Commitment Cost Enhancements Phase 2

Straw Proposal

October 29, 2014

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1. Background

Commitment Cost Enhancements (henceforth referred to as Phase 1) 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 2*, is narrowly scoped to continue that discussion and provide additional policy clarifications.

During the winter season of 2013-2014, the ISO energy market experienced abnormally volatile and high natural gas price spikes. The ISO was not able to reflect these price spikes in its resource commitment decisions, which led to inefficient resource dispatch. To address the potential for additional natural gas price spikes for the duration of the winter season, on March 6, 2014 the ISO filed with the Federal Energy Regulatory Commission (FERC) a proposed tariff waiver until April 30, 2014 to take remedial action. In the tariff waiver filing, the ISO also committed to commence a stakeholder process in April to address the issues raised by gas market conditions and to more comprehensively develop an interim solution that can be implemented in fall 2014 if such solutions do not require substantial system changes. FERC granted the ISO's tariff waiver on March 21, 2014.[1]

The ISO started a stakeholder process in April 2014, *Commitment Cost Enhancements*, to develop an interim solution to enhance the current options for reflecting resource commitment costs for starting a resource and running at minimum load. The ISO provides two options: 1) the "proxy cost," which updates natural gas prices daily and allows daily bidding up to 100 percent of the calculated proxy cost; and 2) the "registered cost," which updates natural gas prices every 30 days but allows for a fixed, 30-day bid up to 150 percent of the calculated proxy cost. The interim solution modified the current rules by increasing the proxy cost bid cap to 125 percent and eliminating the registered cost option for all resources except those categorized as use-limited resources. The interim solution was approved by the ISO Board of Governors in September 2014 and has moved into the tariff stakeholder process to seek approval at the FERC.[2] Once opportunity costs are implemented for use-limited resources, the registered cost option will be eliminated for all resources.

As Table 1 shows, the *Commitment Cost Enhancements stakeholder* processes are also coordinated with the *Reliability Services* initiative for the development of a more stringent must offer obligation for certain use-limited resources by 2016. The phasing of these design elements for use-limited resources helps incorporate an opportunity cost adder earlier and allows market participants to test and fine tune the calculation before affected use-limited resources have an expanded must offer obligation.

The ISO will also address broader market changes related to bidding rules for energy and commitment costs by the end of 2014 in the upcoming *Bidding Rules* initiative. These are

[1] *California Indep. Sys. Operator Corp.*,146 FERC 61,218 (2014).
[2] *California Indep. Sys. Operator Corp.*, FERC docket no. ER15-15, October 1, 2014.

longer-term market changes that will require significant market design, settlements, and system changes.

Table 1
Commitment cost-related initiatives

Initiative	Description	Policy start	Status
Commitment Cost Enhancements Phase 1	Interim solution to address natural gas price spikes. Proxy cap increased to 125% and only use-limited on registered.	Q2 2014	Policy complete. Targeted December 1 implementation
Commitment Cost Enhancements Phase 2	Develop opportunity cost adders for use-limited resources and additional clarifications.	Q4 2014	Policy, coordinate implementation with Reliability Services
Reliability Services	Phase 1 focuses on resource adequacy rules and will develop more stringent must offer obligations for use-limited resources.	Q1 2014	Policy, targeted Q1 2016 implementation
Bidding Rules	Longer-term changes to energy and commitment cost bidding.	Q4 2014	Policy

There are two additional processes that deserve mention here:

- First, a separate stakeholder initiative, *Natural Gas Pipeline Penalty Recovery*, is addressing potential ISO reimbursement of operational flow order penalties under specific limited circumstances.

- Second, on March 20, 2014, the FERC released a notice of proposed rulemaking (NOPR) to address coordination and scheduling practices of the interstate natural gas pipeline companies and the electricity industry.[3] The NOPR provides the natural gas and electricity industries six months to reach a consensus. While the NOPR is not directly related to commitment cost pricing in the ISO market, issues discussed there may overlap with the ISO's commitment cost-related stakeholder initiatives.

2. Schedule for policy stakeholder engagement

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

[3] http://www.ferc.gov/whats-new/comm-meet/2014/032014/M-1.pdf

Date	Event
Wed 10/29/14	Straw proposal posted
Wed 11/12/14	Stakeholder call
Wed 11/19/14	Stakeholder comments due
Mon 12/22/14	Revised straw proposal posted
Tue 1/6/15	Stakeholder call
Tue 1/13/15	Stakeholder comments due on revised straw proposal
Tue 2/3/15	Draft final proposal posted
Tue 2/10/15	Stakeholder call
Tue 2/14/15	Stakeholder comments due on draft final proposal
Thu/Fri 3/26-3/27/15	Board of Governors meeting

3. Initiative scope

This initiative was created to develop a methodology and the business rules to calculate opportunity costs for use-limited resources. In doing so, it is necessary to first clarify the current use-limited resource definition, the process for submitting documentation and qualifying for use-limited status, and modeling those use limitations as opportunity costs.

This initiative also clarifies additional commitment cost-related issues such as transition costs, greenhouse gas costs, and related business practice manual changes. Transition costs are costs incurred by multi-stage generators when transitioning from one configuration to another. They can also be thought of as start-up costs when "starting" a new configuration. *Commitment Cost Enhancements Phase 1* did not make any changes to transitions costs. In this initiative we reevaluate the current calculation of transition costs and how they are similar to start-up costs for non-multi-stage generators.

The *Commitment Cost Refinements, 2012* stakeholder process[4] incorporated greenhouse gas costs into commitment costs for those resources subject to California's greenhouse gas program. This initiative considers applying this cost to additional thermal resources.

Business practice manual changes will be necessary to clarify the current policy as well as support new policy developed in this initiative. Though changes to the business practice manuals do not require FERC approval and have a separate change process, this straw proposal discusses those changes to help stakeholders.

The remainder of this paper is divided into the following sections. Section 4 summarizes all of the proposals. Section 5 clarifies the definition of and process for qualifying for use-limited status. Section 6 details the opportunity cost methodology and related business rules. Section 7 aligns the treatment of multi-stage generator transition costs with start-up costs. Section 8 considers extending the greenhouse gas costs to thermal resources not subject to California's

[4] http://www.caiso.com/informed/Pages/StakeholderProcesses/CommitmentCostsRefinement2012.aspx

greenhouse gas program. Section 9 discusses the business practice manual changes in progress and references additional changes that need to be made pursuant to policy developed in this stakeholder initiative. Section 10 discusses next steps.

4. Summary of proposals

Table 2 summarizes the changes by topic, and whether it is new policy or clarifications to the existing business practice manuals (BPMs).

