



California ISO

**Commitment Cost Enhancements Phase 3
Revised Straw Proposal**

November 3, 2015

Table of Contents

- 1. Changes from straw proposal and response to stakeholder comments..... 3
- 2. Schedule for stakeholder policy engagement..... 5
- 3. Introduction..... 6
- 4. Initiative scope 7
- 5. Use-limited capacity definition..... 7
- 6. Use-limited registration process..... 13
 - 6.1. Registration process for opportunity costs 13
 - 6.2. Evaluating submitted limitations..... 15
- 7. Opportunity Cost Model..... 18
 - 7.1. Opportunity cost methodology overview..... 19
 - 7.1.1. Model inputs 19
 - 7.1.2. Calculating opportunity costs..... 23
 - 7.1.2.1. Nested limitations 25
 - 7.1.2.2. Scheduled model runs..... 26
 - 7.1.3. Outputs..... 29
- 8. Negotiated opportunity cost..... 30
- 9. Multi-stage generating resources 32
- 10. Outage cards..... 34
- 11. Next Steps 35

1. Changes from straw proposal and response to stakeholder comments

Changes made from straw proposal:

Section 5

In response to the recent FERC order rejecting the revised definition of use-limited as proposed under Commitment Cost Enhancements Phase 2 (CCE2), the ISO is further enhancing the definition of use-limited to reflect the justification for including opportunity costs for these resources.

Section 6

The ISO has added more detail to the registration process for use-limited resources in Section 6 to clarify questions posed by stakeholders.

The ISO will be accounting for opportunity costs for daily limitations through enhancements to the real time market. Resources with daily limitations may still qualify for use-limited status but will not receive an opportunity cost associated with daily limitations through the methodology described herein.

Section 7

The straw proposal had a lower bound of one to the conversion factor used in the estimated locational marginal price (LMP) methodology. In response to stakeholder comments made by DMM and PG&E, the conversion factor will no longer have a lower bound of one, thus allowing it to increase and decrease the estimated LMPs. The purpose of including the conversion factor in the estimated LMPs is to capture anticipated market conditions that are not reflected in the historical LMPs or natural gas future prices. If anticipated market condition are expected to decrease LMPs, this should be captured in the estimated LMPs. Furthermore, the lower bound of one could results in a lower opportunity cost for resources with limited starts as explained in Section 7.

The ISO is now proposing to implement an optimization software based model over the previously presented heuristic approach. In order to accurately estimated opportunity costs for resources with multiple constraints, an optimization model is ideal. The frequency of updates was a significant factor for many stakeholders based on comments from the technical workshop. The ISO is still proposing monthly updates with an optimization model.

Several stakeholders noted various concerns or presented arguments for adding a margin of error to the calculated opportunity costs. SDGE expressed concern that flexible RA use-limited resources may not be available at the end of the year in December, which currently has the highest flexible capacity requirement, unless the model incorporates a reserve margin. One proposal would be to run the model with, for example, 90% of the resources' limitations rather than 100%. Running the model with fewer starts, run-hours, and/or output would potentially result

in a higher opportunity cost, as would including a margin of error term to the opportunity cost. The ISO is now proposing to run the model with 90% of a resource's limitation.

In response to stakeholder requests, the ISO is now proposing a dispute and resolution process for resources which have a calculated opportunity cost. If there is a factor which cannot be modeled and has a significant impact on the opportunity cost value calculated by the ISO, the scheduling coordinators can make a case to the ISO in regards to the un-modeled factor. If the ISO agrees with the significance of the factor, and cannot incorporate it in the model, the resource may receive a negotiated opportunity cost.

The previous paper discussed how the ISO will address resources with nested limitations; limitations of the same type (e.g., starts) but different applicable time periods (e.g., monthly and annually). Due to proposing an optimization model, opportunity costs for nested limitations can be determined without post processing steps.

Section 8

Several stakeholders asked the ISO to provided additional detail of the negotiation process including a dispute and resolution process. Section 8 has been expanded to include a more detailed description of the negotiation process and steps involved. A dispute and resolution process is also described along with additional explanation of the proposed tariff amendment regarding negotiated Default Energy Bids.

Section 9

No changes were made to the methodology of including opportunity costs due to start limitations in transition cost bids for certain limitations. To better illustrate how the opportunity cost would be reflected in the transition cost bid caps, an example has been included.

Section 10

The previous straw proposal discussed two outage cards for use-limited resources: short-term use-limited and use-limited reached. Discussion of the latter outage card will take place in the *Reliability Services Phase 2* initiative as that card only pertains to use-limited resource adequacy resources. The ISO believes a more thorough and complete discussion of that card will be addressed in *Reliability Services Phase 2*.

Stakeholder comments and requests not resulting in changes:

Several stakeholders commented on the need for impromptu re-runs based on a trigger comparing actual usage of the resource to the models estimated usage of the resource intra-month. Monthly scheduled updates which capture the actual usage of the resource, updated gas price trends, and anticipated power pricing trends, greatly reduces the need for impromptu updates. Furthermore, the ISO is facing several unknowns in terms of implementing the new process: quantity of resources modeled, computation time for each model, processing time for updating the opportunity costs. The ISO wants to ensure successful implementation, and

proposing impromptu re-runs at this stage could jeopardize the overall quality of the opportunity cost process.

Stakeholders requested the ISO to conduct additional testing of the models, conduct dry-runs of the opportunity cost model to gain insights, and run an offline six month simulation. Given the proposed optimization model, testing for comparison purposes is no longer needed. The preliminary testing that was presented at the technical workshop came from dry-runs of the model. It was intended to allow the ISO and stakeholders to understand the parameters of the model and identify areas that needed to be addressed. Conducting a six month offline simulation run is not generally ISO procedure; the preliminary testing already conducted illustrates the feasibility of the proposal and identified issues that were addressed through the policy development. The justification for retaining the short-term use-limited outage card is to provide a safety net in the event of unforeseen errors or issues with implementation.

One stakeholder requested scheduling coordinators have the option to self-select negotiated or calculated opportunity cost. Ideally, every resource would be modeled and have a calculated opportunity cost as it is likely to be a more accurate estimate, and is based on economic principals. Therefore the ISO will model and calculate an opportunity cost for limitations it can model, and preserve the negotiation process to those which are more complex to model.

One stakeholder asked the ISO to specify how long the short-term use-limited reached outage card will remain in place before the ISO will propose to discontinue it. The purpose of retaining the card for a transition period is to have a safety net for scheduling coordinators of use-limited resources while 1) scheduling coordinator and the ISO gain experience with managing resources through the opportunity cost, and 2) in the event unforeseen issues arise with the opportunity cost, making it less effective. To specify at this phase a date by which scheduling coordinators and the ISO are sufficiently confident in the effectiveness of the policy is challenging. Therefore the ISO will not now specify when it will seek to discontinue the card, but the ISO will only seek to discontinue the card through a tariff amendment once scheduling coordinators and the ISO are confident the opportunity cost is working as intended.

2. Schedule for stakeholder policy engagement

The proposed schedule for the policy stakeholder process is listed below. We have omitted the issue paper since the issue was already discussed under Commitment Cost Enhancements Phase 1.

<i>Date</i>	<i>Event</i>
<i>July 15, 2015</i>	<i>Market Surveillance Committee Meeting</i>
<i>July 20, 2015</i>	<i>Technical Workshop</i>

<i>July 30, 2015</i>	<i>Stakeholder comments due</i>
<i>August 24, 2015</i>	<i>Straw proposal posted</i>
<i>August 31, 2015</i>	<i>Stakeholder call</i>
<i>September 8, 2015</i>	<i>Stakeholder comments due on straw proposal</i>
<i>November 3, 2015</i>	<i>Revised straw proposal posted</i>
<i>November 9, 2015</i>	<i>Stakeholder call</i>
<i>November 23, 2015</i>	<i>Stakeholder comments due on revised straw proposal</i>
<i>January/February, 2016</i>	<i>Draft final proposal posted and stakeholder call</i>
<i>Mar 24-25, 2016</i>	<i>Board of Governors meeting for approval</i>

3. Introduction

Commitment Cost Enhancements and *Commitment Cost Enhancements Phase 2* had proposed the calculation of opportunity costs for use-limited resources but there was insufficient time to vet the methodology and business rules. This follow-on stakeholder process, *Commitment Cost Enhancements Phase 3*, is narrowly scoped to continue that discussion.

This initiative will culminate in implementing a process which will determine an opportunity cost for use-limited resource's limitation(s). The opportunity cost(s) will be reflect in default commitment cost bids and/or the resource's Default Energy Bids (DEBs). Reflecting the opportunity costs in the resource's commitment cost(s) will facilitate a more efficient market solution while respecting the limitations of these resources that cannot be optimized by the applicable market commitment process. Once opportunity costs are implemented for use-limited resources, the registered cost option will be eliminated, and all resources will be on the proxy cost option for commitment costs.

