf at p. 29.

4 *California Independent System Operator Corporation,* 153 FERC ¶61,002 (2015).

regarding perceived anomalies on their settlements statements, the ISO conducted a review to determine the cause of the anomalies. Through this review, the ISO identified several ministerial errors with the implementation of the RAAIM policy and, more significantly, the ability for a resource to significantly reduce the incentive to be available consistent with its must offer obligation.

3. Schedule

Date	Milestone
Aug 31	Post White Paper and Spreadsheet
Sep 7	Hold Stakeholder call on White Paper
Sep 14	Stakeholder comments on White Paper due
Sep 21	Post Draft Final Proposal
Sep 28	Hold Stakeholder call on Draft Final Proposal
Sep 28	Stakeholder comments on Draft Final Proposal due
Nov 1-2	Present Proposal to Board of Governors

3.1. Stakeholder comments on White Paper

The ISO received six sets of comments to the proposed modifications in the white paper. Calpine and Six Cities both submitted comments generally supportive of the ISO's proposed revisions, while still reserving final judgement based on the implementation of the policy. CDWR sought additional clarifications day-ahead and real-time treatment as well as economic bidding versus self-scheduling. SDG&E raised concerns with the ISO's determination that the revisions should only apply prospectively. SCE submitted comments asserting there is a deeper issue with the penalty structure using the same price for both generic and flexible RA. PG&E asked for additional details regarding which variable impact the calculations, the steps taken in the calculation, and additional for additional time. The ISO also agrees with commenters that additional details on the formulas and the treatment of various inputs into those formulas as well as the policy will help provide clarity. As such, additional details are provided in the body of the document to address stakeholder concerns. The ISO provides the following replies in response to the comments that have been submitted by these parties.

PG&E Comments: PG&E requests additional details, including proposed tariff revisions, and examples prior to completing a draft final proposal. In response, the ISO is including the equations that will be core to the BPM development and documentation, which are included in Appendix B.[5] The

[5] These equations are intended to reflect the policy modifications contained herein and the calculations depicted in the spreadsheet at http://www.caiso.com/Documents/ProposedRAAIMCalculationModificationsModel-ForDraftFinalProposal.xlsx. Any formulaic errors detected during the implementation process will be reviewed with stakeholders and corrected to ensure consistency with this new policy.

ISO believes Board approval of these revisions prior to the end of the year are critical to ensuring the revisions can be put in place in time for spring 2018. Delay beyond the November 2017 Board meeting would delay implementation until fall 2018. The ISO further notes that the spreadsheet developed for the white paper does not capture outage replacement and exemptions. Therefore, the ISO has added a section to this draft final proposal to clarify the treatment of outage replacement and exemptions in section 0.

SCE Comments: SCE has outlined an example that shows how two resources, one providing only generic and another providing only flexible, will result in a different penalty than a single resource providing both generic and system RA. The ISO acknowledges that the penalties demonstrated in the SCE example are correct. However, RAAIM is calculated on a resource-by-resource basis, not over multiple resources. SCE brought forward similar arguments in the initial RSI1a tariff filing. FERC has opined on this matter and determined that the use of the highest MOO as the determinant of availability is just and reasonable. The ISO is not proposing to change this principle.

SDGE Comments: While the ISO believes that the proposed changes are consistent with the high level policy approved by the ISO Board of Governors and FERC, the actual calculation of the RAAIM charges and incentives is core to achieving the over-arching policy objective to provide the correct incentives to follow a must offer obligation (MOO) and provide replacement capacity. Further, the ISO believes that the division of generic and flexible RAAIM calculations is a substantive change, thus warranting a prospective treatment. SDG&E asserts that the only difference between the existing calculation and the proposed calculation is the division of the system and flexible RA. SDG&E asserts that after the division of generic and flexible, all of the other calculations in the proposed modification will ultimately result in the same outcome as the current methodology. Specifically, SDG&E asserts that the split of generic and flexible capacity is a sufficient change, that the transition from hourly calculations to daily assessments is not needed, and demonstrates that the "existing formula is consistent with the Tariff and policy and it's the implementation of the formula that's inaccurate." This assertion is incorrect. The use of daily assessments is needed to prevent weighting issues where in a given month a resource has category 1 flexible capacity on some days, and categories 2 and 3 on others. This is a similar issue to that which is described for generic and flexible in section 4.1.1, below.

Beyond these responses, the ISO continues to encourage all stakeholders to test examples and scenarios in the spread sheet provided. For example, all of the examples in this draft final proposal can be tested using the spreadsheet provided. As noted above, actual configuration for outage replacement and exemptions are described herein, but final calculations will be developed in through the implementation process.

4. Review of RAAIM Implementation and Performance

The ISO's review uncovered (1) minor implementation errors and (2) recognized that the RAAIM availability assessment greatly overvalues flexible RA capacity, may not sufficiently incentivize resources to replace capacity, and potentially can incentivize gaming. As to the first issue, the ISO will correct the implementation errors and recalculate and re-settle RAAIM charges and payments back to April 1, 2017. The ISO will address the second issue through a tariff filing at the conclusion of this

stakeholder process. The primary issue with the existing RAAIM formula arises because the availability assessment calculation allows a resource to significantly reduce its exposure to RAAIM charges by making only slight modifications to its flexible RA category 1 capacity on RA supply plans. The fundamental issue related to this rule involves treating all hours with an availability assessment hour equally and calculating monthly availability as a function of hours. This allows flexible RA to inappropriately skew the outcome of the RAAIM calculation. The flaws with the current availability assessment issue has two issues: the equal weighting of all hours and the use of all hours to scale the average monthly MWs with a requirement at the end of a month. These problems are detailed below.

The current calculation method allows resources to significantly reduce their exposure to availability charges and reduce the incentive to follow must offer obligations or provide substitute capacity during outages.[6] Determining the proper weight to place on each MW, each hour, and each day is important for purposes of fairly and effectively assessing the availability of a resource and the magnitude of any charges against or incentive payments made to the scheduling coordinator for the resource.

4.1. Equal weight for all hours with a must offer obligation

When a scheduling coordinator shows only system capacity, the problem of assessing availability is fairly straight forward. For example, if a 100 MW resource is a system only resource for one day (5 availability assessment hours) and has a one-hour outage, the resource is 100 percent available for four hours and zero percent available for the final hour. On average for that day, the resource is 80 percent available. However, if the scheduling coordinator shows 1 MW from that resource as flexible RA, there are multiple ways to calculate the availability of the resource, each potentially yielding different results. Without clarifying this calculation, scheduling coordinators could potentially reduce their exposure to availability charges and reduce the incentive to follow must offer obligations or provide substitute capacity during outages.