Table 2
Summary of proposals

Topic	Change	Type of change*
Use-limited resources	Revised definition and new flag	Policy (and change BPM)
	Application process for use-limited status including documentation	Existing BPM clarifications
Opportunity cost	Types of opportunity costs that can and cannot be modeled	Policy
	Modeling methodology	Policy
	Process for updating the model	Policy
Transition costs	Clarify that calculation used in start-up costs	Existing BPM clarifications
	New methodology to account for transition costs	Policy
Greenhouse gas costs	Allow all thermal resources to incorporate a greenhouse gas cost	Policy
Costs for non-thermal resources	Clarify that non-thermal resources may use the “fuel cost” field to reflect certain costs	Existing BPM clarifications
Major maintenance adder	Clarify the documentation required for and methodology to calculate major maintenance adders and responsible parties.	Existing BPM clarifications

*The *type of change* category only reflects whether the topic is new policy or only requires clarification to an existing business practice manual section. It does not determine whether the policy changes will be detailed in the tariff or in a business practice manual. Consistent with the existing FERC-approved ISO tariff, the ultimate tariff language may mention the new policy and provide relevant details in a business practice manual.

5. Use-limited resources

Use-limited resources cannot operate continuously because of environmental, operational, or other non-economic limits. Consequently, the ISO provides for a separate treatment of these resources in accordance with their approved limitations. *Commitment Cost Enhancements*

Phase 1 clarified the definition of use-limited resources as shown in the first column of Table 3. The definition is pending FERC approval.[5]

While some resources are deemed use-limited, most apply for use-limited status.[6] The ISO reviewed the current list of use-limited resources and found that additional clarification is needed. The ISO proposes a policy change to modify the definition to what is presented in the second column.[7] These changes will greatly benefit the subsequent calculation of opportunity costs.

Table 3
Existing and proposed use-limited resource definition

Existing	Proposed
A resource that, due to design considerations, environmental restrictions on operations, cyclical requirements, such as the need to recharge or refill, or other non-economic reasons, is unable to operate continuously. This definition is not limited to Resource Adequacy Resources. A Use-Limited Resource that is a Resource Adequacy Resource must also meet the definition of a Resource Adequacy Resource.	A resource with non-economic and non-contractual limitations the CAISO optimization cannot model but for the inclusion of opportunity cost adders. Limitations may include environmental, regulatory, or operational restrictions, as approved by the CAISO. This definition is not limited to Resource Adequacy Resources. A Use-Limited Resource that is a Resource Adequacy Resource must also meet the definition of a Resource Adequacy Resource.

Under the proposed definition, use-limited resources are those resources with non-economic and non-contractual limitations that the ISO optimization cannot capture without opportunity costs because the ISO only optimizes all resource parameters over a single 24-hour trade date. The limitations may be environmental (such as an air permit) or operational (such as supporting a thermal host for combined heat and power resources) but must be non-economic (*i.e.*, not based on contractual obligations).

The ISO's optimization can respect an air permit daily start limit by reflecting daily starts in the Master File. On the other hand, periods longer than a day (*i.e.,* monthly, annual) or a combination of longer periods and daily limitations cannot be accurately modeled in the ISO system without opportunity cost adders. But for these limitations, the resource could physically continue to operate.

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[5] *California Indep. Sys. Operator Corp.*, FERC docket no. ER15-15, October 1, 2014.
[6] 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 deemed to be use-limited.
[7] Policy change.

A use-limitation is different from a fuel limitation. 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. The resource has an opportunity cost if it is run in less profitable hours reflecting the foregone profits. Since the ISO system cannot optimize the resource over the month without opportunity cost adders, we do not automatically generate bids for the resource but instead allow scheduling coordinators to bid in accordance with a submitted use plan.[8] Similarly, hydro resources may be limited by a combination of storage capacity and fish and wildlife restrictions.

On the other hand, wind, solar, and geothermal resources (all without storage) run only when the fuel is available. While these generators may have some level of control (*e.g.,* feathering blades) and can submit decremental bids, the fuel supply cannot be optimized by the scheduling coordinator (*e.g.,* wait to use the fuel at a later time in order to maximize profits). Therefore, these resources do not inherently have opportunity costs.

Table 4 below is partially reproduced from the *Reliability Requirements* business practice manual. Text copied from the manual is in black and bolded text in blue reflect changes to the use-limited categorization under the proposed definition.

The first two changes under **gas-fired resources** with limited fuel storage and environmental restrictions clarify that approval of use-limited status means the limitation cannot be modeled by the ISO optimization without opportunity cost adders because it runs over a single day.

Hydro resources will all remain "deemed use-limited" resources under the proposed definition.

As noted above, **wind and solar** generators will not be considered default use-limited resources under the proposed definition. However, tariff section 40.6.4.3.4 exempts them from automatic bid insertion for the day-ahead and real-time. Impact on Resource Adequacy designation is discussed below in Section 5.1.

Qualified facilities (QFs) under the ISO tariff are categorized as regulatory must-take resources, a type of self-scheduling, and are exempt from the standard capacity product availability standard reporting requirements related to resource adequacy capacity. This largely negates the need for additional use-limited status. Since the resources are self-scheduled, there is no opportunity cost. If resources lose their QF status, they will be treated as non-use-limited resources unless they qualify otherwise under the proposed definition.

Proxy demand and reliability demand response resources are deemed use-limited by the tariff and the ISO does not propose any changes to this status. Reliability demand response

[8] Most resources with a resource adequacy designation have a must offer obligation to bid that capacity into the market or else the ISO automatically generates a bid. Use-limited resources are exempt from automatic bid insertion unless there is a residual unit commitment availability bid or residual unit commitment schedule for a resource without a corresponding economic bid or self-schedule. Changes under the *Reliability Services* initiative will address must offer obligations for use-limited resources. See: http://www.caiso.com/informed/Pages/StakeholderProcesses/ReliabilityServices.aspx

resources do not have non-zero start-up or minimum load costs and therefore do not have commitment cost-related opportunity costs. Proxy demand resources may have shut-down costs and minimum load costs that the ISO may consider. However, both can have energy-based opportunity costs. The ISO would only calculate these costs to include in a default energy bid if these resources were mitigated as part of the market power mitigation process. But since demand response is not subject to mitigation, there is no need for the ISO to calculate these costs. Proxy demand resources can directly reflect opportunity cost in the energy bids up to the offer cap and reliability demand response resources are already required to bid in near the offer cap.

Combined heat and power resources that are no longer QFs but have signed a Net Scheduled Participating Generator Agreement can have the capacity used to support a thermal host designed as regulatory must-take. Tariff section 4.6.10 determines the maximum regulatory must-take capacity. Above this amount, the resource can apply to be treated as a use-limited resource if it can demonstrate that the ISO's co-optimize of non-regulatory must-take capacity would unduly interfere with the operation of the thermal host or undermine regulatory policy objectives concerning efficiency or greenhouse gas emission.[9]

Nuclear resources under the ISO tariff are also categorized as regulatory must-take resources. Similar to QFs, the ISO proposes to remove nuclear units from the use-limited designation.