A technical workshop for *Commitment Cost Enhancements Phase 3* was held at the California ISO on July 20th, 2015. During the workshop, the ISO presented two potential prototype models that could be developed to calculate opportunity costs for use-limited resources along with preliminary test results. The ISO also discussed with stakeholders various issues that arose during the development of the models as well as additional processing and policy related questions that will be addressed during the policy development of this initiative.

4. Initiative scope

This initiative was created to allow additional time for development and vetting of the business rules to determine opportunity costs for use-limited resources. The definition of a “use-limited capacity” developed under *Commitment Cost Enhancements Phase 2* (henceforth referred to as CCE2). FERC recently issued an order rejecting the revised definition, therefore the scope of CCE3 has expanded to now include revisions to of the definition of use-limited¹.

The remainder of this paper is divided into the following sections.

- Section 5 proposes a revised definition of “use-limited” to align with the reasoning of incorporating opportunity costs.
- Section 6 summarizes the use-limited application process and evaluation of limitations to be modeled or negotiated.
- Section 7 describes the modeling process and how the calculated opportunity costs will be incorporated into commitment cost bids and default energy bids.
- Section 8 describes the negotiated opportunity cost method for those limitations that cannot be modeled.
- Section 9 proposes modifications to how opportunity costs will be incorporated into commitment cost bids for MSG resources.
- Section 10 proposes modifications to the use-limited outage card established through the Reliability Service initiative.
- Section 11 provides the next steps for this initiative.

5. Use-limited capacity definition

Use-limited resources are those that cannot operate continuously because of limitations set forth in regulations, statutes, ordinances, court orders, or due to design considerations. Consequently, the ISO provides for separate treatment of use-limited resources to accommodate their use limitations. *Commitment Cost Enhancements Phase 1* clarified that use-limited status is separate from a resource’s resource adequacy status. Therefore, non-resource adequacy resources can also have use-limited status if they meet the definition.

Commitment Cost Enhancements Phase 2 further modified the definition of use-limited to not include resources that would not have opportunity costs as developed through this initiative. The ISO filed the modified definition with FERC on June 5, 2015, which was rejected by FERC in the

¹ <http://www.ferc.gov/CalendarFiles/20150909162131-ER15-1875-000.pdf>

September 9th order. The ISO is taking this opportunity to clarify the definition to address FERC’s concerns.

Use-limited revised definition

Table 1 below summarizes FERCs’ concerns along with a response from the ISO and how that concern will be addressed through this policy process. The ISO does not intend to substantively modify the definition, but rather to provide additional clarification and examples of use-limits that will qualify for opportunity cost consideration. The ISO maintains its longstanding policy that non-economic limitations should not qualify a resource as use-limited and for inclusion of opportunity costs, such as contractual provision that limits starts to 30 per month in contrast to an environmental permit that might limit starts to 600 starts per year. The former is an example of an economic limitation that will not be eligible for an opportunity cost. The latter is an example of a limit that will be eligible for an opportunity cost. Accordingly, the ISO will provide additional discussion and clarification in this stakeholder process. The ISO believes this stakeholder process addresses all concerns raised by FERC and welcomes stakeholder feedback in this regard.

Table 1 FERCs’ concerns on CCE2 use-limited definition and ISO response

FERC order	ISO’s response
“. . . not sufficiently explained or justified the potential effect on market participants of changing from a definition of use-limited resource to use-limited capacity.”	Changing the definition from “resource” to “capacity” was to accommodate resources that may not be use-limited year round or only have a portion of the capacity use-limited. After further reflection, the reference to “capacity” is not necessary. This initiative will retain the original language that defined resources as use-limited.
“. . . should be able to identify a list of limitations to be included in the tariff, and it must do so in order for the Commission to understand how such a revision to the definition of use-limited resources impacts the market participants. . . “	The revised definition will identify the limitations as limits on starts, run-hours, and/or output.
“CAISO fails to include in its proposed definition any specific examples of the statutes, regulations, or ordinances it will honor or the criteria it will use in making such determinations. Although an exhaustive list of specific regulations in the tariff may not be feasible, these examples are necessary”	The definition will include a non –exhaustive list of specific examples which, to the ISO’s understanding, captures the majority of restrictions.
“. . . to the extent certain resources are use-limited by default, it is unclear why they are not included in the definition.”	All resources will be required to register for use-limited status and there will no longer be a subset receiving default designation.

<p>“ . . . failed to discuss in sufficient detail the interaction of contractual limitations with economic and non-economic limitations. “</p>	<p>Additional discussion in regards to contractual limitations will be included in the stakeholder process as will be discussed in the transmittal letter in support of the revised definition. The ISO will also be eliminating the term “non-economic” from the definition.</p>
<p>“ . . .removed clarifying language from the tariff regarding the use-limited registration process without any justification. . .”</p>	<p>FERC approved RSI1 tariff language included details regarding the registration process as will the tariff filing for CCE3.</p>

The ISO is proposing to define use-limited as:

“A resource with one or more limitation on starts, run-hours, and/or output due to environmental restrictions or design considerations, which cannot be optimally dispatched over the limitation horizon without consideration of opportunity costs.

Acceptable environmental restrictions are those that are imposed by regulatory bodies, legislation, or courts. A non-exhaustive list of acceptable environmental restrictions include: limits on emissions, water use restrictions, or run-hour limitations in operating permits. Restrictions with soft caps that allow the resource to increase production above the soft cap through purchasing additional compliance instruments are not acceptable restrictions.

Acceptable design considerations are those that are due to physical equipment limitations. A non-exhaustive list of acceptable design considerations include: restrictions documented in original equipment manufacturer recommendations or bulletins, or limiting equipment such as storage capability for hydroelectric generating resources.”

The definition will retain the existing language defined in terms of a use-limited “resource” rather than use-limited “capacity.” The original intention of defining use-limited capacity in CCE2 was to accommodate resources that 1) may not be use-limited year round, or 2) only a portion of the capacity is use-limited. Examples include a resource with use-limited capacity above regulatory must take capacity or resources that are only restricted during a given season, such as those subject to Delta Dispatch. The use-limited status flag in Master File is set at the resource level, therefore defining a use-limited resource better aligns with the application of the status flag. The ISO does not anticipate any complications arising from defining use-limited resource rather than capacity. For example if a resource has 100 MW of must-take capacity that would not be eligible for an opportunity cost, but has 300MW of capacity that is eligible for an opportunity cost, the flag can be set to “use-limited” without complications. Must take capacity can only be self-scheduled. Therefore, capacity not eligible to be self-scheduled can be eligible for an opportunity cost. Resources that are restricted only during a given season, such as those subject to Delta Dispatch, can simply only be considered use-limited resources during that season. Thus, there is no need to define the use-limited at the capacity level.

The ISO is identifying acceptable limitations in the definition, consistent with FERC direction, as limitations on starts, run-hours, and/or output. The type of limitation will dictate which commitment

cost component the opportunity cost can be reflected in, i.e., start-up or minimum load, or if the opportunity cost is included in the resource’s Default Energy Bid.

Limitations accepted by the ISO must originate from restrictions imposed by external regulatory bodies, legislation, or courts, or due to the design of the resource. They cannot be contractual, such as a monthly start limitation that is well below any binding environmental limit, based on economic decisions such as staffing requirements or maintenance cost tradeoffs (e.g., to avoid catastrophic maintenance events), or due to fuel intermittency (e.g., wind and solar without storage). Again, the ISO is not proposing to change the intention of the revised definition as developed through CCE2. The following table includes a non-exhaustive list of acceptable and unacceptable examples, as requested by FERC.

Acceptable?	Source	Non-exhaustive list of examples
Yes	Statutes, regulations, other ordinances, or court order	<ul style="list-style-type: none"> • Such as from Air Quality Management Districts, California Energy Commission, Local Regulatory Authorities, etc. <ul style="list-style-type: none"> ○ This limitation is largely environmental and most commonly in the form of an air permit. For example, emissions limitations with an absolute limit (cannot pay to emit more and would incur a penalty), wildlife/natural resource management, etc.
	Design	<ul style="list-style-type: none"> • Limited due to the actual design of the resource. <ul style="list-style-type: none"> ○ This limitation is largely applicable to hydro, pumped storage, and participating load. For example, limited reservoir storage capacity or restrictions documented in OEM recommendations, etc.
No	Contractual	<ul style="list-style-type: none"> • Limitations based on a power purchasing or tolling agreements
	Economic	<ul style="list-style-type: none"> • To reduce wear and tear • Staffing constraints or lack of investment • Avoid purchasing more compliance instruments (credits, allowances, etc). to manage emissions (e.g., South Coast Air Quality Management District allows purchase of additional permits rather than a strict limit)
	Fuel intermittency	<ul style="list-style-type: none"> • Variable energy resource <ul style="list-style-type: none"> ○ Such as wind and solar without storage, geothermal

The ISO will not accept limitations that originate in contracts such as power purchasing or tolling agreements. These limitations exist not as a result of restrictions imposed by external statutes or regulations but rather because of trade-offs made by the contracting parties. If the ISO were to accept contractual limitations to deem a resource eligible for opportunity costs, there is an incentive to include these types of restrictions in all contracts and therefore enable market participants to dictate the resources’ commitment costs. The ISO will be developing policy through

the Bidding rules enhancements initiative² potentially allowing scheduling coordinators a way to reflect contractual limitations without impacting the resource's commitment costs. For example, the Bidding Rules initiative is contemplating a "market-based" master file field for maximum daily starts. This would allow market participants a means to manage contractual restrictions without affecting a resources commitment cost cap.