The RAAIM calculation developed in the RSI 1 stakeholder initiative specifies that complying with a 1 MW flexible RA capacity obligation for one hour at 7:00 a.m. is of equal weight to complying with a 1 MW system RA capacity obligation for one hour at 4:00 p.m. On the face, this may appear to be a reasonable methodology for assessing availability. However, treating all hours equally has the unintended consequence of placing far greater weight on 1 MW of flexible RA than is placed on 1 MW of system RA when all of the hours are summed together over the month. For example, 1 MW of flexible capacity must economically bid for 17 hours to meet its must offer obligation, while 1 MW of system capacity only needs to be available for five hours to meet its must offer obligation. In other words, if the CAISO were to treat all hours with a must offer obligation equally, and there are more hours of flexible RA capacity obligations, then 1 MW of flexible RA capacity will have a much larger effect on the availability calculation than 1 MW of system RA capacity. This places substantially more

[6] A slightly modified version of the spreadsheet developed in the RSI1 policy development process is available at http://www.caiso.com/Documents/ResourceAdequacyAvailabilityIncentiveMechanismCalculationCalculator.xls. Only two modifications have been made. First, for transparency, the ISO has unhidden a sheet that was hidden in the original sheet. Second, the ISO has corrected an autofill feature for flexible capacity that will be corrected as part implementation error corrections.

weight on a day with flexible RA relative to a day with only Generic RA. This allows a resource to dilute its incentive to make its capacity available to the ISO during peak load hours.

4.1.1. Examples of equal weight for all hours with a must offer obligation

The following examples show how the current availability calculation can inappropriately skew RAAIM charges and payments.

Availability Assessment Hours

System: 5 hours, non-holiday weekdays

Category 1 Flexible RA: 17 hours, everyday

Category 2 Flexible RA: 5 hours, everyday (may be different hours than system RA)

Category 3 Flexible RA: 5 hours, non-holiday weekdays (may be different hours than system RA)

Example 1:

Two day month, both weekdays. 1 MW of system RA capacity on both days, and 0 MW of Category 1 flexible RA capacity shown. Resource is fully out on the first day, and fully available on the second.
Step 1: Calculate the sum total of RA capacity obligation across all hours. 1 MW times 5 hours for the first day of system RA, and 1 MW times 5 hours for the second day, for a total of 10.
Step 2: Calculate compliance. 0 MW times 5 hours for the first day of system RA, and 1 MW times 5 hours for the second day, for a total of 5.
Step 3: Determine the percent availability. Divide 5 by 10. **The resulting availability equals 50%.**

Example 1 demonstrates an expected availability percentage of 50%, where the resource is on outage for 1/2 of the days it was shown for some type of RA.

Example 2:

Two day month, one weekday and one weekend. 1 MW of system RA capacity on the weekday and 1 MW of Category 1 flexible RA capacity weekend.[7] Resource is fully out on the weekday and fully available on the weekend.
Step 1: Calculate the sum total of RA capacity obligation across all hours 1 MW times 5 hours of system RA on the weekday, and 1 MW times 17 hours for the flexible RA capacity on the weekend, for a total of 22.
Step 2: Calculate compliance. 0 MW times 5 hours of system RA on the weekday, and 1 MW times 17 hours for the flexible RA capacity on the weekend, for a total of 17.
Step 3: Determine the percent availability. Divide 17 by 22. **The resulting availability equals 77.2%.**

Example 2 demonstrates that the resource could be on outage for 1/2 of the days it was shown for some type of RA, same as in example 1, but the availability calculation will show it as being more than 3/4 available. This shows that resource has effectively q1cut the incentive to provide replacement capacity for system RA in half. This is relative to the calculation in example 1.

Example 3:

Three day month, two weekdays and one weekend. 1 MW of system RA capacity on both weekdays and 1 MW of Category 1 flexible RA capacity weekend. Resource is fully out on both weekdays and fully available on the weekend.
Step 1: Calculate the sum total of RA capacity obligation across all hours. 1 MW times 10 hours for both days of system RA, and 1 MW times 17 hours for the flexible RA capacity, for a total of 27.
Step 2: Calculate compliance. 0 MW times 10 hours for both days of system RA, and 1 MW times 17 hours for the flexible RA capacity, for a total of 17.

[7] A weekend day is used for flexible RA in example 2 to avoid any confusion regarding generic and flexible RA, the calculation would be the same for if a weekday had been used. This is true regardless of whether the resource shows zero or one MW of system RA on that day.

Step 3: Determine the percent availability. Divide 17 by 27. **The resulting availability equals 62.9%.**

Example 3 demonstrates that the resource could be on outage for 2/3 of the days it was shown for some type of RA, but the availability calculation will show it as being almost 2/3 available.

Example 4:

Two day month, one weekday and one weekend. 2 MW of system RA capacity on the weekday, and 1 MW of Category 1 flexible RA capacity for both days. Resource is derated by 1 MW on the weekday and fully available on the weekend.
Step 1: Calculate the sum total of RA capacity obligation across all hours. 1 MW times 5 hours for the day of system RA that is beyond the flexible RA, and 1 MW times 34 hours for both days of flexible capacity, for a total of 39.
Step 2: Calculate compliance. 0 MW times 5 hours for the one day of system RA that has been derated and is beyond the flexible RA (This assumes the resource economically bids the other MW), and 2 MW times 17 hours for the weekend day of flexible capacity, for a total of 34.
Step 3: Determine the percent availability. Divide 34 by 39. **The resulting availability equals 82.2%.**

Example 4 demonstrates the impact the current availability assessment calculation can have in reducing the incentive to provide system capacity to meet peak load. In this example, the resource provides only 66 percent of the MWs it committed to provide, but receives credit for providing over 80 percent of its capacity. Specifically, the incentive to provide replacement capacity for anything above the flexible RA value is significantly diminished.

These examples demonstrate the fundamental problem with the current RAAIM calculation treating all hours. Specifically, they demonstrate that the number of hours from flexible capacity, particularly flexible RA Category 1, have a disproportionate weight on the availability calculation. The examples show that including flexible RA affects the availability changes in a disproportionate manner, weighting flexible RA MWs much more heavily. Further, they show how the current methodology reduces the incentive to provide system RA needed to address peak load conditions.

4.2. Monthly penalty comprised of a series of hourly assessments

A second issue the ISO identified is how the current policy attempts to scale capacity to assess a monthly penalty comprised of a series of hourly assessments. Specifically, the current calculation scales the availability requirement and performance based on the average MW with a MOO in a given availability assessment hour. The following example demonstrates this outcome using the current methodology. If one resource has 100 MW of system capacity, the average capacity with a MOO in a given hour would be 100 MW (i.e., (100*5)/5). However, if another similar 100 MW system capacity resource simply adds one MW of flexible capacity, then the average MWs of the resource with a MOO in a given hour changes to 30.11 MW (i.e., [(99*5)+(1*17)]/17]. This allows the resource to appear to have less MWs to assess for availability, according to the current calculation. If the two similar 100 MW resources described above were both 75 percent available, one would be subject to a penalty for a 25 MW deficiency at $3.79/kw-month, while the other would be subject to a penalty for only a 7.5 MW deficiency.[8] As a result, the first resource would face a penalty of $94,750, but the second resource would only face a penalty of $28,303.

This is significant because RA is a product of capacity measured in MWs. However, the existing availability assessment is essentially a function of the number of hours or MWh, not MWs.

A related issue is that the calculation sums all hours over the month, The RA process requires LSEs and resource to submit RA showings and supply plans, respectively, 45 days prior to the beginning of the month. While most of these showings demonstrate that a resource will provide RA for an entire month, the ISO allows for daily RA designations in the demonstrations, and replacement and substitution capacity can be provided on a daily basis. The ISO does not allow for hourly RA showings.[9] The current methodology does not recognize that RA is a daily product.