The last four rows have been added to the original table and assumes none of the generation types are QFs. As noted above, **geothermal** resources' fuel source is limited in the same way that wind and solar are and do not qualify for use-limited status. If **storage** resources can be fully optimized by the ISO within a single day, then they do not qualify as use-limited. Lastly, we seek stakeholder feedback on how to address potential limitations for **biomass, landfill gas, and other resources** not discussed.

[9] Addendum to Draft Final Proposal, Regulatory Must-Take Generation stakeholder initiative, April 30 2012, California ISO. http://www.caiso.com/Documents/Addendum_DraftFinalProposal-RegulatoryMust-TakeGeneration.pdf

Table 4
Use-limited categorization changes under proposed definition

Resource-Type	Use-Limited (Yes/No)	Proposed changes
Gas-Fired (Steam)	No	**None**
Gas-Fired (Combined Cycle)	No	**None**
Gas-Fired (GT with limited fuel storage)	Yes	**Not use-limited if can be optimized by ISO**
Gas-Fired (GT without limited fuel storage)	No	**None**
Gas-Fired with environmental restrictions that constraint its operation	Yes	**Not use-limited if can be optimized by ISO**
Hydro-Large Storage	Yes/No - although Hydro with large amount of storage may have more flexibility to generate on demand and thus may not be use-limited in a manner similar to a run-of-the river, downstream water flow and water-release needs and other environmental conditions may dictate output so as to warrant Use-Limited status	**None.** See additional discussion above on run-of-river hydro.
Hydro-Small Storage/Small Conduit	Yes	**None**
Hydro-Run of the River	Yes	**None.**
Wind	Yes	**Not default use-limited. Do not have to bid in DAM (40.6.4.3.4). Assume same treatment in RTM.**
Solar	Yes	**Not default use-limited. Do not have to bid in DAM (40.6.4.3.4). Assume same treatment in RTM.**
Nuclear	Yes	**Not use-limited – regulatory must-take.**
QF	Yes	**Not use-limited – regulatory must-take.** See additional discussion on combined heat and power resources.
Resource with Contractual Limitation that Limits Availability	No	**This is an overarching requirement, not just under QFs.**
Clarification: Proxy demand and reliability demand response resources	**Yes, per current tariff section 40.6.4.1**	**No commitment-related opportunity cost. Energy-related opportunity costs can be reflected otherwise.**
New: Combined heat and power (non-QF)	**n/a**	**Not use-limited for regulatory must-take capacity; may be use-limited otherwise.**

Resource-Type	Use-Limited (Yes/No)	Proposed changes
New: Geothermal (non-QF)	**n/a**	**Not default use-limited.**
New: Storage	**n/a**	**Not default use-limited.**
New: Biomass, landfill gas, others (non-QF)	**n/a**	**Likely not use-limited but more discussion needed.**

This proposal does not change the definition or use of the terms "dispatchable" and "non-dispatchable." Under the current paradigm, non-dispatchable use-limited resources include regulatory must-take, regulatory must-run and fuel limited resources such as wind, solar, and some combined heat and power, biomass, hydro, and geothermal units. However, this proposal may eliminate or vastly decrease resources considered non-dispatchable *use-limited* and instead categorize them as non-dispatchable only. As a consequence, resources that have been previously exempt from the residual unit commitment process per tariff section 40.6.4.3.2 may now be subject to it if they have resource adequacy capacity.[10]

In summary, use-limited resources:

- Have non-economic, non-contractual limitations not strictly due to fuel limitations;
- Cannot be optimized per their limitations via the ISO's optimization without an opportunity cost adder; and
- Have an opportunity cost.

Today's use-limited resources use the daily start limit field to approximate monthly or annual starts that the ISO optimization cannot model. In future, the ISO expects its opportunity cost methodology to reflect limitations greater than a single day and will subsequently require that resources only use the daily start limit field to reflect daily use-limitations. Under the proposed use-limited definition, daily start limits (and any other limitations that fall within a single day and can be modeled by the optimization) alone will not qualify a resource for use-limited status.[11]

5.1. Use-limited designation and resource adequacy

As discussed in the tariff stakeholder process for *Commitment Cost Enhancements*, a use-limited resource need not be a resource adequacy resource. Consequently, the ISO proposes that two existing flags in the Master File be used as follows: 1) the use-limited flag will be used for use-limited resources regardless of resource adequacy status and 2) the must-offer flag will be used more generically (and may be renamed) to indicate that the ISO does not insert a bid regardless of resource adequacy status.[12] The use-limited flag will be used to indicate that the

[10] Policy change.
[11] Policy change.
[12] Policy change.

resource has an opportunity cost (and may also be renamed to reflect this use). A single resource may have one, both or none of the flags selected. The *Reliability Services* initiative will establish the criteria for which the ISO uses the no bid insertion flag for both use-limited and non-use-limited resource adequacy capacity.[13] In addition, the business practice manual discussion for use-limited resources will be moved out of the Reliability Requirements manual to the Market Operations manual.[14]

5.2. Application process

The ISO has made corresponding business practice manual changes to clarify the current application process for use-limited resources. The ISO submitted changes to require an affidavit verifying that each resource categorized as use-limited continues to qualify as such the next calendar year.[15] In addition, the ISO clarifies that a use-limited resource will be considered available 24 hours a day, 7 days a week unless the ISO receives a valid annual or monthly plan.

6. Opportunity costs

The Market Surveillance Committee opinion on the *Commitment Cost Refinements 2012* initiative noted 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.[16] 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 Committee presented a methodology to model start-up, run hour, and energy output opportunity costs for gas-fired resources.[17] The ISO developed a prototype model based on this methodology and presented it to stakeholders in *Commitment Cost Enhancements*. Based on stakeholder feedback, there was not enough time to fully develop the methodology and its application for the 2014-2015 winter. Therefore, the ISO allowed use-limited resources to retain use of the registered cost option to reflect opportunity costs until an opportunity cost methodology is implemented.