The next part of the proposed definition explicitly points out the limitation in the ISO's commitment time horizon and why an opportunity cost should be calculated. The ISO proposed to consider a use-limitation if the applicability³ of the limitation is longer than the resource's appropriate commitment process in the ISO market. For example, a long start resource with a daily limitation would not be considered use-limited because it is committed in the day-ahead market which optimizes over 24 hours; the applicability of the limitation is 24 hours which is not longer than the optimization horizon of the market which commits the resource. If the same resource has a monthly limitation, then it would be considered use-limited because the day-ahead market does not optimize over the month. Resources that receive operationally binding commitment instructions in the real-time market with daily limitations, under the revised definition, will still qualify for use-limited status. However, the ISO will not be determining an opportunity cost for the daily limitations through this methodology as a more efficient and accurate method for managing these limitations is obtainable through real-time market enhancements, as further discussed in section 6.2.

Lastly, there must be an opportunity cost associated with the limitation. A use-limitation is different from a limitation based on intermittency such as is the case with wind and solar resources. For example, a gas-fired resource with an air permit limiting run hours to 200 per month could physically continue to run more than this limit. Since the run hours are restricted, it is most optimal to only run the resource during the most profitable 200 hours per month. These are the hours in which energy is most valuable. The use-limited capacity has an opportunity cost if it is run in less profitable hours reflecting the foregone profits (*i.e.*, forgone greater benefit to the ISO system).

On the other hand, wind, solar, and geothermal resources (all without storage) run only when available based on the energy source. While these generators may have some level of control (*e.g.*, feathering blades) and can submit decremental bids, the availability cannot be optimized by the scheduling coordinator (*e.g.*, wait to use the resource at a later time in order to maximize profits and system benefit). Therefore, these resources do not inherently have opportunity costs. The proposed definition of "use-limited" would no longer include these resources.⁴

In summary, a use-limited resource:

² <http://www.caiso.com/informed/Pages/StakeholderProcesses/BiddingRulesEnhancements.aspx>

³ The ISO is using the term "applicability" to mean the time frame for which the limitation applies and not the run time limitation. For example, a long-start resource has an air permit that limits its operation to 200 hours per month. The applicability is the month whereas the run time limitation is 200 hours. Since a month is clearly greater than the 24 hours of the day-ahead commitment process, this resource may apply for use-limited status.

⁴ These resources would continue to be exempt from bid insertion rules.

- Is limited by restrictions set forth by regulatory bodies, legislation, court, or due to design elements of the resource. Limitations cannot be based on contractually negotiated limits.
- Cannot be optimized per their limitations because of the ISO's commitment horizon as appropriate for the resource without an opportunity cost adder; and
- Has an opportunity cost.

Default use-limited status

In addition to providing clarity in the definition of use-limited, as directed by FERC and discussed above, the ISO is now proposing to no longer have certain resource types use-limited by default. Based on tariff section 40.6.4.1, hydroelectric generating units, proxy demand resources, reliability demand response resources, and participating load, including pumping load, are currently deemed to be use-limited. However, under the revised tariff language, these resources will no longer default as use-limited resources, but they can go through the registration process and seek to qualify as “use-limited” under the revised terms.

Hydro-resources and participating load (including pumping load) may register and qualify for use-limited status, and be eligible for an opportunity cost, provided sufficient documentation is provided to the ISO in accordance with the definition of use-limited and policy described herein.

Reliability demand response resources, per the ISO tariff, have no commitment costs and therefore do not require any commitment cost related opportunity costs. Energy related opportunity costs are also not warranted given RDRR are required to bid in at or near the energy price cap.

Proxy demand resources may have non-zero commitment costs, and if sufficient evidence can be provided indicating such costs, they may qualify for use-limited status and commitment cost related opportunity cost. Energy related opportunity costs, however, are not warranted as PDRs are not subject to energy bid mitigation and PDR owners can incorporate energy related opportunity costs in energy bids without risk of bid mitigation.

No longer having resources deemed use-limited by the tariff, enables the ISO to redefine the term “use-limited”, and develop its applicability, solely focused on the eligibility for an opportunity costs in commitment cost bids and/or Default Energy Bids. These resources will continue to be exempt from bid insertion.

6. Use-limited registration process

The ISO has made corresponding business practice manual changes to clarify the current application process for use-limited resources⁵.

Additional changes were made to the business practice manual for the application process of use-limited resources to reflect refinements made through the *Reliability Services* initiative. During the registration process, scheduling coordinators will:

- Identify resources seeking use-limited status,
- Provide the limitations in terms of starts, run-hours, output, or other,
- Indicate the applicability of those limitations, i.e. monthly, quarterly, annual, and
- Upload required documentation which defines the limitations.

This initiative will further clarify the registration process and required documentation for purposes of determining opportunity costs.

6.1. Registration process for opportunity costs

For a use-limited resource to receive an opportunity cost, it must first register as a use-limited resource in accordance with the Business Practice Manual as modified to reflect changes made under Reliability Services initiative. During the registration process, scheduling coordinators will also need to provide the supporting documentation as described below to obtain an opportunity cost.

Given a targeted implementation date of Fall 2016, the first set of opportunity costs are anticipated to have an effective date of January 1, 2017. Therefore the registration process, model development, calculations, and negotiations will need to be finalized prior to January 1, 2017. To obtain an opportunity cost valid for the start of 2017, registration and all documentation for the 2017 calendar year will be required to be submitted to the ISO in sufficient time to allow for document review, negotiation process, model development, and opportunity cost calculations.

Supporting documentation

For each resource applying for use-limited status, the market participant will submit to the ISO copies of original documentation stating the resources' limitations or restrictions imposed by regulatory agencies, legislation, or providing evidence of design limitations. The ISO currently

⁵ Existing business practice manual clarifications. See PRR 787 available at: <http://bpmcm.caiso.com/pages/default.aspx> and see PRR 868 available at <http://bpmcm.caiso.com/Pages/ViewPRR.aspx?PRRID=868&IsDlg=0>

understands these to be restrictions imposed on resources by a regulatory agency, such as air quality management districts, due to environmental considerations such as air pollutants or wild life preservation. Resources seeking use-limited status due to design considerations will have to submit documentation proving to the ISO why the design of the resource limits the resource in such a way to qualify for an opportunity cost. Examples include OEM recommendation or bulletin.

In some instances, the market participant may translate the limitation as stated in the original documentation to a limit which can be modeled by the ISO, which is described below. If the limitation has been translated, a document showing the methodology used to translate the limitations as stated in the original documentation to what was submitted in the registration process will be required.

Documentation review

Once the scheduling coordinator has completed the registration process and provided all supporting documentation, the ISO will verify and validate that 1) the resource meets the definition of use-limited and is eligible for an opportunity cost, and 2) the limitations identified through the application process, which qualifies the resource for use-limited status, are supported by the documentation provided. For limitations that have been translated, the ISO will verify the methodology used to translate the limitations from those stated in the supporting documentation is reasonable and results in the limitations identified in the registration process.

The ISO reserves the right to revoke use-limited status if, upon review of the documentation, finds either 1) the restrictions or design elements do not meet the definition of use-limited, or 2) the limitations identified in the registration process are not reasonably supported to qualify as use-limited and receive an opportunity cost.

If during the documentation review process, the ISO requires additional information and/or clarification from the scheduling coordinator, the scheduling coordinator will be contacted by the ISO. In the event the additional documentation and/or clarification are not provided in a timely manner, the scheduling coordinator risks not having an opportunity cost in place prior to the limitation horizon or the ISO may revoke use-limited status.

Maintaining opportunity costs and use-limited status

In subsequent years following the first registration process, if nothing has changed from the supporting documentation previously submitted and reviewed by the ISO, scheduling coordinators can submit an affidavit in lieu of re-submitting all supporting documentation already on file and reviewed by the ISO. The affidavit must attest that the use limitations, and all supporting documentation provided continues to qualify the resources of use-limited for the upcoming year, is accurate, and continues to be supported by documentation. The affidavit will

need to be submitted to allow for sufficient time for the ISO to update the negotiated values⁶ or re-run the model to generate opportunity costs for the upcoming calendar year.