The current methodology thus creates an incentive to simply show 1 MW of flexible capacity, which can significantly reduce exposure to availability charges. The issue described above also reduces the incentive for resources to follow their MOOs and provide substitute capacity during outages.

As explained above, the ISO's review concluded that two features of the current methodology cause it to produce problematic results that allow a resource to significantly reduce its exposure to RAAIM charges by adding flexible capacity to its showing. The primary objectives of the RAAIM policy were to ensure resources have the proper incentives to: (1) be available to the ISO consistent with their applicable must-offer obligations and; (2) provide replacement capacity if the resource goes on a forced outage. These are proper policy objectives, however, the RAAIM formula that was developed to assess availability has unintended consequences and does not fully achieve these objectives.

5. Proposed Modifications to Resolve Issues

A resource's availability should reflect its ability to provide a given product on a given day. Further, the availability or the number of hours required of one product should not have a direct impact on the

[8] Actual availability calculations start at availability of 94.5 percent and less. However for simplicity of explaining the examples, the ISO is using 100 percent as the availability standard.
[9] The ISO does allow for midday outage replacement. However, that replacement must be designated through at least the end of the next day. See tariff Section 40.9.3.6(c)(2) and Section 9.3.1 of the Reliability Requirements Business Practice Manual for additional details.

incentive to be available for another product. Meeting these important principle requires an assessment of the compliance with a must offer obligation for a day for that product, not for an hour for all products.

The ISO proposes to resolve the issues identified above by making three modifications to the current RAAIM calculation.

1) Calculate availability as a MW value each day, and for each product, instead of MW by hour.
2) Calculate availability for system RA and flexible RA separately.
3) Scale RAAIM penalty and incentive based on the number of days the resource was shown for system RA and flexible RA separately relative to how many days it could have been shown.

The ISO has created a new spreadsheet designed to more clearly demonstrate how the new RAAIM availability assessment. This new spreadsheet is available at http://www.caiso.com/Documents/ProposedRAAIMCalculationModificationsModel-ForDraftFinalProposal.xlsx.

All tabs within the spreadsheet are visible and color-coded to align with the descriptors on the "Read me" tab.

A complete example of the ISO's proposed solution is described in the appendix of this paper and included in the above spreadsheet.

5.1. Calculating Daily Availability

To remedy the problems the ISO's review identified, the ISO proposes to calculate a daily availability measure for each product, system and flexible RA, separately. For example, instead of treating each MW of each hour equally as is done currently, the ISO will treat each MW equally.

5.1.1. System and Category 1 Flexible Capacity Daily Assessments

For a day on which a MW has been shown for both system and flexible RA, the ISO will first consider MW's availability based on the most stringent MOO. Because flexible capacity must economically bid and cannot self-schedule, it has the more stringent MOO the ISO will first assess flexible capacity and then assess compliance with the resource's system MOO for any MW in excess of the resource's flexible capacity showing. For example, if a resource is shown as 25 MW system and 5 MW of category 1 flexible capacity on the same day, the ISO will assess compliance with 20 MW system and 5 MW of flexible capacity.[10] There are additional complications when system RA is combined with categories 2 and 3 flexible capacity,[11] and the ISO discusses the specific issues further below in section 5.1.2. Upon further consideration, the ISO believes the calculation should be based

[10] The ISO will continue to use hourly values from the entirety of either day-ahead or real-time market, not the individual hours from each day. For example, for a given day, the ISO will use all of the day-ahead hourly values or all of the real-time hourly values, not a combination of hours from both the day-ahead and real-time markets.
[11] The ISO is not changing the existing policy of using the availability assessment hours for the highest quality flexible capacity for which a resource has been shown.

on the average compliance with each MOO for the entire day. Therefore, the ISO proposes to assess the availability of the flexible RA portion by calculating the performance of the resource relative to the MOO for the product, divided by the obligation to provide that product. This percentage is then multiplied by the MW value that the resource was supposed to provide to meet its obligations. This calculation yields a daily availability MW value for system or flexible RA.

This proposal provides the basis to resolve both of the issues identified in section 4, above. This proposed modification differs from the current methodology in two important ways. First, the number of hours for category 1 Flexible RA no longer gives flexible RA a disproportionate weight in the availability calculation. For example, if a resource shows 2 MW of capacity shown on a given day, one system[12] and one flexible, then the ISO will assess one MW as a system MW that must meet five availability assessment hours for the day and the other as one MW of flexible capacity that must meet 17 availability assessment hours for the day. Second, there is now no need to spread MWs across hours to determine the average availability across a month. This allows the availability calculation to "right size" the resource and the products it is providing, in other words, the proposal allows for resource's capacity to be considered for availability according to the correct magnitude based upon the resource's showing. The proposed methodology ensures system and flexible MWs receive the correct weight in the availability calculation. Specific examples of this calculation are provided below.

5.1.1.1. System and Category 1 Flexible Capacity Daily Assessments Examples

The following examples are intended to describe how the ISO would implement the calculation described above.[13]

Example 5 (same scenario as example 2, above):

Two day month, one weekday and one weekend, 1 MW of system RA capacity on the weekday, and 1 MW of Category 1 flexible RA capacity on the weekend. Resource is fully out on the weekday and fully available on the weekend.
Step 1: Calculate the average RA obligation for each capacity type each day 1 MW times 5 hours divided by 5 hours for the day of system RA, or 1 MW system RA on the weekday 1 MW times 17 hours divided by 17 hours for the day flexible RA capacity, or 1 MW flexible on the weekend
Step 2: Calculate average daily compliance on each capacity type each day

[12] Technically, both would be system, but the first MW would be assessed as flexible, and the second only as system in this example.

[13] The examples in this section are for illustrative purposes only. Additional scenarios are possible, but these examples are designed to represent the concepts described above. Further the examples in this section assume system and Category 1 flexible capacity.

0 MW times 5 hours divided by 5 hours for the day of system RA, or 0 MW system RA availability on the weekday 1 MW times 17 hours divided by 17 hours for the day flexible RA capacity, or 1 MW flexible RA availability on the weekend
Step 3: Determine monthly availability for each product System: 0 MW of total availability divided by 1 MW of obligation equals zero percent available Flexible: 1 MW of total availability divided by 1 MW of obligation equals 100 percent available

Example 5 demonstrates that the proposed change provides a much more logical result than the current methodology and more accurately represents the idea that capacity is a daily product. Example 6 further demonstrates this calculation.

Example 6:

Three days of RA shown for a month, two weekdays and one weekend. 1 MW of system RA capacity shown on both weekdays, and 1 MW of Category 1 flexible RA capacity shown on the weekend. Resource is fully out on the first weekday and fully available on the second weekday and the weekend.
Step 1: Calculate the average RA obligation for each capacity type each day. 1 MW times 5 hours divided by 5 hours for the each day of system RA, or 1 MW system RA on each day, for a total of 2 MWs of system RA on the weekdays. 1 MW times 17 hours divided by 17 hours for flexible RA capacity, or 1 MW flexible RA, on the weekend.
Step 2: Calculate average daily compliance on each day for each product. 0 MW times 5 hours divided by 5 hours for the first weekday of system RA or 0 MW total, 1 MW times 5 hours divided by 5 hours for the second day of system RA or 1 MW total, for a sum total 1 MW system RA availability for both weekdays. 1 MW times 17 hours divided by 17 hours for flexible RA capacity, or 1 MW flexible RA availability, on the weekend.
Step 3: Determine monthly availability percentage for each product. System: 1 MW of total availability divided by 2 MW of obligation equals 50 percent available. Flexible: 1 MW of total availability divided by 1 MW of obligation equals 100 percent available.