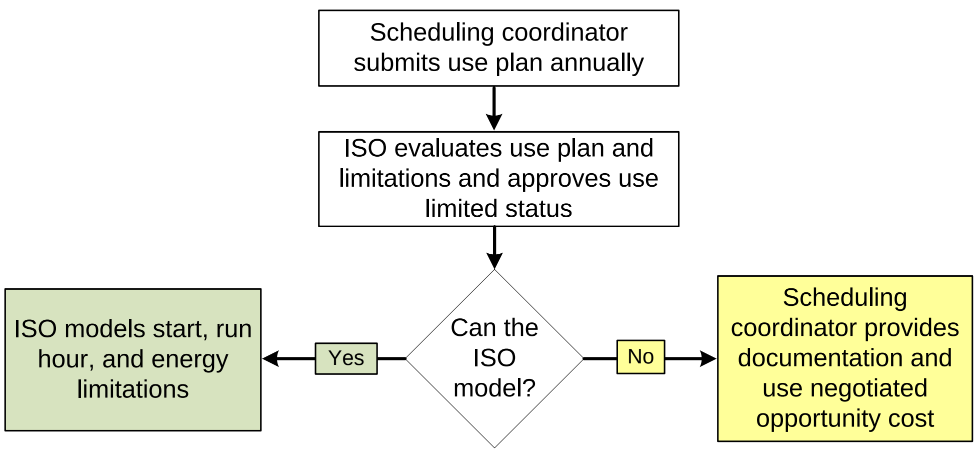
[13] See http://www.caiso.com/informed/Pages/StakeholderProcesses/ReliabilityServices.aspx
[14] BPM change pursuant to policy change.
[15] Existing BPM clarifications. See PRR 787 available at: http://bpmcm.caiso.com/pages/default.aspx
[16] http://www.caiso.com/Documents/MSCFinalOpinion-BidCostRecoveryMitigationMeasures_CommitmentCostsRefinement.pdf
[17] See Market Surveillance Committee meeting documents for November 15, 2013 available at: http://www.caiso.com/Documents/Presentation-MSC-FRACMOO_OpportunityCost-Hobbs.pdf. The opportunity cost methodology for use-limited resources was also discussed in the *Flexible Resource Adequacy Criteria and Must-Offer Obligation* initiative and was originally scheduled to be included in the *Reliability Service* initiative.

6.1. Opportunity costs under proposed definition

Based on the proposed definition, all resources categorized as use-limited resources have opportunity costs. The ISO will not be able to model every type of opportunity cost but will determine if modeling is possible based on reviews of documents submitted as part of the normal use-limited application process. Figure 1 below shows that the ISO will either calculate opportunity costs or work with scheduling coordinators to develop negotiated opportunity cost adders after the ISO has received the documentation needed to evaluate use limitations and has approved the resource's use limited status.[18]

The ISO will evaluate each submission on a case-by-case basis and determine whether the ISO can model the opportunity costs. The ISO expects that its methodology will largely be used by gas-fired resources with clearly defined limitations based on starts, run hours, and energy use, as shown in the green box.

Figure 1
Opportunity costs modeled



Based on conversations with scheduling coordinators, many hydro 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 documentation of the modeling methodology for calculating opportunity costs. The resource will then use negotiated opportunity cost adders as approved by the ISO based on the submitted methodology, as depicted by the yellow box. The ISO expects that thermal host needs for combined heat and power and more complicated environment permits (*e.g.,* Delta Dispatch) may also require

[18] Policy change.

negotiated opportunity cost adders. Lastly, there may be some resource for which the ISO can model some limitations but not others. The ISO proposes to consider these resources under the negotiated option where the final opportunity cost is a combination of ISO calculated and scheduling coordinator provided data.

6.2. Opportunity cost methodology overview

The figure 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 use plans provided to the ISO, Master File characteristics,[19] 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, and recent natural gas and greenhouse gas prices to simulate a distribution of the node-specific locational marginal prices for the resource. For start-up and minimum load opportunity costs, the optimization model will use these inputs to calculate the difference between the profits of two model runs: a base run, and a run in which the start-up or run hour limitations are tightened by one unit. The difference in the objective function (the generating unit's profit) will be the opportunity cost of that resource's limitation. 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 added to the calculated proxy cost and the 125 percent cap will be applied to both. This is a change from previous discussions where the opportunity cost was added to the proxy cost cap. The change provides resources with the flexibility to reflect forward looking costs but also manage the limitations and current market conditions through bidding.

Figure 2
Opportunity cost methodology overview

Model inputs	Opportunity cost calculation	Model outputs
• Use plan limitations • Unit characteristics • Historical commitment costs • Historical implied heat rate • Natural gas prices • Greenhouse gas prices	Unit commitment optimization 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. Used as an adder and will have 125% proxy cap applied to it.

[19] The model accounts for each resource's minimum run time and minimum down time. It does not consider maximum daily starts if it has a start-up limitation in its use-limitation plan.

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

6.2.1. 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 resource. The variable energy cost will be based on the average heat rate, gas price index, greenhouse gas cost, and the O&M adder. For commitment costs, the ISO will use the prior month's calculated proxy start-up and minimum load costs.

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.

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 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 prices for the current time period. For example, if the ISO is estimating November 2013 prices, we will use November 2012 real-time energy prices, greenhouse gas costs, and daily natural gas prices. This will generate an implied heat rate for every real-time interval, which will then be used to forecast November 2013 real-time energy prices for a given resource.

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

$$\mathrm{Im}\,pHR_{i,t-1} = \frac{LMP_{i,t-1}}{NatGasP_{l,t} + (GHGas_{t-1} * EmRate)}$$

Where

$\mathrm{LMP}_{\mathrm{i,t-1}}$ is the real time energy price at pnode *i* from the previous year's period, *t-1.*

$\mathrm{GHG}_{\mathrm{t-1}}$ is the greenhouse gas allowance price from the previous year's period, *t-1*.

EmRate is the emissions rate per MMBtu of gas, which is $.053165\mathrm{mtCO_2e/MMBtu}$

$\mathrm{NatGasP}_{\mathrm{l,t-1}}$ is the daily natural gas price from the region *l* of pnode *i* of the previous year's period, t-1

To simulate the energy prices, the implied heat rate is multiplied by the sum of: (1) the average natural gas prices of the preceding month; and (2) the greenhouse gas costs multiplied by the unit's emissions rate. The ISO's preliminary analysis showed that there was little difference between using the futures versus the daily spot prices for the period of analysis. However, based on discussions in *Commitment Cost Enhancements Phase 1*, the average of daily futures prices over a month did not reflect the major price spike experienced in February 2014 but then traded in March 2014 at much higher levels than the spot price. Moreover, trading for natural gas futures becomes less liquid the further out the analysis is. The ISO may instead use the average of historical prices (*e.g.*, 3 year average). We seek stakeholder feedback on this issue.

The ISO proposes to use forecasted 15-minute real-time prices in the model because unit commitment and de-commitment decisions are made based on that price. Previously the ISO had proposed a 10 percent adder to account for the difference in forward looking 15 minute prices, which are used to make commitment decisions, and the market binding 15 minute prices, and any other forecast error that may result in lower forecasted energy prices. We now propose to remove the adder since we are proposing to apply the 125 percent proxy cap to the final opportunity cost.