If there have been changes to any documentation previously submitted, the scheduling coordinator will need to re-register the resource and submit the updated supporting documentation. Updated documents will need to be submitted to the ISO to allow for sufficient time to incorporate those changes into the negotiations or models which are used to determine the opportunity costs, prior to the effective date of the changes. If documents are not received allowing for sufficient time, the ISO cannot guarantee an opportunity cost prior to the start of the limitation horizon.

Use-limited registration of new resources

This section only applies to resources seeking use-limited status after the initial registration in 2016.

Scheduling coordinators seeking use-limited status for existing or new resources for the first time must complete the registration process and provide all required documentation in sufficient time to allow for the ISO to review documentation and complete the negotiation process or model and calculate an opportunity cost prior to the first effective date of the limitation. Failure to allow for sufficient time, could result in the resource not having an opportunity cost effective at the start of the limitation time horizon.

Sufficient data is necessary for the ISO to model and calculate opportunity costs or have a basis for the negotiation process. This would be, at a minimum, one year's worth of historical nodal LMPs from the fifteen minute market. New resources seeking use-limited status prior to having one year of historical LMPs can complete the registration process, be approved by the ISO as use-limited, and remain on the registered cost option until the minimum data requirement has been met. At that time, the ISO will commence with the negotiation or modeling process to determine the first set of opportunity costs for the resource. The scheduling coordinator will also be required to maintain use-limited status for the resource.

6.2. Evaluating submitted limitations

All use-limited resources will be evaluated to determine if their limitation results in a non-zero opportunity cost. The ISO will not be able to model every type of limitation but will determine if modeling is possible based on reviews of documents submitted as part of the use-limited registration process. The ISO will either calculate opportunity costs or work with market participants to develop negotiated opportunity costs after the ISO has received the documentation needed to evaluate use limitations and has approved the resource's use limited status.

⁶ Resources with negotiated opportunity costs with no changes would trigger an expedited negotiation process where they can update the inputs used in the previously approved methodology for the upcoming calendar year without re-registering.

The ISO will evaluate each submission on a case-by-case basis and determine whether the ISO can model the resource and limitations to calculate opportunity costs. The ISO expects that its calculated methodology will largely be used by gas-fired resources with clearly defined limitations based on starts, run hours, and output.

Modeled limitations

The proposed opportunity cost model will be able to model limitations on the number of starts, run hours, and/or output. Limitations may be applicable for a month, quarter, or year. A resource with more than one limitation which can be modeled will have a calculated opportunity cost for each limitation. For purposes of this initiative, each modeled limitation has two components:

- **Operating characteristic:** this refers to the operating component which is limited, i.e. starts, run-hours, or output.
- **Applicability:** this refers to the time frame for which the limitation is applied, e.g., monthly, annual, etc.

Some limitations may not explicitly be a limit on the quantity of starts, run-hours, and/or output but rather in terms of emissions, fuel usage, etc. It is the ISOs understanding that some of these limitations can be translated into a limit on starts, run-hours, and/or output, but may not be a simple translation. For example, emissions may differ at start-up and vary across the operating range of the resource. Scheduling coordinators of these resources have the expertise and knowledge on how they operate most efficiently within their current limitations. Therefore the ISO proposes that market participants translate such limitations into a limit on starts, run-hours, and/or output if possible, and submit the translated limitations to the ISO during the registration process. When a limitation is translated into a limit on starts, run-hours, and/or output, the market participant will also provide the ISO documentation summarizing the methodology used to translate the limitations. This documentation will be submitted along with the other required documentation during the use-limit registration process.

Negotiated limitations

Limitations that the ISO determines cannot be modeled will be eligible to request a negotiated opportunity cost. Based on conversations with scheduling coordinators, many hydro, participating load, and pumped storage resources develop costs based on sophisticated models that synthesize the impact of current and projected hydrology data, including snowpack levels, watershed topology and size, and various fish and wildlife restrictions. The ISO will not be able to replicate such a model. Instead, the ISO expects the scheduling coordinator to provide the opportunity cost(s) and documentation of the modeling methodology for calculating the opportunity cost(s). The resource will then use negotiated opportunity cost adders as approved by the ISO based on the submitted methodology. The ISO expects that more complicated environmental permits (e.g., Delta Dispatch), as well as multi-stage generators with use limitations, may also require negotiated opportunity costs.

Scheduling Coordinators will be required to provide documentation describing the methodology used to determine the submitted opportunity cost for each negotiated limitation. The methodology will be subject to ISO review. More detail on the process for negotiated opportunity costs is provided in Section 8.

Daily limitations

The ISO is no longer proposing to provide opportunity costs, calculated or negotiated, for daily limitations. There was concern that setting the calculated opportunity costs due to daily limitations at the maximum daily opportunity cost from all days within the given month could result in excessive headroom; in other months it may not be high enough to be effective. The potential inaccuracy could worsen, rather than improve, the status quo. Discussion at the most recent MSC meeting determined that daily limitations are more effectively and accurately addressed through real-time market enhancements. For example, extending the real-time optimization horizon or utilizing IFM solutions to determine a daily opportunity cost are two potential solutions. Therefore, the opportunity cost for daily limitations will be addressed through real-time market enhancements.

It is the ISO's understanding that daily limitations as stated in current Master File fields are not a result of imposed daily restrictions but rather reflect imposed monthly or annual limitations, which would receive an opportunity cost. Given the current use-limited resources and supporting documentation available to the ISO, there are only a limited number of resources with daily limitations. All but three of those resources have the same limitation type, e.g, limit on starts, over a longer horizon, e.g., annual. Therefore the resource would still receive an opportunity cost associated with a limitation on starts, in this example, that can be reflected in start-up cost bids to optimally use the daily and annual starts.

Resources that have daily limitations supported by acceptable documentation can be managed through tools currently available to scheduling coordinators and grid operators. Scheduling coordinators can use daily Masterfile fields, including max daily starts, max daily MWh⁷, minimum up time, minimum down time, to ensure the resource does not exceed the daily limits. ISO grid operators can also ensure resources with daily limitations are available in real-time when most needed by

- blocking sub-optimal commitment instructions that would ultimately make the resource unavailable when needed most, or
- issuing bridging exceptional dispatches the resource to remain on such that it is still available to the market when needed most.

⁷ This field is only available to use-limited resources, therefore it is essential for resources with daily limitations that want to utilize this field to register as use-limited with the ISO.

The ISO anticipates this change in the policy from the straw proposal to have minimal impact on resources with daily limitations given the limited number of resources this change would affect, and the current tools available to help manage daily limitations in the market.

Multi-stage generating resources

Use-limited multi-stage generating resources (MSGs) may be use-limited if they meet the criteria set forth in the modified definition of use-limited and are approved such status through the registration process. Based on conversations with scheduling coordinators some limitations on MSG resources apply to the resource in its entirety, i.e. at the parent resource level, while others apply to the configurations and transitions between configurations. The ISO intends to calculate opportunity costs for limitations the model can accurately reflect. Therefore, the ISO will determine through the use-limited application process MSG limitations it can model and calculate an opportunity cost, and those it cannot model and consequently would be subject to a negotiated opportunity cost.

In some cases, transition costs for MSG resources with limitations on the configuration level become another commitment type cost. Therefore additional consideration as to which commitment costs for MSG resources is warranted and is discussed in Section 9.

7. Opportunity Cost Model

The Market Surveillance Committee opinion on the *Commitment Cost Refinements 2012* initiative noted the committee members' concern that relying on use plans (i.e., limiting the hours a resource is bid into the market to avoid over-use) could result in inefficient use of a unit's limited starts, run-hours, and energy output.⁸ Traditionally, the highest prices and need predictably occurred during on-peak hours. With increasing renewable penetration and the need for flexibility and ramping capability, high prices may occur more frequently during off-peak periods that cannot be anticipated by a use plan.

The Committee concluded that it would be more efficient to allow high start-up and minimum load bids that reflect opportunity costs of operation, which then gives flexibility to the market software to determine if the resource is economic. The ISO will implement an optimization model capable of frequent model runs that provides market participants an effective tool to manage use-limited resources through the market while accurately reflecting opportunity costs. The model will use an algorithm to estimate commitment and dispatch of a resource and the foregone profits of having one less start, run-hour, or MWh to generate. The opportunity costs for each limitation will then be determined by the estimated foregone profits.

The ISO proposes to implement an optimization software model to estimate the opportunity costs. An optimization model can simultaneously enforce multiple limitations, thus resulting in more

⁸ http://www.caiso.com/Documents/MSCFinalOpinion-BidCostRecoveryMitigationMeasures_CommitmentCostsRefinement.pdf

accurate opportunity costs. In addition, it is the more adaptable approach which would lend itself to more cleanly implementing potential future enhancements.