As a final example, the ISO demonstrates how this calculation works for a resource shown as both system and flexible on the same day, but in different quantities.

Example 7:

One day month, weekday. 2 MW of system RA capacity and 1 MW of Category 1 flexible RA capacity. Resource is fully on line, but self-schedules the entire day (*i.e*., not compliant with flexible capacity MOO to bid economically).
Step 1: Calculate the average RA obligation for each capacity type. 1 MW times 5 hours divided by 5 hours for the quantity of system RA that is beyond the flexible RA, or 1 MW system RA. 1 MW times 17 hours divided by 17 hours for flexible RA capacity, or 1 MW flexible RA capacity.
Step 2: Calculate average daily compliance on each day for each product. 1 MW times 5 hours divided by 5 hours for the quantity of system RA availability that is beyond the flexible RA, or 1 MW of system RA availability. 0 MW times 17 hours divided by 17 hours for flexible RA capacity, or 0 MW flexible RA availability.
Step 3: Determine monthly availability percentage for each product System: 1 MW of total availability divided by 1 MW of obligation equals 100 percent available. Flexible: 0 MW of total availability divided by 1 MW of obligation equals zero percent available.

These examples provide more specific details about how the ISO is proposing to modify the availability calculation. Splitting the system and flexible assessments allows for a much cleaner and precise assessment of availability for each type of RA provided;[14] although, they can lead to instances where system RA receives an incentive payment, but flexible RA pays a charge, or vise-versa. However, the ISO prefers splitting the calculations because it provides clearer incentives to be available to provide each RA product and removes the potential for a resource to manipulate its overall availability measurement by taking advantage of the differences between flexible RA and system RA,

[14] One MW of economic bid will not count towards system RA obligations unless it is in excess of the flexible RA obligation. Each MW will only go into a single bucket of RA (i.e. generic or flexible).

i.e., the fact that the assessment for system RA is five hours per day five days a week, but the assessment for Type 1 Flex RA is for 17 hours per day seven days a week.

5.1.2. Addressing the Interaction between System RA Capacity and Flexible Capacity Categories 2 and 3

As shown above, the ISO proposes that a MW of capacity will continue to be viewed as flexible capacity first, then any capacity above the flexible RA would be treated as system. This works simply when assessing system and flexible capacity category 1 and the system availability assessment hours are a subset of the flexible capacity category 1 availability assessment hours. However, for flexible categories 2 and 3, some the availability assessment hours do not overlap with the system availability assessment hours, while other hours do overlap. Take for example a resource that shows 2 MW of system RA and one MW of flexible RA category 2: the resource could be subject to the system availability assessment hours for hours 1-5 for two MW and flexible RA availability assessment hours for hours 3-8 for one MW.

The ISO's proposed modification will account for all availability assessment hour obligations. This means the ISO will account for hours in which a resource only has a system assessment. Note that for the system hours, the first 2 hours, 1-2, do not overlap with flex category 2, and the last three hours, 3-5, overlap with flex category 2. This is demonstrated in the following example.

5.1.2.1. Addressing the Interaction between System RA Capacity and Flexible Capacity Categories 2 and 3 Examples

The following examples are designed to demonstrate how the ISO calculates a resources total availability, accounting for resource availability when the category 2 and 3 flexible RA and system RA assessment hours do not completely overlap (As they do with category 1 and system RA as shown in the examples 5-8, above).

Assumed Availability Assessment Hours

System: Hours 1-5

Flexible Category 2: Hours 3-8

Example 8:

One day month, weekday, 2 MW of system RA capacity and 1 MW of Category 2 flexible RA capacity. Resource is on line, but self-schedules 1 MW the entire day (i.e. not compliant with flexible capacity MOO to bid economically).
Step 1: Calculate the average RA obligation for each capacity type.

2 MW times 2 hours for the system RA not overlapping with flexible RA, plus 1 MW times 3 hours for the system RA beyond the flexible RA. Then divide by 5 hours for 1.4 MW system RA. 1 MW times 5 hours divided by 5 hours for flexible RA capacity, or 1 MW flexible RA capacity. Divide by the maximum of the system or flexible RA shown for the day (i.e. the maximum amount of RA the resource is providing that day) by the sum MW across all products to develop a scaling factor needed to determine each products daily MW availability requirement:[15] 2/(1.4 + 1) = 2/2.4 = 0.833 This weighting factor can now be used to attribute a MW value to system and flexible RA when the availability assessment hours for system and flexible do not fully overlap.
Step 2: Apply weighting factor. Weighting factor: 2 MW/2.4MW = 0.833 System requirement: 1.4 MW x 0.833 = 1.167 MW Flexible requirement: 1 MW x 0.833 = 0.833 Note: If summed, the obligation would equal 2 MW for the day which equals the maximum amount of RA the resource is providing that day.
Step 3: Calculate average daily compliance for each product. 1 MW times 2 hours where the system RA is not overlapping with flexible RA, plus 1 MW times 3 hours where the system RA is beyond the flexible RA. Then divide by 5 hours for 1 MW system RA availability Apply weighting factor for system RA availability: 1 MW x 0.833 = 0.833 MW 0 MW times 5 hours divided by 5 hours for flexible RA availability, or 0 MW flexible RA availability. Apply weighting factor for flexible RA availability: 0 MW x 0.833 = 0 MW
Step 4: Determine monthly availability for each product. System: 0.833 MW of total availability divided by 1.167 MW of obligation equals 71.43 percent available. Flexible: 0 MW of total availability divided by 0.833 MW of obligation equals zero percent available.

[15] The weighting factor is needed because each product has five availability assessment hours, but they total seven availability assessment hours for the purposes of the availability assessment. The weighting factor allows the ISO to correctly capture each the entirety of each product's availability assessment hours, accounting for both the number of hours and MWs. This calculation can also be done for examples 5-8. The result of this calculations in all of those examples equals one.

The proposed solution demonstrated in Example 8 above ensures the complete availability and compliance with MOOs during the availability assessment hours, including all hours and MWs, are assessed for both for system and flexible RA. Further, if the category 1 flexible capacity availability assessment hours did not completely overlap the system availability assessment hours completely, this methodology can be also be applied to ensure that the relative MW weights of all products is maintained (*i.e.*, it does not over emphasize 1 MW of flexible RA over 1 MW of system or vice versa).

5.1.3. Daily outage replacement and exemptions

RA resources may go on outage and use another resource for replacement or substitute capacity. When this occurs, the RA obligation moves from the original resource to the replacing or substituting resource. The calculation to determine the average RA obligation for each capacity type, as shown in each of the preceding examples, takes this into account. If for a given day, a resource with 50 MW of system RA goes on forced outage in real-time, and uses another resource to substitute for 50 MW for the last availability assessment hour, then the resource's average system RA obligation in real-time would be 50 MW * 4/5 or 40 MW. The substituting resource's average system RA obligation in real-time would be 50 MW * 1/5 or 10 MW, assuming it originally did not have RA.