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

$$LMPi,t = ImpHR_{i,t-1} * \left(NatGasF_{\ l,t} + (GHGasF_t * EmRate)\right)$$

Where:

$LMP_{i,t}$	is the forecasted real time price at pnode *i* for interval *t*
$ImpHR_{i,t-1}$	is the calculated implied heat rate at pnode *i* from the previous year's period, *t-1*
$NatGasF_{l,m}$	is the average natural gas price of the preceding month for region *l*
$GHGasF_{t,m}$	is the average greenhouse gas allowance price of the preceding month.
$EmRate$	is the emissions rate per MMBtu of gas, which is $.0530731\ mtCO_2e/MMBtu$

6.2.2. Opportunity cost calculation

The ISO will develop a model to optimally commit and dispatch each resource given its use-limitations and operational constraints against generation node-specific forecasted real-time prices over a given time period. The difference in profit from changes in dispatch due to each limitation will be the calculated opportunity cost. This section discusses how the ISO will calculate opportunity costs for start-up, run hour, and energy limitations.

6.2.2.1. Start-up limitations

Resources with limited starts will have a start-up opportunity cost calculated for the modeled time period, (*e.g.*, month or year). Since the affected variables in the optimization are binary variables (0-1), the opportunity cost is calculated as the difference between the profits of two model runs: a base run, and a run in which the start-up limitations are tightened by one (or more) unit(s) over the study time period. The difference in the objective function (the generating unit's profit) will be the opportunity cost of that resource's limitation.

Further analysis can be conducted on whether this basic approach is sufficient or if it is appropriate to use an average over more runs, because the calculated opportunity cost might be volatile. Take for example a resource with 15 starts per month. Three opportunity costs can be calculated. One based on the difference in profits with 15 and 14 starts; the second based on the difference in profits with 14 and 13 starts; the third based on the difference in profits with 13 and 12 starts. The average of all three opportunity costs will be the final calculated opportunity cost which can then be incorporated into start-up costs. Yet another methodology will average the difference in profits between 16 and 14 starts. The precise methodology can be refined with stakeholder input.

6.2.2.2. Run hour limitations

Resources with a limitation on operation hours per time period will have a run time opportunity cost calculated for the modeled time period, (*e.g.*, month, year). Similar to the start-up opportunity cost, run hour limitations are also binary. The run time opportunity cost will be determined by comparing maximized profits from all run hours to one less run hour. As noted above, there may be modifications to this basic approach.

6.2.2.3. Energy generation limitations

Resources with a maximum generation level per time period will have an opportunity cost calculated for the last megawatt hour of generation. Since this is not a discrete decision in the optimization model (continuous versus binary variable), the shadow value on this constraint is the opportunity cost of the last megawatt. Therefore this will only require one model run. The shadow value on this constraint is in $/MWhs so this cost will be added on to the variable energy cost component used in calculating the default energy bid, shifting the entire curve upward by the $/MWh shadow value.

6.2.3. Model outputs

The calculated opportunity costs will be an adder to the calculated proxy costs for start-up and minimum load. The 125 percent proxy cap will be applied to the sum of the opportunity cost and calculated proxy cost. The scheduling coordinators will then be able to bid in start-up and minimum load costs up to the combined cap for each limitation.

6.2.4. Initial results

The ISO developed a prototype that is a unit commitment optimization model based on the proposed methodology presented by the Market Surveillance Committee to calculate the opportunity cost for start-up, energy, and run hour limitations. The prototype is a work in progress. See Section 6.2.5 for additional considerations and expected improvements.

The prototype simulated 2013 prices based on 2012 historical data. The accuracy of the forecast was compared to 2013 actual prices. Next, the forecasted prices were used to dispatch five sample use-limited resources to calculate the opportunity costs. The opportunity costs were then added to the appropriate commitment cost to compare with historical dispatch of the resource. Overall, the methodology produced opportunity costs that significantly helped resources to stay within their use-limitations.

6.2.4.1. Simulated future real-time prices

The ISO applied the methodology outlined above to simulate 2013 real-time energy prices, based on the implied heat rates for 2012. The two sets of price distribution charts below compare the simulated 2013 real time energy prices to the actual real time energy prices at a northern (Figure 3 through Figure 5) and a southern (

Figure 6 through Figure 8) node.

Overall, the methodology produced reasonable distributions for 2013 energy prices in both the north and the south. In both locations, there is a small percentage of hours (less than 5%) where the simulated price is significantly higher than the actual price. This is attributed to inconsistent congestion patterns from one year to the next. All else being equal, higher congestion will lead to higher implied heat rates and higher prices. The opposite is also true.

If the methodology was to systematically overstate or understate prices, this would possibly translate into biases in the estimated opportunity costs. The behavior of simulated and actual price distributions will be monitored to assess whether such systematic differences arise in the future.

Figure 3
North node: price distribution curves for 2013 real-time energy prices, all

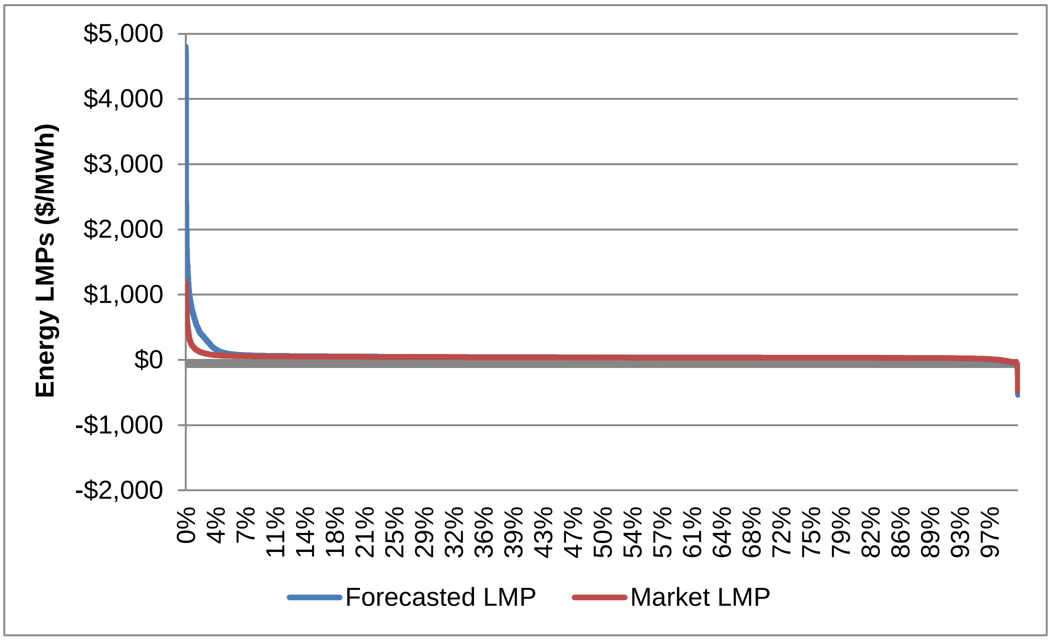


Figure 4
North node: price distribution curves for 2013 real-time energy prices, <5%