7.1. Opportunity cost methodology overview

Table 2 below provides an overview of the major components needed to calculate and utilize the opportunity cost estimates, including the inputs, calculation procedures, outputs, and the usage of the outputs. Under the “inputs” column, the optimization model will rely on limitations provided to the ISO through the registration process, Master File characteristics,⁹ and applicable commitment and variable energy costs to provide a resource- and limitation-specific opportunity cost. This cost is based on calculating the profit (or gross margin) that is foregone in some future interval if one less start, one less operating hour, and/or one less MWh is available, as appropriate. In order for the model to calculate the profit, we will use historical implied heat rates, natural gas future prices, recent gas transportation and greenhouse gas prices, and an inflator based on future power prices to simulate a distribution of the node-specific LMPs for the resource. As noted under the “outputs” column, the model will provide for each resource a specific opportunity cost for each limitation it has over a specific period of time (e.g., month or year). Lastly, the opportunity cost will be reflected in commitment cost bids or added to the resource’s DEB.

Table 2 Opportunity cost methodology overview

Model inputs	Opportunity cost calculation	Model outputs
<ul style="list-style-type: none"> • Use plan limitations • Unit characteristics • Commitment costs • Historical implied heat rate • Natural gas futures • Greenhouse gas prices • Gas transportation costs • Future power price conversion factor 	Unit commitment model over future time period (e.g., month) based on simulated node-specific LMPs.	Separate resource specific opportunity costs for start-up, minimum load, and energy, as appropriate. Can be reflected in commitment cost bids or resource’s DEB.

The subsections below discuss each of the columns in Table 2 in greater detail.

7.1.1. Model inputs

This section discusses resource characteristics and market inputs to the optimization model.

The ISO will rely on submitted use plans to determine the resource’s limitation(s). The ISO will also use Master File characteristics such as the minimum load and maximum capacity of the

⁹ The model accounts for each resource’s minimum run time and minimum down time. It does not consider maximum daily starts in Master File.

resource. The variable energy cost will be based on the megawatt weighted average heat rate, forward gas prices, recent gas transportation and greenhouse gas costs, and the O&M adder. For commitment costs, the ISO will calculate proxy start-up and minimum load costs based on the recent heat rates, gas transportation and greenhouse gas costs, O&M and major maintenance adders, GMC, and forward gas prices.

Scheduling coordinators will need to know their resource-specific opportunity costs for the month or year prior to the start of that period in order to reflect the costs in their bidding. Therefore the opportunity cost of each limitation will have to be calculated in advance of the time period based on simulated future prices.

Most use-limited resources are committed and de-committed based on the 15-minute real time prices; there are three gas-fired long-start use-limited resources that are committed and de-committed based on day-ahead prices. On average, 15-minute real-time prices have been slightly lower than day-ahead prices by \$1-\$2/MWh, but are more volatile. Price volatility in the real-time market can result in use-limited resources cycling through starts and run hours, thus making them more likely to expend the limitations. Furthermore, the higher volatility of real-time prices is likely to result in higher opportunity costs, especially for infrequently used resources. The ISO recognized these pricing trends may not persist as the resource fleet and system conditions evolve. However, based on stakeholder feedback and discussion at a Market Surveillance Committee meeting, the ISO proposes to estimate 15-minute real-time prices to use in the opportunity cost model.

The ISO will simulate real-time prices by calculating an implied marginal heat rate at each use-limited resource's pricing node (Pnode) based on fifteen minute real-time energy prices from the same time period the previous year. Each interval's and location's LMP is assumed to reflect the heat rate of a marginal unit, and that heat rate can be inferred from the prices of gas and emissions allowances at that time and place. This procedure will allow the implied heat rate to inherently capture real-time price volatility which will then be used to forecast future prices. For example, if the ISO is estimating November 2016 prices, we will use November 2015 15-minute real-time energy prices, greenhouse gas costs, daily gas prices, and gas transportation costs. This will generate an implied heat rate for every 15-minute real-time interval, which will then be used to forecast November 2016 real-time energy prices for a given resource.

Implied heat rate, $ImpHR_{i,t-1}$, will be determined as follows:

$$ImpHR_{i,t-1} = \frac{LMP_{i,t-1}}{NatGasP_{i,t-1} + (GHGas_{i,t-1} * EmRate)}$$

Where

$LMP_{i,t-1}$ is the real time energy price at pnode i from the previous year's period, $t-1$.

GHG _{t-1}	is the greenhouse gas allowance price from the previous year's period, <i>t-1</i> .
EmRate	is the greenhouse gas content of natural gas, which is <i>.0531148mtCO2e/MMBtu¹⁰</i>
NatGasP _{i,t-1}	is the daily natural gas price and transportation costs from the region <i>l</i> of pnode <i>i</i> of the previous year's period, <i>t-1</i>

The ISO previously proposed to simulate the energy prices by multiplying the implied heat rate by the sum of: (1) the most recent natural gas future prices for the applicable month; (2) the most recent gas transportation costs; and (3) the most recent greenhouse gas costs multiplied by the standard emissions rate. Using an implied heat rate from the previous time period to simulate energy prices assumes that (1) real time volatility and congestion patterns from the previous year will materialize in the modeled year, and (2) the average nodal LMPs, adjusted for gas and GHG costs, will remain consistent year over year. Changes in market conditions, both anticipated and unanticipated, may result in the estimated energy prices diverging from market energy prices.

Based on discussions with the Market Surveillance Committee and stakeholder feedback, incorporating anticipated changes in market conditions, such as changes in hydro conditions from one year to the next, into the simulated energy prices may minimize the need for more frequent model runs. Therefore the ISO proposes to simulate the energy prices as previously proposed, using the implied heat rate methodology described above, but scaling the implied heat rate by a conversion factor based on future power prices, adjusted for changes in natural gas and GHG costs.

The previous proposal had a lower bound of one on the conversion factor, thus only increasing estimated LMPs. As noted in comments by DMM and PG&E, the conversion factor should be allowed to also decrease the LMP. There are two reasons for this change. First, purpose of including the conversion factor is to reflect anticipated market conditions that are not captured by the historical implied heat rate and future natural gas price method. Therefore if anticipated market conditions are decreasing energy prices relative to the previous year, the estimated LMPs should also reflect the anticipated condition. Secondly, only allowing the conversion factor to increase estimated LMPs may actually result in a lower opportunity cost for limitations on starts. For example, a resource that is started up twice in one day would instead be started up once and remain on with higher LMPs. Using one start rather than two could result in the resource having a lower opportunity cost.

The conversion factor will be generated as follows:

$$PPConv_{h,m} = \frac{ImpHRF_{h,m,tou}}{ImpHRH_{h,m-12,tou}}$$

Where:

¹⁰ Per EPA

$ImpHRF_{h,m,tou}$ is the implied heat rate based on the future power price at hub h for the analysis month m and time of use tou (peak or off peak), calculated as:

$$ImpHRF_{h,m,tou} = \frac{PPF_{h,m,tou}}{NatGasF_{m,l} + (GHGas_{m-1} * EmRate)}$$

where:

$PPF_{h,m,tou}$ is the future power price at hub h of node i , for the analysis month m and interval time of use tou . Future power prices at NP15 hub will be applied to resources in PGE1 and PGE2 fuel regions; SP15 hub will be applied to resources in SCE1 and SCE2 fuel regions; resources in CISO fuel region will use the maximum future power prices of NP15 and SP15.

$NatGasF_{m,l}$ is the natural gas future price for the analysis month m , from region l of hub h

$GHGas_{m-1}$ is the monthly average greenhouse gas allowance price from the previous month, $m-1$

$EmRate$ is the greenhouse gas emissions rate per MMBtu of natural gas, which is $.0531148mtCO_2e/MMBtu$

And where:

$ImpHRH_{h,m-12,tou}$ is the implied heat rate based on average monthly power price at hub h from the same month the previous year, $m-12$, and time of use (peak or off peak), tou , calculated as:

$$ImpHRH_{h,m-12,tou} = \frac{PP_{h,m-12,tou}}{NatGas_{m-12,l} + (GHGas_{m-12} * EmRate)}$$

Where:

$PP_{h,m-12,tou}$ is the monthly average power price at hub h of node i from the previous time period $m-12$, and interval time of use tou . Power prices at NP15 hub will be applied to resources in PGE1 and PGE2 fuel regions; SP15 hub will be applied to resources in SCE1 and SCE2 fuel regions; resources in CISO fuel region will use the maximum future power prices of NP15 and SP15.