RA resources may go on outage, and due to reasons as indicated by the outage type or nature of work, would have RA capacity be eligible to be exempt from RAAIM assessment. The calculation to determine the average RA obligation for each capacity type takes this into account. If for a given day, a resource with 50 MW of Category 2 flexible RA has a planned outage to be out of service that starts in the day's last availability assessment hour, then the resource's Category 2 flexible RA obligation would be 50 MW * 4/5 or 40 MW in day-ahead and real-time. In the last availability assessment hour, the resource's obligation is 0 MW, where 50 MW was exempt. The exemption applies to both day-ahead and real-time, because the planned outage was entered before the day-ahead market of the given day.

Market participants can explore these scenarios in the spreadsheet by modifying the obligations by the hour in the Generic tab (rows 28-51) and Flex tab (rows 2-25), after inputting values in the Input tab.

5.1.4. Day-Ahead vs Real-Time compliance for each RA Type

The daily RA obligation and RA availability used in the monthly calculations will be from the lesser performing, on a percentage basis, of the day-ahead or real-time. This will be done separately for system and flexible RA. It is possible that on a given day a resource could be assessed system from DA, and flexible from RT, or vice versa.[16] Exceptions to this rule are for resources that are assessed in RT only, such as VERs, where only the real-time RA obligation and availability would be used. Or

[16] The ISO will continue to use hourly values from the entirety of either day-ahead or real-time market, not the individual hours from each day. For example, for a given day, the ISO will use all of the day-ahead hourly values or all of the real-time hourly values, not a combination of hours from both the day-ahead and real-time markets.

for resources that are assessed in day-ahead only, such as Long Start resources not committed in day-ahead or RUC, where only the day-ahead RA obligation and availability would be used.

In the substitution scenario from section 5.1.3, since the forced outage occurred in real-time, the original resource's average system RA obligation in day-ahead is 50 MW, and the substituting resource's obligation is 0 MW. The daily RA obligation and availability for the substituting resource would be from real-time only, since it did not have any RA in day-ahead. Then for the original resource, the lower performance percentage between day-ahead and real-time would determine whether 50MW from day-ahead or 40 MW from real-time is used.

The ISO acknowledges that the day-ahead vs real-time compliance check was not built into the spreadsheet. The ISO determined not do so here. Adding more inputs to distinguish between day-ahead and real-time, and to account for exceptions, added greater complexity to an already complex spreadsheet. However, the ISO is providing formulas to illustrate the check in Appendix B.

5.2. Calculating Monthly Availability

The above examples and explanations demonstrate how the ISO would calculate daily values under its proposal, and the following section will describe how it is possible to translate these daily values into monthly availability measurements. Additionally, the ISO believes it is important that each assessment reflect the number of days within a month that a resource provides a particular type of capacity. A resource that provides 1 MW of RA for one day should not have the same impact on the incentive calculation as a resource that provides 1 MW of RA every day in month. However, it must also account for the number of days that a resource could be available to provide a given product. This section provides additional details about how the ISO will scale both system and flexible RA products' daily performances in determining a monthly availability incentive charge or payment

5.2.1. Combining Daily Availability Calculations into a Monthly Availability Assessment

Section 5.1 above demonstrates how hourly and daily performance should be combined into a daily MW value. Now the assessment must convert this value into a monthly performance percentage. This formulation can be done in manner similar to what was done originally, but with one key change proposed herein by the ISO: using the methodology developed in Section 5.1, which eliminates the potential for a resource to "shrink" its MW value by increasing the hours within the assessment. As a result, monthly performance can be calculated simply as follows:

Availability percent = Sum MW performance over all days ÷ Sum MW obligation over all days

There will be a monthly availability percentage calculated for system RA, and a separate monthly availability percentage calculated for flexible RA capacity.

5.2.2. Scaling for the Number of Days a Resource is Shown as RA

The ISO's proposed solution is to calculate availability for system and flexible RA separately. One of the primary reason supporting this approach is that system and flexible RA capacity are required to

be available a different number of days in each month. This fact is particularly important when it comes to assessing availability charges and incentive payments because products with fewer days of obligation will have a different effective daily capacity prices. For example, the system RA availability assessment hours are for non-holiday weekdays, while category 1 flexible capacity availability assessment hours are seven days a week. Therefore, the ISO will calculate availability charges, or incentive payments, by accounting for the number of days a given product *could be* shown for each RA type.

The number of days a resource can be shown for each type of RA capacity is an important aspect of the availability charge calculation because it determines the equivalent daily capacity value of a given product. System RA and flexible RA have a different number of assessment days in a month. Availability is assessed based on satisfaction of a resource's availability assessment hours for a different number of days. For example, if a resource is shown as both system and flexible RA for one week in a month, should the ISO determine the availability charge based on a 21 day month (based on the fact that system RA is assessed based on an obligation to be available five days a week), a 30 day month (based on the fact that flexible RA is assessed based on an obligation to be available seven days a week), some combination of the two, or should each RA category be assessed separately. Since the ISO will calculate availability separately for system and flexible RA, the most reasonable solution is to calculate system and flexible capacity incentives based on the number of days over which a product could be provided. This will allow the ISO to calculate system RA availability based on the number of days a resource could be subject to a system availability assessment, and flexible RA availability based on the number of days a resource could be subject to a flexible RA availability assessment. The following example demonstrates this, where a monthly MW obligation is determined as a summation of weighting each daily MW obligation to the RA type's total possible assessment days in a month.

Example 9

System: There are 21 total possible system availability assessment days in a 30 day month. A resource has 10 MW of system RA capacity for 2 of the assessment days in the month. System monthly MW obligation = $\frac{10\ MW}{21} + \frac{10\ MW}{21}$ = 0.95 MW
Flex: There are 30 total possible Category 1 flex availability assessment days in a 30 day month. A resource has 10 MW of Category 1 flex RA capacity for 3 days in the month. Flex monthly MW obligation = $\frac{10\ MW}{30} + \frac{10\ MW}{30} + \frac{10\ MW}{30}$ = 1 MW

After monthly MW obligations are determined, availability charges and incentive payments are calculated for system and flexible RA separately. The availability charge is determined by the monthly MW short multiplied by the non-availability price, where the monthly MW short is determined by taking the monthly MW obligation multiplied by 94.5% less the availability percentage. The incentive payment is determined by the monthly MW incentive multiplied by the incentive price, where the monthly MW

incentive value is determined by taking the monthly MW obligation multiplied by the availability percentage less 98.5%.

This allows for a resource to be assessed based upon its performance measured over a month, instead of incurring penalties or payments based on an assessment of performance measured on single days. This is consistent with the original policy, and the ISO sees no reason to change this prospectively.

6. Next Steps

The ISO will discuss this proposal with stakeholders during a conference call on September 28, 2017. Stakeholders are welcome to submit written comments by October 3, 2017 to initaitivecomments@caiso.com.

7. Appendix A: Complete Example of ISO proposed modified solution

To illustrate the many aspects of the ISO proposal a full example has been preloaded into the spreadsheet available at http://www.caiso.com/Documents/ProposedRAAIMCalculationModificationsModel-ForDraftFinalProposal.xlsx. [17]

The example is broken into three type of showings, each covering 10 days of the month.