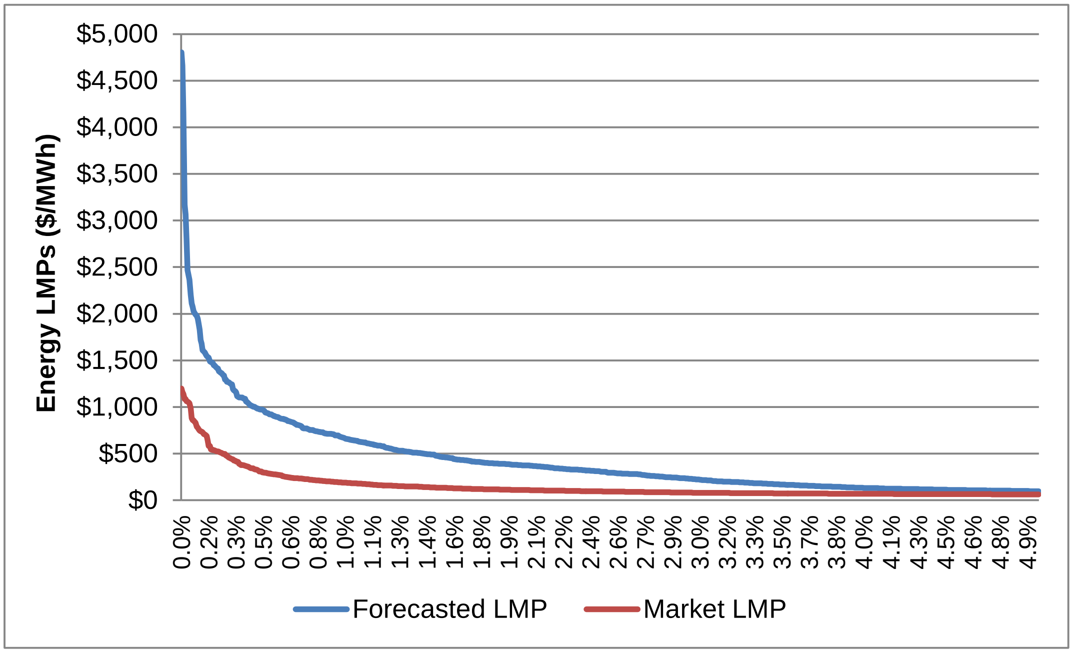


Figure 5
North node: price distribution curves for 2013 real-time energy prices, >95%

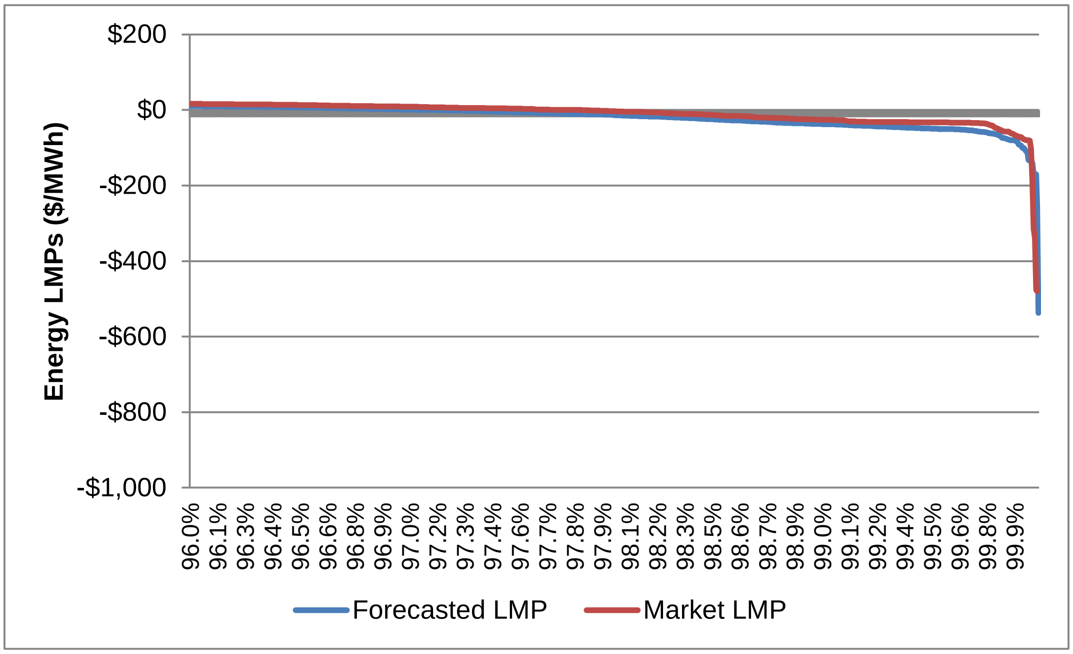


Figure 6
South node: price distribution curves for 2013 real-time energy prices, all

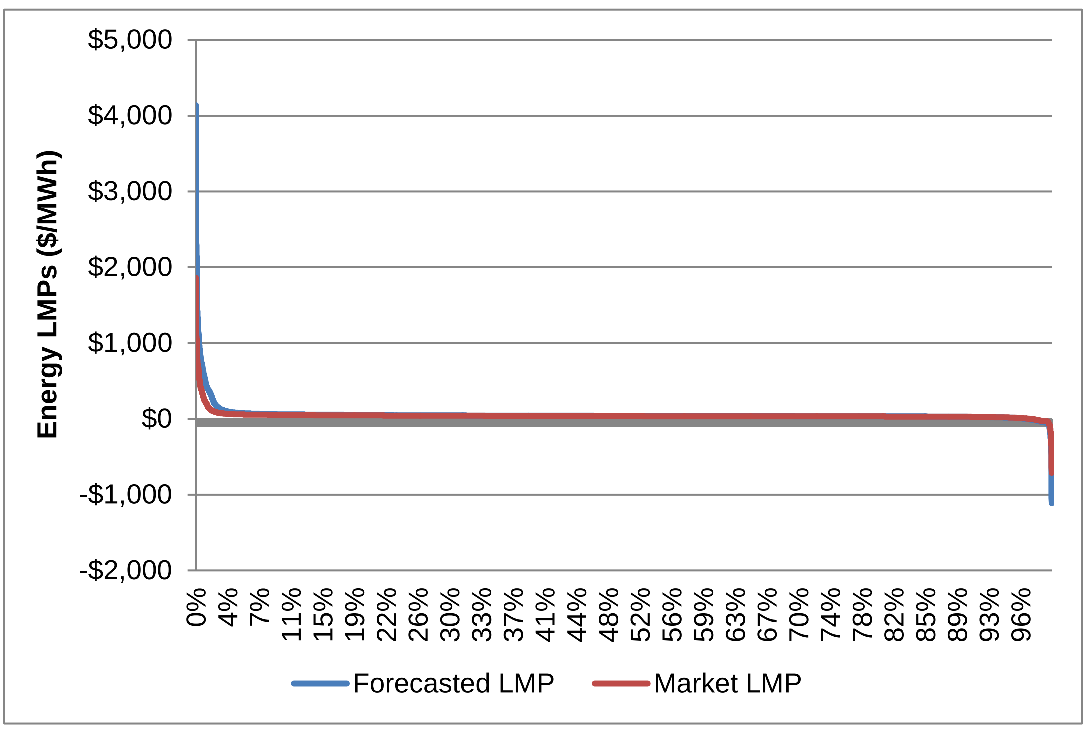


Figure 7
South node: price distribution curves for 2013 real-time energy prices, <5%