- $NatGas_{m-12,l}$ is the monthly average of daily natural gas price from the region l of the previous year's period, $m-12$
- $GHGas_{m-12}$ is the average greenhouse gas allowance price from the previous year's period, $m-12$.
- $EmRate$ is the greenhouse gas content of natural gas, which is $.0531148mtCO_2e/MMBtu$

Simulated 15-minute real-time energy prices will be generated as follows:

$$LMP_{i,t} = ImpHR_{i,t-1} * PPConv_{h,m,tou} * (NatGasF_{l,t} + GasTrans_{l,m-1} + (GHGas_{m-1} * EmRate))$$

Where:

- $LMP_{i,t}$ is the forecasted real time price at node i for interval t
- $ImpHR_{i,t-1}$ is the calculated implied heat rate at node i from the previous year's period, $t-1$
- $NatGasF_{l,m}$ is the natural gas futures for the analysis month for region l
- $GasTrans_{l,m-1}$ is the average gas transportation cost for region l from the previous month
- $GHGas_{t,m-1}$ is the average greenhouse gas allowance price from the previous month.
- $EmRate$ is the greenhouse gas content of natural gas, which is $.0531148mtCO_2e/MMBtu$
- $PPConv_{h,m,tou}$ is the conversion factor based on future power prices at a given hub h for the analysis interval m and time of use, tou

The end result is a set of node specific forecasted 15-minute real-time energy prices for each use-limited resource with a limitation that can be modeled. These forecasted prices will be used in the opportunity cost model, along with the estimated resource costs and characteristics, to estimate the dispatch of the resource over the modeled time period.

7.1.2. Calculating opportunity costs

The ISO will develop an optimization model which estimates a resource's 15 minute interval dispatch, over a given time period, using estimated resource specific costs and characteristics against the forecasted 15-minute real-time energy prices. The ISO will have to run the model, and calculate opportunity costs, prior to the time period for which the limitations are applicable.

An opportunity cost will be calculated for each limitation a use-limited resource has that can be modeled.

The opportunity cost will be based on the estimated profits foregone if the resource has one less start, run-hour, or MWh to generate. The foregone profits are based on the difference between estimated profits of the relevant time period from a model run with all limitations set at 90% of the limitation and the estimated profits from the same time period from a model run with the limitation reduced by one, i.e., 90% of actual, or remaining limitation, minus one start, run-hour, or MWh. In the case of a limitation being one, the opportunity cost will be based on the difference of estimated profits from a model run with the limitation set at two and estimated profits from a model run with the limitation set at one.

In response to stakeholder comments, the limitation used in the base run model will be reduced by a reserve margin. The ISO is proposing the reserve margin to be ten percent; the limitation in the base model run will be set at 90% of the actual, or remaining, limitation. There was concern that without a reserve margin, resources may not be available at the end of the year in December, which currently has the highest flexible capacity requirement. Stakeholders also commented on the need for a margin of error, e.g., 10% adder to the opportunity cost. Running the base model with the limitation set at 90% of the actual limitation will ultimately achieve a higher opportunity cost, as would the 10% adder. However, the reserve margin approach will determine a more appropriate error term based on a sensitivity analysis as opposed to a fixed percent.

For illustrative purposes, assume a resource has an annual limitation of 300 starts and we are estimating the opportunity cost. The opportunity cost will be the difference in estimated profits from the two model runs.

Model Run #1 (base run): Run the model with start limitation set to 270 ($.9 \times 300$) for January through December.

Model Run #2: Run the model with start limitation set to 269 for January through December.

Start-up limitations: The calculated opportunity cost for a limitation on the number of start-ups will be determined by the estimated profits foregone if the resource had one less start in the relevant time period.. This will be a \$/start-up value.

Run-hour limitations: The calculated opportunity cost for a limitation on the number of run-hours will be determined by the estimated profits foregone if the resource had one less run hour in the relevant time period. This will be a \$/hour value.

Energy limitations: The calculated opportunity cost for a limitation on the output of the resource will be determined by the estimated profits foregone if the resource had MWh to generate in the relevant time period. This will be a \$/MWh value.

As previously noted, another element of a resource's limitation is applicability: the time period for which the limitation is applied. The ISO anticipates these to be daily, monthly, quarterly, calendar year, or rolling 12-month limitations. All opportunity costs will be calculated prior to the start of the applicable day, month, quarter, year, or 12-month period. In addition to the initial model run

for the upcoming applicable time period, the ISO intends to run the model and update opportunity costs throughout the time period. More detailed information on scheduled runs, and how the opportunity costs are updated, is provided in Section 7.1.2.2. The following describes how opportunity costs for different applicable time horizons will be determined.

Calendar year limitations will have an opportunity cost valid for that calendar year, subject to updated values as a result of scheduled runs within the calendar year.

Rolling 12-month limitations (or other rolling limitations) will have an opportunity cost valid for the applicable period, subject to updated values as a result of scheduled runs that contain months within the previously modeled time horizon. As discussed at the MSC meeting, opportunity costs today due to rolling limitations are impacted by an infinite number of rolling 12-month time horizons. To estimate opportunity costs for rolling limitations, the model will enforce at least two rolling time horizons: M-11 to M and M to M+11 where M is the last and first month of the rolling time horizon respectively.

Quarterly limitations will have an opportunity cost valid for each quarter, subject to updated values as a result of scheduled runs within, or before, the quarter.

Monthly limitations will have an opportunity cost for each month, subject to updated values as a result of scheduled runs before the month.

Daily limitations will no longer have an opportunity cost determined through either the model or negotiated process.

7.1.2.1. Nested limitations

A resource may have more than one limitation of the same type, i.e. limitation on starts, with different applicability, i.e. monthly and annual. The estimated opportunity costs due to these two limitation need to be combined into one value such that it can be reflected in the bid cap of the appropriate commitment cost or DEB. The straw proposal used an example to illustrate the issue and proposed a solution. Using an optimization that includes multiple resource constraints simultaneously would allow the ISO to solve the nested limitation problem discussed in the straw proposal without adding additional post processing steps. Therefore, the issue has become a non-issue with an optimization based modeling approach.

For resources with nested limitations, the opportunity cost will be based on the difference of estimated profits from the following two model runs. For illustrative purposes, assume a resource has monthly and annual limitation on starts of 20 and 140 respectively and we are estimating the opportunity cost for January.

Model Run #1: Run the model with monthly and annual limitations set at 18 ($18 = .90 * 20$) and 126 ($126 = .90 * 140$) respectively, for the full calendar year. Note the January profits.

Model Run #2: Run the model with the annual limitation set at 125 and the January limitation at 18. Leave the remaining monthly limitations set at 19. Note the January profits.

The estimated opportunity cost for January that can be reflected in the start-up cost bid is the difference of the January profits from the two model runs.

7.1.2.2. Scheduled model runs

The opportunity cost model will be run prior to the time period for which the limitation is applicable. Most limitations are based on a calendar year, therefore the model will need to be initially run in Q4 of the year prior, to calculate opportunity costs for the year the limitation is applicable. As the year progresses, any re-runs of the model will model the months remaining in the calendar year and update previously calculated opportunity costs. Table 3 illustrates how scheduled runs throughout the year will update previously calculated opportunity costs.

Rolling 12-month limitations include the current month and either the preceding or upcoming 11 months. Theoretically, the opportunity cost today is based on energy prices in infinitely continuous 12-month rolling periods. For such limitations, the ISO will model at least two rolling 12-month periods; the preceding eleven months plus the current month, and the current month plus the subsequent eleven months. Based on stakeholder discussion and input from the Market Surveillance Committee, this is a reasonable way to approximate opportunity costs for rolling 12-month limitations.

Frequency of scheduled model runs

The closer the model is run to the actual time period for which the limitation is applied, the more accurate the opportunity costs, and more effective the tool is for the market to optimize the use of these resources. Therefore the frequency of scheduled runs is a significant factor in developing opportunity costs through this initiative. At the recent technical workshop, and through submitted comments, stakeholders have encouraged the ISO to update opportunity costs throughout the year as frequently as possible; the effectiveness of the model as a tool is strongly related to the frequency of updates. Some stakeholders mentioned their willingness to forego model accuracy that would not enable more frequent updates, for a model that would enable frequent updates.

Given stakeholder comments, at this time, the ISO proposes to run the model and update opportunity costs monthly¹¹. Table 3 below illustrates 1) when the model will be run, 2) what calculated opportunity costs are generated in each model run, and 3) how previously calculated opportunity costs are updated during subsequent model runs.

¹¹ The software platform that will be used to develop the model and calculate opportunity costs will be determined in implementation. Processing speeding of the software and required CAISO resource time will both determine how frequently the model can be run.

Table 3 Schedule for calculating opportunity costs

Limit applicability	Current year Dec	Calendar year limitations are applicable				
		Jan	Feb	Mar	Apr	May . . . Dec
Monthly	Model Jan - Dec					
		Model Feb - Dec				
			Model Mar - Dec			
Quarterly	Model Jan - Dec					
		Model Feb - Dec				
			Model Mar - Dec			
Annual	Model Jan -Dec					
		Model Feb - Dec				
			Model Mar - Dec			
Rolling 12-months	Model Feb _{t-1} -Jan; Jan -Dec					
		Model Mar _{t-1} -Feb; Feb -Jan _{t+1}				
			Model Apr _{t-1} -Mar; Mar -Feb _{t+1}			
Where		Binding		Binding, subject to updates		Advisory

Monthly limitations: The December model run will model January through December and generate monthly opportunity costs for monthly limitations. January opportunity costs will be binding; opportunity costs generated for February through December are advisory. The model run in January will model February through December, and produce binding opportunity costs for February and advisory opportunity costs for March through December. This will continue for each month through November where the November run will only model December and produce the final binding opportunity cost for that calendar year; the December run will then model January through December of the next year.