	Days		
Capacity Type	1-10	11-20	21-30
System	100 MW	100 MW	100 MW
Category 1		75 MW	
Category 2			
Category 3			25 MW

These capacity values are added to the input tab of the sheet in the cells highlighted in green.

Next, input the resources bidding/availability. In this instance, it is assumed that to resource will have two outages: days 6-10 and days 17-20. The bidding behavior on the days on which the resource is not on outage are shown below.

	Days						
	1-4	5	6-10	11-15	16	17-20	21-30
Self-schedule	100 MW	100 MW for hours 1-14 50 MW for hours 15-24	0	25	25 MW for hours 1-14 10 MW for hours 15-24	0	65
Economic bids*	0	0	0	75	75 MW for hours 1-14	0	25

[17] Note many values are rounded to the nearest whole number and may cause rounding error relative to spreadsheet. However, all final values should reflect those from the spreadsheet.

					65 MW for hours 15-24		

These bidding inputs are entered into the input tab of the sheet in the cells highlighted in orange and blue.

With these inputs set. It is now possible to do a full step by step calculation of the resource's availability. The process will start with an hourly review, roll all hours into a daily calculation, and then roll all days up into the final monthly assessment. As noted in the ISO proposal, the ISO will do each of these steps for both system and flexible capacity. Each step will pull from a specific entry in the spreadsheet to illustrate the proposed calculation.

All hours in these examples are input as hour ending (i.e. 1:00 p.m. is entered as hour ending 14).

Example 1a: Day 5

Hourly assessment:

Step 1: Determine hourly MOO requirements for each product

Capacity type	Hour																	
	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
System										100	100	100	100	100				
Category 1																		
Category 2																		
Category 3																		

Step 2: Determine performance[18]

Capacity type	Hour																	
	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
System Obligation										100	100	100	100	100				
System Performance										100	50	50	50	50				

[18] See rows 43-66 of the "Calculations MW" tab in the spreadsheet for system performance.

Category 1																		
Category 2																		
Category 3																		

System Performance = [(100*1)+(50*4)]/(100*5)= 300/500 = 60%

Step 3: Determine Daily MW available

System availability = System MW obligation * system performance

= 100 * 0.6

= 60 MW

Example 1b: Day 16

Hourly assessment:

Step 1: Determine hourly MOO requirements for each product

Capacity type	Hour																
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
System									25	25	25	25	25				
Category 1	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
Category 2																	
Category 3																	

Step 2: Determine performance[19]

Capacity type	Hour																
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
System Obligation									25	25	25	25	25				

[19] See rows 69-92 of the "Calculations MW" tab in the spreadsheet for flexible performance.

System Performance									25	10	10	10	10				
Category 1 Obligation	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
Category 1 Performance	75	75	75	75	75	75	75	75	75	65	65	65	65	65	65	65	65
Category 2																	
Category 3																	

System Performance = [(25*1) + (10*4)]/(25*5) = 65/125 = 52%

Flexible performance = [(75*9) + (65*8)]/(75*17) = [675 + 520]/1275 = 1,195/1,275 = 93.7%

Step 3: Determine Daily MW available

System availability = System MW obligation * System performance

= 25MW * 0.52

= 13 MW

Flexible availability = Flexible MW obligation * Flexible performance

= 75 * 0.937

= 70.3 MW

Example 1c: Day 25

Hourly assessment:

Step 1: Determine hourly MOO requirements for each product

Capacity type	Hour																
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
System									100	100	75	75	75				
Category 1																	
Category 2																	
Category 3											25	25	25	25	25		

Step 1.1: Determine weighting factor

Weighting Factor = Max(Daily system RA showing, Daily Flexible Category 3 showing)/
Average hourly system obligation + Average hourly Category 3 obligation

= 100/(85 + 25) = 0.91

Step 1.2: Apply weighting factor to determine Daily MW Obligation

Daily system obligation = Average hourly system obligation * weighting factor

= 85 MW * 0.91 = 77.27 MW

Daily flexible obligation = Average hourly Category 3 obligation * weighting factor

= 25 MW * 0.91 = 22.73 MW

Note: System obligation + Flexible Obligation = Max of the daily system or flexible obligation

Step 2: Determine performance[20]

Capacity type	Hour																
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
System Obligation									100	100	75	75	75				
System Performance									90	90	65	65	65				
Category 1 Obligation																	
Category 2																	
Category 3 Obligation											25	25	25	25	25		
Category 3 Performance																	

System Performance = [(90*2) + (65*3)]/[(100*2) + (75*3)] =375/425 = 88.2%

Flexible performance = [(25*5)]/(25*5) = 125/125 = 1,195/1,275 = 100%

Weighting Factor = Max(Daily system RA showing, Daily Flexible Category 3 showing)/

[20] See rows 69-92 of the "Calculations MW" tab in the spreadsheet for flexible performance.

(Average hourly system obligation + Average hourly Category 3)

= 100/(85 + 25) = 0.91

Step 3: Determine Daily MW available

Step 3.1: Determine Daily MW available, including weighting factor

System availability = Average hourly system MW obligation * System performance

= 85 MW * 0.882 * 0.91

= 68.25 MW

Flexible availability = Flexible MW obligation * Flexible performance * Weighting factor

= 25 MW * 1 * 0.91

= 22.72 MW

This completes examples of how daily performance is measured for three different days within a month. The next step of the process is to transform these daily values into a monthly availability measure for both system and flexible capacity products.

Example 2: Converting daily availability into a monthly availability measure

Calculating monthly system RA performance

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Assess Generic Daily MW Availability	0	100	100	100	60	0	0	0	0	0	25	25	25	0	0
Assess Generic Daily MW Obligation	0	100	100	100	100	100	0	0	100	100	25	25	25	0	0
Day	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Assess Generic Daily MW Availability	13	0	0	0	0	0	0	68	68	68	68	68	0	0	68
Assess Generic Daily MW Obligation	25	25	25	25	25	0	0	77	77	77	77	77	0	0	77
Summary	Total Requirement = 1363 MW-days							Total performance = 857 MW-days							

Monthly Percent Availability = 857/1363 = 62.85%

Calculating monthly flexible RA performance

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Assess Flexible Daily MW Availability	0	0	0	0	0	0	0	0	0	0	75	75	75	75	75
Assess Flexible Daily MW Requirement	0	0	0	0	0	0	0	0	0	0	75	75	75	75	75

Day	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Assess Flexible Daily MW Availability	70	0	0	0	0	0	0	23	23	23	23	23	0	0	23
Assess Flexible Daily MW Requirement	75	75	75	75	75	0	0	23	23	23	23	23	0	0	23
Summary	Total Requirement = 886 MW-days							Total performance = 582 MW-days							

Monthly Percent Availability = 582/886 = 65.62%

These calculations are all provided on the "Calculations MW" tab of the spreadsheet and demonstrates how each of the individual days is rolled up to generate a monthly availability percentage. The next step is calculating converting the various RA values into a single monthly equivalent RA value so that a monthly MW deficiency or excess value can be calculated

Example 3: Scale MW to portion of the month

Because there are different quantities of system and flexible capacity shown on different days, it is necessary to scale MW to portion of the month for which they have been shown. This scaling accounts for the MW shown of a given product, number of days the resource is shown for a given product, and the number of days a resource could be shown for a given product

Example 3a: Day 5

The resource is shown for 100 MW of system capacity. It is assessed as a single day. However, there are 21 possible days in which a resource can be assessed for system RA. Since all of the assessments can be done on a day-by-day basis, the first step is to scale the MW by the number of days in a month to create a daily MW factor.