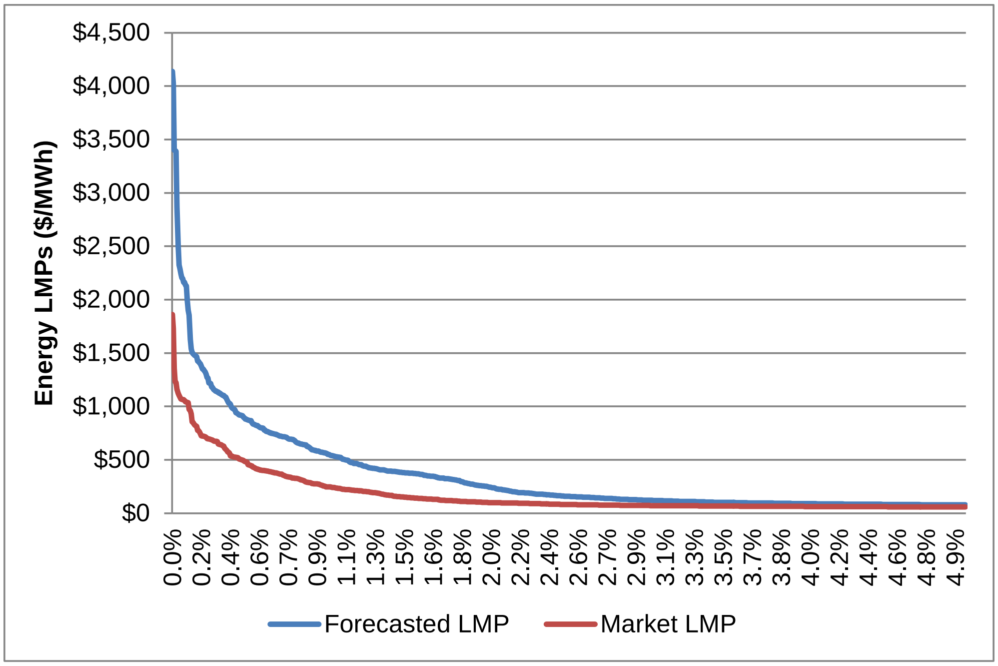
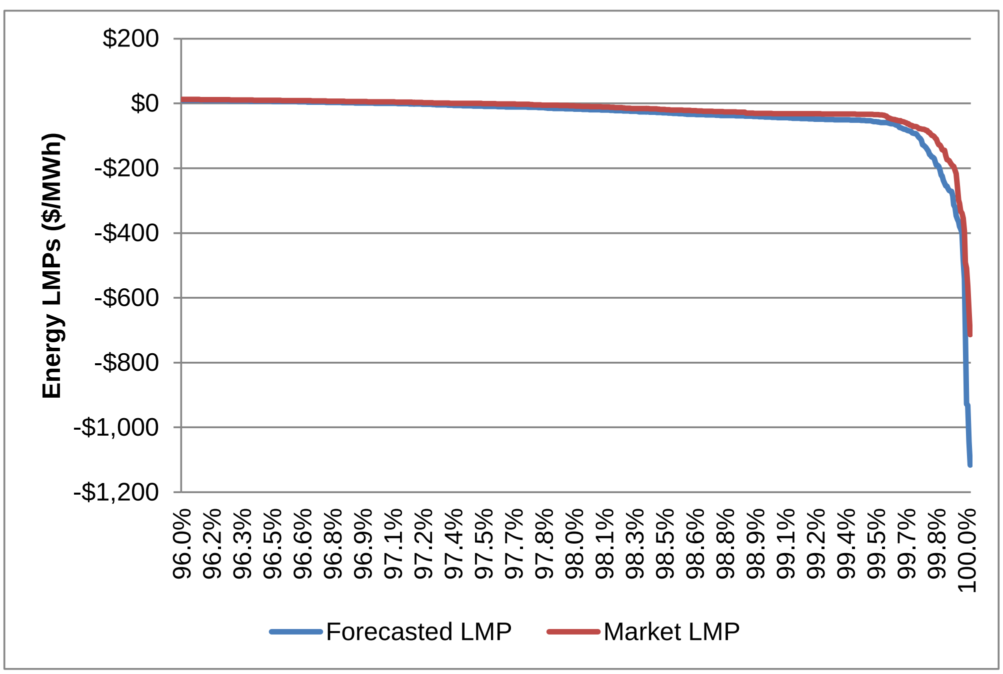


Figure 8
South node: price distribution curves for 2013 real-time energy prices, >95%



6.2.4.2. Opportunity cost calculation and back-casting

The ISO calculated the opportunity costs for five dispatchable, natural gas-fired use-limited resources. Of those, only two had non-zero opportunity costs. For these units the ISO conducted a back-cast analysis to compare how they would have been dispatched with and without the calculated opportunity costs. For Resource 1, we first assume that the resource has start-up and minimum load costs of 100 percent of proxy (*i.e.,* calculated proxy costs). This is a conservative assessment because this is more restrictive than the proxy cap of 125 percent. We then calculated the opportunity cost of the resource's monthly limitations based on the 2012 implied heat rates and monthly natural gas and greenhouse gas costs per our methodology above. Resource 1 has both a monthly start-up and run hour limitation and each was analyzed separately.[20] Based on the generated real-time prices, there were opportunity costs for both limitations. As discussed in Section 6.2.4.1, simulated and actual real-time prices were very close but diverged slightly as the locational marginal prices were higher in 2012, likely due to higher overall congestion.

For the back-cast, we simulated two cases: one with and one without opportunity costs. In the first case, we removed the use limitations and dispatched the resource against actual 2013 prices, again assuming start-up and minimum load cost of 100 percent proxy and no opportunity cost. In the comparison case, we included the use-limitations and added the entire calculated opportunity costs for start-up and minimum load to 100 percent of their respective proxy costs.