Quarterly limitations: The December model run will model January through December and generate an opportunity cost for each quarter. The opportunity cost for Q1 will be binding for January; the Q1 opportunity cost will also be binding for February and March but may be updated in the January and February model runs. The model run in January will model February through December and update the previously binding Q1 opportunity cost for February and March, and produce advisory opportunity costs for Q2 through Q4. The model run in March will model April through December and produce a binding opportunity cost for Q2, which will be binding for April through June but with May and June values subject to updated model runs. This will continue for each month through November where the November model run will update the previously calculated Q4 opportunity cost for December; the December run will then model January through December of the next year

Annual limitations: The December model run will generate one opportunity cost for January through December. That cost will be binding for January but subject to updates from the monthly model runs for the opportunity costs used February through December. Each monthly model run will model the remaining months of the year.

Rolling 12-month limitations: These limitations will be modeled each month as well but always include at least two 12 month modeled periods. A model run for a rolling 12-month limitation will generate a binding opportunity cost for the upcoming month.

Model runs that update a previously calculated opportunity cost, whether it was binding subject to updates or advisory, will supersede any prior value. Model updates are intended to more accurately capture changes in gas price futures and how the resource has been used in the market, both of which impact opportunity costs. This will enable uneconomic commitment of the resources, testing, and/or failed starts, to be reflected in the next model run. If those changes result in the limitations being less/more binding due to either lower/higher future gas prices or being committed less/more in the market than anticipated, the opportunity costs need to reflect the changes. Therefore opportunity costs can increase and decrease month to month.

The ISO is proposing to re-run the model and update calculated opportunity costs monthly. As with any new process, unforeseen circumstances may arise that result in the ISO unable to update the opportunity costs monthly. In the event the ISO cannot re-run the model in a timely manner such that the scheduling coordinators have an updated opportunity cost value for the upcoming month, the most recent advisory calculated opportunity cost for the relevant time period will become binding. Limitations based on rolling time periods will continue to use the most recent calculated opportunity cost.

Impromptu re-runs were discussed at the technical workshop as well as through submitted comments. Most stakeholders felt that some method of impromptu re-runs be made available to scheduling coordinators. Given the ISO current proposed monthly scheduled model runs, along with incorporating a conversion factor based on future power prices, the need to have impromptu re-runs has diminished. Therefore, the ISO is not proposing to have impromptu re-runs within a month.

Updating limitations in model

As the year progresses and the model is run to update opportunity costs, the limits used in the model also need to be updated. The ISO presented three options at both the August Market Surveillance Committee Meeting and the recent technical workshop on this initiative. During both discussions, and through stakeholder comments, one option was preferred by all whom commented on the issue. Therefore the ISO proposes to update the limits used in the model runs throughout the calendar year based on actual commitment and dispatch of the resource in the market. For example, the model run for March through December will use 90% of an annual limitation on starts reduced by the number of starts the resource incurred in January and February. This will enable the opportunity cost model to accurately reflect unanticipated pricing events, failed starts, testing, or uneconomic commitment, that resulted in a resource using more of its limitation than initially estimated by the model.

Based on discussion with stakeholders, there are some instances where a resource may incur a start or run hour that counts towards its limitation but that the ISO market data does not reflect. The ISO considers a resource start when it reaches minimum load. These are primarily failed starts or testing. When a resource has a failed start, testing, or any other even that leads to a reduction in remaining starts, run hours, and/or output that is not reflected in the ISO market data, the scheduling coordinator will communicate that to the ISO such that it can be reflected in the remaining model runs for that calendar year.

7.1.3. Outputs

Each model run will produce a calculated opportunity cost for each limitation type.

Start limits will be reflected in an opportunity cost adder for start-up costs; run hour limits will be reflected in an opportunity cost adder for minimum load costs; energy limits will be reflected in an opportunity cost adder for DEBs¹².

Presently, the bid cap for start-up and minimum load costs is determined by 125% of the daily calculated proxy cost. How the opportunity costs are determined to be reflected in commitment cost bids through this initiative will flow directly into the Bidding Rules Initiative. The ISO is proposing commitment cost bids can reflect up to 100% of the opportunity cost for the corresponding commitment cost. For example, if a resource has a \$100/start opportunity cost, and the maximum start-up cost bid as determined by the Bidding Rules initiative, excluding the opportunity cost component, is \$5,000, the scheduling coordinator can submit a start-up cost bid up to \$5,100. Opportunity costs associated with output limitations will be added to the resource's DEB. Therefore:

- Start-up cost bids can reflect up to 100% of the opportunity cost due to a limitation on starts.
- Minimum load cost bids can reflect up to 100% of the opportunity cost due to a limitation on run hours.
- Opportunity costs due to a limitation on output will be added to the resource's Default Energy Bid.

Upon completion of each model run, the ISO will provide each scheduling coordinator a summary of the model outputs for each use-limited resource modeled. The summary will include:

- Estimated usage of each limitation, i.e. starts, run-hours, and/or output, by applicability, i.e. month, quarter, etc.
- Calculated binding and advisory opportunity cost for each limitation.
- Final binding and advisory opportunity cost adder for each limitation type, i.e. start, run hour, and/or output.

This will enable scheduling coordinators to track actual usage to how the model estimated the resource to be committed and dispatched. This will be significantly useful in the first year or so of implementation to aid in identifying any modeling enhancements that may increase the

¹² Opportunity costs due to energy related limitations are not included in generated bids as use-limited resources are exempt from bid insertion.

effectiveness of the tool. Furthermore, it will provide some transparency to how the final opportunity cost adders are determined.

Dispute and resolution process

In the event a scheduling coordinator with a resource identified as having limitations that can be modeled does not agree with the ISO's calculated opportunity cost, the scheduling coordinator can submit a request to the ISO to consider a significant factor not accounted for in the model that cannot be reasonably modeled, and significantly impacts the calculated opportunity cost. The ISO will then work with the scheduling coordinator to negotiate an appropriate opportunity cost with sufficient justification and supporting documentation from the scheduling coordinator that 1) identifies the factor(s) not included in the model, and 2) proves the factor(s) significantly impacts the calculated opportunity costs. The ISO also has to determine the factor(s) cannot be reasonably modeled.

Similar to the process for a negotiated default energy bid or a negotiated major maintenance adder, if a scheduling coordinator and the CAISO cannot reach mutual agreement on an opportunity cost to be used, the scheduling coordinator may file at FERC pursuant to Section 205 of the Federal Power Act for approval of a rate.

8. Negotiated opportunity cost

Upon receipt of all required documentation through the registration process, the ISO will review the limitations and identify those that cannot be modeled and notify scheduling coordinators of those resources. The notification to the scheduling coordinators will initiate the negotiation process. The ISO anticipates it will not be able to model and calculate opportunity costs for hydro resources and resources with complex limitations that cannot be translated into a limit on the number of starts, run-hours, and/or output. These limitations will have a negotiated opportunity cost. The negotiation process, as outlined below, will culminate with an approved methodology used to determine the opportunity cost for each limitation, an opportunity cost for each limitation, and the frequency of which the approved opportunity cost can be updated throughout the limitation's applicable time horizon.

As discussed in Section 6.1, resources with negotiated opportunity costs will provide additional documentation to the ISO. The documentation will include an opportunity cost for each limitation that cannot be modeled by the ISO that can be reflected in start-up cost bids, minimum load cost bids, or included in the Default Energy Bid. Documentation describing the methodology used to determine the submitted opportunity cost values will also be required and a proposed frequency of updates for the calendar year. The methodology should include details such as input variables, values used, values that may vary throughout the year, and/or process(es) used to arrive at the submitted values (i.e. formulas, simulation models, historical analysis, etc).

The ISO will then review the submitted negotiated opportunity costs and methodology. The ISO will either approve the submitted methodology and opportunity costs, or work with the market participants to reach an approved methodology and opportunity cost values. In the event the

negotiation has not been finalized prior to the effective date(s) of the limitation(s), the ISO may propose a temporary opportunity cost value that the ISO finds reasonable while the negotiation process continues. The scheduling coordinator may accept or reject the proposed temporary value. If the scheduling coordinator rejects the proposed value, no opportunity cost will be included until a negotiation is reached.

The temporary value established by the ISO would be applicable only in the event that the CAISO determines that resource warrants establishing a non-zero temporary opportunity cost based on submitted documentation pending any agreement or resolution of a negotiated opportunity cost proposed by the SC. If a Scheduling Coordinator and the CAISO cannot reach mutual agreement on an opportunity cost to be used, the Scheduling Coordinator may file at FERC pursuant to Section 205 of the Federal Power Act for approval of a rate.