System daily MW factor = System obligation/Total days of system availability assessment in a month

= 100 MW / 21 days

= 4.7619

Example 3b: Day 16

The resource is shown for 25 MW of system RA and 75 MW of category 1 flexible RA. All MWs are assessed as a single day. There are 21 possible days in which a resource can be assessed for system RA and 30 days in which it can be assessed for category 1 flexible RA. Since all of the assessments can be done on a day-by-day basis, these MWs are scaled by the MW by the number of days in a month for each product to create a daily MW factor.

System Daily MW factor = System availability/Total days of system availability assessment in a month

= 25 MW / 21 days

= 1.1905

Flexible Daily MW factor = System availability/Total days of category 1 flexible RA availability assessment in a month

= 75 MW / 30 days

= 2.5

Example 3b: Day 25

The resource is shown for 75 MW of system RA and 25 MW of category 3 flexible RA. All MWs are assessed as a single day. There are 21 possible days in which a resource can be assessed for system RA and 21 days in which it can be assessed for category 3 flexible RA. Since all of the assessments can be done on a day-by-day basis, these MWs are scaled by the MW by the number of days in a month for each product to create a daily MW factor.

System Daily MW factor = System availability/Total days of system availability assessment in a month

= 77.27 MW / 21 days

= 3.6797

Flexible Daily MW factor = System availability/Total days of category 3 flexible RA availability assessment in a month

= 22.72 MW / 21 days

= 1.0823

Example 4: Calculating incentive charges/payments

The incentive payments must continue to account for the size (i.e. MW) and the duration (i.e. number of days) of a resource's RA obligation. This is done using the sum of daily MW factors for each product from examples 3a-c, above. When summed, these values equal the MW value of what the resource would have provided if shown for the same number of MWs for every day of the month. This value is then multiplied by the availability percentage (shown in Example 2) to determine the monthly MW availability and incentive payments relative to the established deadband (i.e. 94.5 percent – 98.5 percent).

System Monthly RA Value

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Daily MW Requirement / Possible	0	4.76	4.76	4.76	4.76	4.76	0	0	4.76	4.76	1.19	1.19	1.19	0	0

Assessment Days															
Day	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Daily MW Requirement / Possible Assessment Days	1.19	1.19	1.19	1.19	1.19	0	0	3.67	3.67	3.67	3.67	3.67	0	0	3.67
Sum Total = 64.94 MW															

System RA MW subject to charges/incentive = 64.94 MW * (0.945 - 0.6285)

= 64.94 MW * 0.3165

= 20.55 MW shortage

Total system RAAIM charges = 20.55 MW * $3.786/kW-mth = $77,802

Flexible Monthly RA value

Day	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Daily MW Requirement / Possible Assessment Days	0	0	0	0	0	0	0	0	0	0	2.5	2.5	2.5	2.5	2.5
Day	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Daily MW Requirement / Possible Assessment Days	2.5	2.5	2.5	2.5	2.5	0	0	1.08	1.08	1.08	1.08	1.08	0	0	1.08
Sum Total = 31.49 MW															

Flexible RA MW subject to charges/incentive = 31.49 MW * (0.945 - 0.6562)

= 31.49 MW * 0.2888

= 9.09 MW shortage

Total Flexible RA RAAIM charges = 9.09 MW * $3.786/kW-mth = $34,414

8. Appendix B: Formulas of ISO proposed modified solution

The following formulas illustrate the ISO's proposed solution. The formulas also takes into account exemptions and the compliance check between day-ahead and real-time.

Please note that the variable names and subscripts in the formulas may differ upon implementation of the settlements BPM.

Where
r = Resource
f = Flexible Category
m = Month
d = Day
h = Hour

Hourly RA obligations less exemptions:

$$\text{HourlyDAGenericRAObligation}_{rmdh} = \text{HourlyDAGenericRA}_{rmdh} - \text{HourlyDAGenericRAExemption}_{rmdh}$$

$$\text{HourlyRTGenericRAObligation}_{rmdh} = \text{HourlyRTGenericRA}_{rmdh} - \text{HourlyRTGenericRAExemption}_{rmdh}$$

$$\text{HourlyDAFlexibleRAObligation}_{rfmdh} = \text{HourlyDAFlexibleRA}_{rfmdh} - \text{HourlyDAFlexibleRAExemption}_{rfmdh}$$

$$\text{HourlyRTFlexibleRAObligation}_{rfmdh} = \text{HourlyRTFlexibleRA}_{rfmdh} - \text{HourlyRTFlexibleRAExemption}_{rfmdh}$$

Capping for Generic RA obligation and availability:

$$\text{HourlyDAGenericRACappedObligation}_{rmdh} = \text{Max}(0, \text{HourlyDAGenericRAObligation}_{rmdh} - \sum_{f} \text{HourlyDAFlexibleRAObligation}_{rfmdh})$$

$$\text{HourlyRTGenericRACappedObligation}_{rmdh} = \text{Max}(0, \text{HourlyDAFlexibleRAObligation}_{rfmdh} - \sum_{f} \text{HourlyRTFlexibleRAObligation}_{rfmdh})$$

$$\text{HourlyDAGenericRACappedAvailability}_{rmdh} = \text{Min}(\text{HourlyDAGenericRAAvailability}_{rmdh}, \text{HourlyDAGenericRACappedObligation}_{rmdh})$$

$$\text{HourlyRTGenericRACappedAvailability}_{rmdh} = \text{Min}(\text{HourlyRTGenericRAAvailability}_{rmdh}, \text{HourlyRTGenericRACappedObligation}_{rmdh})$$

Calculate daily performance by RA and market type:

$$DAGenericPerformance_{rmd} = \sum_{h} HourlyDAGenericRACappedAvailability_{rmdh} / \sum_{h} HourlyDAGenericRACappedObligation_{rmdh}$$

$$RTGenericPerformance_{rmd} = \sum_{h} HourlyRTGenericRACappedAvailability_{rmdh} / \sum_{h} HourlyRTGenericRACappedObligation_{rmdh}$$

$$DAFlexiblePerformance_{rfmd} = \sum_{h} HourlyDAFlexibleRAAvailability_{rfmdh} / \sum_{h} HourlyDAFlexibleRAObligation_{rfmdh}$$

$$RTFlexiblePerformance_{rfmd} = \sum_{h} HourlyRTFlexibleRAAvailaiblity_{rfmdh} / \sum_{h} HourlyRTFlexibleRAObligation_{rfmdh}$$

Calculate average daily obligation by RA and market type:

$$DailyDAGenericRAObligation_{rmd} = \sum_{h} HourlyDAGenericRACappedObligation_{rmdh} / GenericAssessmentHoursInDayCount_{md}$$

$$DailyRTGenericRAObligation_{rmd} = \sum_{h} HourlyRTGenericRACappedObligation_{rmdh} / GenericAssessmentHoursInDayCount_{md}$$

$$DailyDAFlexbileRAObligation_{rfmd} = \sum_{h} HourlyDAFlexibleRAObligation_{rfmdh} / FlexibleAssessmentHoursInDayCount_{fmd}$$

$$DailyRTFlexbileRAObligation_{rfmd} = \sum_{h} HourlyRTFlexibleRAObligation_{rfmdh} / FlexibleAssessmentHoursInDayCount_{fmd}$$

Determine DA vs RT compliance:

$$DailyGenericRAAssessDAorRT_{rmd} =$$

If (DAGenericPerformance $_{rmd}$ < RTGenericPerformance $_{rmd}$ And DailyDAGenericRAObligation $_{rmd}$ > 0)

Or (DailyDAGenericRAObligation $_{rmd}$ > 0 And DailyRTGenericRAObligation $_{rmd}$ = 0)

Then 1

Else 0

DailyFlexibleRAAssessDAorRT $_{rfmd}$ =

If (DAFlexiblePerformance $_{rfmd}$ < RTFlexiblePerformance $_{rfmd}$ And DailyDAFlexbileRAObligation $_{rfmd}$ > 0)

Or (DailyDAFlexbileRAObligation $_{rfmd}$ > 0 And DailyRTFlexbileRAObligation $_{rfmd}$ = 0)

Then 1

Else 0

Determine daily obligation by RA type:

DailyGenericRAObligation $_{rmd}$ =

If DailyGenericRAAssessDAorRT $_{rmd}$ = 1

Then DailyDAGenericRAObligation $_{rmd}$

Else DailyRTGenericRAObligation $_{rmd}$

DailyGenericRAUncappedObligation $_{rmd}$ =

If DailyGenericRAAssessDAorRT $_{rmd}$ = 1

Then $\sum_{h}$ HourlyDAGenericRAObligation $_{rmdh}$ / GenericAssessmentHoursInDayCount $_{md}$

Else $\sum_{h}$ HourlyRTGenericRAObligation $_{rmdh}$ / GenericAssessmentHoursInDayCount $_{md}$

DailyFlexbileRAObligation $_{rfmd}$ =

If DailyFlexibleRAAssessDAorRT $_{rfmd}$ = 1

Then DailyDAFlexbileRAObligation $_{rfmd}$

Else DailyRTFlexbileRAObligation $_{rfmd}$

Calculate daily availability by RA type:

DailyGenericRAAvailability $_{rmd}$ =

If DailyGenericRAAssessDAorRT $_{rmd}$ = 1

Then DAGenericPerformance $_{rmd}$ * DailyDAGenericRAObligation $_{rmd}$

Else RTGenericPerformance $_{rmd}$ * DailyRTGenericRAObligation $_{rmd}$

DailyFlexibleRAAvailability $_{rfmd}$ =

If DailyFlexibleRAAssessDAorRT $_{rfmd}$ = 1

Then DAFlexiblePerformance $_{rfmd}$ * DailyDAFlexbileRAObligation $_{rfmd}$

Else RTFlexiblePerformance $_{rfmd}$ * DailyRTFlexbileRAObligation $_{rfmd}$

Calculate daily weighting factor:

DailyWeightingFactor $_{rmd}$ = Max(DailyGenericRAUncappedObligation $_{rmd}$, $\sum_{f}$ DailyFlexbileRAObligation $_{rfmd}$) / (DailyGenericRAObligation $_{rmd}$ + $\sum_{f}$ DailyFlexbileRAObligation $_{rfmd}$)

Calculate obligation and availability by RA type with daily weighting factor applied:

DailyGenericRAObligationAssess $_{rmd}$ = DailyWeightingFactor $_{rmd}$ * DailyGenericRAObligaiton $_{rmd}$

DailyFlexbileRAObligaitonAssess $_{rfmd}$ = DailyWeightingFactor $_{rfmd}$ * DailyFlexbileRAObligation $_{rfmd}$

DailyGenericRAAvailabilityAssess $_{rmd}$ = DailyWeightingFactor $_{rmd}$ * DailyGenericRAAvailability $_{rmd}$

DailyFlexibleRAAvailabilityAssess $_{rfmd}$ = DailyWeightingFactor $_{rfmd}$ * DailyFlexibleRAAvailability $_{rfmd}$

Calculate monthly availability percentage by RA type:

$$\text{MonthlyGenericAvailabilityPercentage}_{rm} = \sum_{d} \text{DailyGenericRAAvailabilityAssess}_{rmd} / \sum_{d} \text{DailyGenericRAObligationAssess}_{rmd}$$

$$\text{MonthlyFlexibleAvailabilityPercentage}_{rfm} = \sum_{d} \text{DailyFlexibleRAAvailabilityAssess}_{rfmd} / \sum_{d} \text{DailyFlexbileRAObligaitonAssess}_{rfmd}$$

Calculate monthly obligation by RA type:

$$\text{MonthlyGenericRAObligation}_{rm} = \sum_{d} (\text{DailyGenericRAObligaiton}_{rmd} / \text{GenericAsssementDaysInMonthCount}_{md})$$

$$\text{MonthlyFlexibleRAObligation}_{rfm} = \sum_{d} (\text{DailyFlexbileRAObligation}_{rfmd} / \text{FlexibleAsssementDaysinMonthCount}_{fmd})$$

Calculate monthly non availability by RA type:

$$\text{MonthlyGenericRANonAvailable}_{rm} = \text{MonthlyGenericRAObligation}_{rm} * \text{Max}(0, 94.5\% - \text{MonthlyGenericAvailabilityPercentage}_{rm})$$

$$\text{MonthlyFlexibleRANonAvailable}_{rfm} = \text{MonthlyFlexibleRAObligation}_{rfm} * \text{Max}(0, 94.5\% - \text{MonthlyFlexibleAvailabilityPercentage}_{rfm})$$

Calculate monthly non availability amount by RA type:

$$\text{MonthlyGenericRAAIMNonAvailableAmount}_{rm} = \text{MonthlyGenericRANonAvailable}_{rm} * \text{RAAIMNonAvailabilityRate}_{m}$$

$$\text{MonthlyFlexibleRAAIMNonAvailableAmount}_{rfm} = \text{MonthlyFlexibleRANonAvailable}_{rfm} * \text{RAAIMNonAvailabilityRate}_{m}$$

Calculate monthly availability incentive by RA type:

$$\text{MonthlyGenericRAIncentive}_{rm} = \text{MonthlyGenericRAObligation}_{rm} * \text{Max}(0, \text{MonthlyGenericAvailabilityPercentage}_{rm} - 98.5\%)$$

$$\text{MonthlyFlexibleRAIncentive}_{rfm} = \text{MonthlyFlexibleRAObligation}_{rfm} * \text{Max}(0, \text{MonthlyFlexibleAvailabilityPercentage}_{rfm} - 98.5\%)$$

Calculate monthly availability incentive amount by RA type:

$MonthlyGenericRAAIMIncentiveAmount_{rm} = MonthlyGenericRAIncentive_{rm} * RAAIMAvailabilityIncentiveRate_{m}$

$MonthlyFlexibleRAAIMIncentiveAmount_{rfm} = MonthlyFlexibleRAIncentive_{rfm} * RAAIMAvailabilityIncentiveRate_{m}$