As discussed at the technical workshop, and reiterated through submitted comments, stakeholders requested resources with negotiated opportunity costs to also be eligible for updated values throughout the calendar year. The ISO agrees that these resources, while not modeled by the ISO, may encounter unanticipated events that result in running through their limitations faster, or slower, than initially estimated. Due to the potential complexity of updating negotiated opportunity costs as well as the unpredictability of when updates will be requested, the additional ISO resources required to support this process in a timely manner may become insufficient. To ensure updates to negotiated opportunity costs can be updated in a timely manner acceptable by the ISO and market participants, the frequency of updates will be part of the negotiation process. In addition to the approved methodology and opportunity costs determined through the negotiation process, the ISO will also negotiate with the market participants the frequency of updates. The ISO envisions the frequency of updates to be dependent on the transparency of the approved methodology; more formulaic methodologies are likely to be easier to update and therefore have more frequent updates compared to those that are less transparent.

Updates to negotiated opportunity costs will only include updates to the opportunity cost values, not the approved methodology used to determine the opportunity costs. To initiate an update, the market participant will need to provide the ISO the new value(s) along with an explanation of why the opportunity costs have changed. Market participants will need to identify the input variables or original assumptions from the approved methodology that changed in such a way to warrant an updated opportunity cost.

Finally, the ISO will be reviewing negotiated default energy bids, many of which include an opportunity cost that may no longer be appropriate once the policies in this straw proposal are implemented. Allowing recovery of opportunity costs as proposed in this initiative obviates the justification to recover opportunity costs for the same restrictions through negotiated default energy bids. The ISO will be amending section 39.7.1.3 of the ISO tariff to allow the ISO to review and propose modifications to existing negotiated default energy bids and to require the scheduling coordinator to provide updated supporting information and cost justification.

9. Multi-stage generating resources

This section only applies to Multi-stage generating resources.

It is the ISO's understanding that limitations on MSG resources may apply to either the collective resource, i.e. parent level, or on the individual configurations. Furthermore, each configuration has a biddable minimum load cost, biddable start-up cost (for startable configurations), and upon implementation of CCE2, biddable transition costs. Therefore, additional consideration to determine which commitment cost bids may reflect opportunity costs is warranted. The following discussion pertains to all opportunity costs for MSG resources, independent of if the opportunity cost was calculated by the ISO or negotiated. The overall methodology used to determine which commitment costs may reflect the opportunity costs is based on the concept that any commitment type decision, i.e. transition or direct start, made by the market should reflect the appropriate opportunity cost.

Limitations that apply to the collective resource will have one opportunity cost for each limitation. Up to 100% of an opportunity cost due to a start limitation may be reflected in the start-up bid for each startable configuration. This ensures that when the market commits the resource from being "off" to "on", the start-up cost incurred can reflect the opportunity cost associated with a limitation on starting the collective resource. Up to 100% of an opportunity cost due to a run-hour limitation may be reflected in the minimum load cost bid for each configuration. The opportunity cost due to an energy limitation will be added to the DEB of each configuration.

Limitations that apply to each configuration will have an opportunity cost for each limitation, for each configuration. Theoretically the opportunity cost for the same limitation may differ for each configuration. Up to 100% of an opportunity cost due to a run-hour limitation on a given configuration may be reflected in the minimum load cost bid for that configuration. Opportunity costs due to energy limitations on a given configuration will be added to the DEB of said configuration.

In cases where transitions between configurations is considered a start to which the limitation applies, transition costs can be considered another commitment type cost analogous to a start-up cost for that configuration. Essentially the configuration may be started by either 1) being started directly, if a startable configuration, or 2) being transitioned into that configuration. Upon implementation of *Commitment Cost Enhancements Phase 2*, transition costs will also be a biddable commitment cost. Therefore, where a limitation on starts is applied to the configuration level, an opportunity cost will be determined for each configuration. Up to 100% of the opportunity cost can be reflected in start-up cost bid for that configuration as well as the transition costs transitioning into that configuration.

The following tables illustrate how the transition cost bid caps will be determined in cases where the opportunity costs can be reflected in transition cost bids. The proposed method further expands upon the method developed in CCE2, which was accepted by FERC in the order released on September 9, 2015.

Table 1 shows the calculated start-up cost for each configuration of a four configuration MSG resource, which are used to determine the bid caps for transition costs. The bid cap for transition costs are shown in table 2. The transition cost bid cap is equal to the difference of 125% of start-up cost of the to-configuration and 125% of start-up cost of the from-configuration, as developed in CCE2.

The shaded blue columns in table 1 reflect the opportunity cost for each configuration due to a limitation on starts that considers transitions as a start. Assume each configuration has a different opportunity cost for a start limitation, as shown in Table 1. The ISO would then create a matrix of transition opportunity costs, shown in Table 3. The opportunity cost for each transition is the opportunity cost of the to-configuration. For example, the opportunity cost for transitioning from UnitA_2 to UnitA_3 is \$150, which is the opportunity cost of UnitA_3.

The bid cap for transition costs including the opportunity cost is shown in Table 4. These are determined by adding the transition opportunity costs in Table 3 to the transition cost bid caps in Table 2. This results in the opportunity cost associated with the to-configuration to be reflected in the transition cost bids for transitions going into that configuration.

Assume the start-up cost shown in table 1 is the daily calculated proxy start-up cost for these configurations. Currently, the start-up cost bid cap is set to 125% of the daily calculated proxy cost. With opportunity costs, the new start-up cost bid cap for each configuration is increased by the opportunity cost of that configuration, shown in the far right column of table 1.

Configuration start-up costs

Config IDs	Config number	Start-up Cost	Cost x 125%	Opp Cost	Start-up cost bid cap
UnitA_1	1 - Startable	\$645	\$806	\$100	\$906
UnitA_2	2 - NOT startable	\$1,320	\$1,650	\$50	\$1,700
UnitA_3	3 - Startable	\$2,145	\$2,681	\$150	\$2,831
UnitA_4	4 - NOT startable	\$3,020	\$3,775	\$75	\$3,850

Transition costs bid caps

"From" Configuration	"To" configuration			
	UnitA_1	UnitA_2	UnitA_3	UnitA_4
UnitA_1		\$844	\$1,875	\$2,969
UnitA_2			\$1,031	n/a
UnitA_3				\$1,094
UnitA_4				

Transition opportunity costs

"From" Configuration	"To" configuration			
	UnitA_1	UnitA_2	UnitA_3	UnitA_4
UnitA_1		\$50	\$150	\$75
UnitA_2			\$150	n/a
UnitA_3				\$75
UnitA_4				

Transition cost bid caps with opportunity costs

"From" Configuration	"To" configuration			
	UnitA_1	UnitA_2	UnitA_3	UnitA_4
UnitA_1		\$894	\$2,025	\$3,044
UnitA_2			\$1,181	n/a
UnitA_3				\$1,169
UnitA_4				

10. Outage cards

The Reliability Service initiative modified the must offer obligation for Resource Adequacy resources. Along with the modified must offer obligations, the initiative also implemented the Resource Adequacy Availability Incentive Mechanism (RAAIM) intended to incentivize RA resource to adhere to their must offer obligations.

Use-limited resources may or may not also be RA resources, subject to must offer obligations and RAAIM. For the use-limited RA resources, the Reliability Service initiative established the following outage card specific for use-limited RA resources. The card was created to use as an interim solution between when RAAIM becomes effective and the ISO implements an economic tool, i.e. the opportunity cost, and can optimize the use-limited resource through the market. The card was intended to be retired upon implementation of an opportunity cost method.

Short-term use-limited reached: This card may be submitted for use-limited resources as a tool to manage the resource until the ISO implements opportunity costs. The resource can then stop bidding into the market and be exempt from RAAIM.

The ISO is proposing the short-term use-limited reached outage card will be retained upon implementation of the opportunity cost methodology. This will allow time for the ISO and scheduling coordinators to become effective in using the opportunity costs in commitment cost bids and address any potential unforeseen issues that may arise. The outage card will serve as a safety net for scheduling coordinators during this period and will aid in a smooth transition away from the outage cards and towards an economic tool to optimize use-limited resources.

The card will remain available to use-limited resources until the ISO deems the opportunity cost methodology an effective economic tool to manage use-limited resources. At that juncture, the ISO will seek to retire the short-term use-limited reached outage card through a tariff amendment filing

Discussion of the use-limited reached outage card and RAIM treatment has been moved to Reliability Services Phase 2 initiative to allow for a more complete discussion of RAIM treatment.

11. Next Steps

The ISO will discuss this revised straw proposal with stakeholders on a conference call on November 9, 2015. Stakeholders should submit written comments by November 23, 2015 to initiativecomments@caiso.com.