Table 5 below compares the two cases for Resource 1 for every month. The data is presented as the percentage of starts or run hours to its respective limitation. For example, in column [1A] for January, the resource would have used 188 percent of the allowed starts. On the other hand in column [1C], the addition of the full opportunity cost for start-ups reduced the number of starts to 63 percent of allowed starts, showing that the calculated cost is providing enough flexibility to ensure the resource does not violate its use limitations. Similarly, the run hour percentages without opportunity costs under column [1B] are higher than the percentages under column [1D].[21]

The opportunity cost is provided as a cap so the resource's scheduling coordinator can bid in lower start-up and minimum load costs to manage limitations. In this case, the scheduling coordinator would likely lower the start-up and minimum load costs below the level allowed, assuming it was behaving competitively.

[20] The actual number of starts and run hours are not provided to protect the confidentiality of the resource.
[21] Note that the simulation to calculate run hour limitation opportunity costs produced non-zero values in only some months. However, all of the percentages in column [1B] in Table 5 are below 100 percent because dispatch was lower using 2013 actual real-time prices than simulated 2012 real-time prices.

Table 5
Resource 1: sample comparison of opportunity cost impact

	100% Proxy cost only		100% Proxy cost with opportunity cost	
	Percent of start-up limitation used	Percent of run hour limitation used	Percent of start-up limitation used	Percent of run hour limitation used
	[1A]	[1B]	[1C]	[1D]
Jan	188%	24%	63%	11%
Feb	338%	50%	100%	26%
March	225%	31%	25%	4%
April	325%	53%	13%	3%
May	250%	47%	38%	23%
June	100%	17%	0%	0%
July	138%	19%	0%	0%
August	275%	61%	25%	7%
September	150%	21%	0%	0%
October	313%	51%	63%	29%
November	150%	29%	13%	1%
December	225%	43%	25%	6%

Repeating the process for Resource 2, the data in Table 6 show very similar results to Resource 1 with a few notable exceptions. First, the percent of start-ups used in column [2C] exceeds 100 percent in the first three months. Since our analysis is conservatively based on only 100 percent of proxy plus opportunity costs, results will likely change if the scheduling coordinator bids up to 125 percent of proxy costs. However, if this reflected a significant change in market conditions, the ISO may rerun the model, as discussed in the next section. Second, the percentages for run hour limitation used in column [2D] for March and December are higher than the percentages for the same months in column [2B]. This difference can be explained by the interplay between start-ups and run hour limitations in the optimization. For these months, and for other months as well, the calculated opportunity cost was zero for run hour limitations but non-zero for start-up costs. Since the start-ups were more binding, the unit commitment in the rerun case with opportunity costs kept the unit online to avoid having to incur the high start-up costs again. This results in greater use of the allowed run hour limitation in the rerun case. Nonetheless, the percentages are all below 100 percent.

Table 6
Resource 2: sample comparison of opportunity cost impact

	100% Proxy cost only		100% Proxy cost with opportunity cost	
	Percent of start-up limitation used	Percent of run hour limitation used	Percent of start-up limitation used	Percent of run hour limitation used
	[2A]	[2B]	[2C]	[2D]
Jan	150%	50%	105%	47%
Feb	110%	41%	105%	40%
March	155%	55%	110%	58%
April	115%	35%	40%	25%
May	85%	46%	35%	19%
June	55%	37%	40%	23%
July	105%	50%	30%	27%
August	105%	87%	80%	67%
September	110%	46%	85%	45%
October	125%	58%	90%	50%
November	85%	41%	45%	26%
December	105%	63%	30%	72%

6.2.5. Additional considerations for the optimization model and process

The ISO is improving its current prototype. The model currently can reflect monthly limitations and we expect to be able to expand that to an annual optimization as well. The ISO is evaluating whether it can model rolling annual periods.

The ISO will not be able to model multi-stage generating resources. However, our preliminary review of use-limited resources and their limitations did not find this to be a significant drawback. In the first series of resources reviewed, we found the limitations for the resource complicated enough that it may be more appropriate to use negotiated opportunity costs as proposed in this initiative. In the second series of resources, we found limitations on starts of the plant, rather than each configuration. The ISO can model plant-level starts. Therefore, the ISO's proposed methodology can largely capture the limitations in conjunction with the additional 25 percent bidding headroom.

The ISO is currently proposing to refresh the model quarterly. More frequent updates may be appropriate if: there are significant system or network changes; energy or fuel prices increase appreciably from what was assumed in the original model runs; or there are significant Master File or use plan changes that impact how the resource is modeled. The ISO can establish a process where recent market and reliability runs are checked against the model output to see if more recent prices have not increased by more than 25 percent, the proposed adder to opportunity costs.

Note that not all significant changes may trigger a rerun or a resetting of opportunity costs. For example, if natural gas prices are lower than what was modeled (and therefore reduces market prices and costs), the ISO may not need to rerun the model since the calculated opportunity cost will be provided as a bid cap. Therefore, the resource could bid lower to manage its use limitations.

The ISO expects scheduling coordinators to adjust their bids up to the total cap in accordance with good utility practice. Units with resource adequacy obligations should be bid in so that the limitations can be maximally used in a rational and operationally useful manner. The ISO is providing this additional bidding flexibility but since the opportunity cost is only updated once a month, we expect scheduling coordinators to adjust their bids to reflect current market conditions within reasonable bounds.

The *Reliability Services* initiative will develop availability incentive mechanism rules around a more stringent must offer obligation that may entail reporting of when use limitations are exhausted (*e.g.,* declaring an outage related to use limitations).

7. Transition costs

This topic only applies to multi-stage generators.

Transition costs are a type of start-up cost specific to multi-stage generators. Transitions costs can be thought of as the costs to "start" a configuration (or conversely the cost savings to "shut down" a configuration). The ISO maintains the separate terminology to differentiate between changes in configuration when the resource is already on versus plant-level start-up, which turns the resource "On" or "Off" per the ISO tariff definitions. A plant-level start reflects an operational need to validate a physical start and adherence to certain physical parameters such as inter-temporal constraints for the plant, versus the configuration. Otherwise, they are the same.

7.1. Transition cost business practice manual changes

The ISO will clarify Attachment H of the Market Instruments business practice manual.[22] This can be accomplished without any policy changes and will largely preserve the current calculation of transition costs.

The ISO will clarify that resources with an approved major maintenance adder, the adder from the highest start-able configuration below the non-start-able configuration, will be added to the non-start-able configuration for the purposes of calculating the transition cost. This clarification is needed to prevent negative calculations from missing data.

[22] Existing BPM clarifications. The change has not been made at the time of this straw proposal publication.

7.2. Transition cost policy changes

The ISO proposes the following policy changes and clarifications to transition costs. The ISO expects to make corresponding business practice manual changes.

A transition cost is a type of start-up cost

The ISO will clarify that the transition cost is the cost to transition between multi-stage generator configurations when the resource is already "On." It is the ISO's understanding that the transition cost reflects the fuel input to transition from one configuration to another. The fuel input is based on the resource's actual unit-specific performance parameters, as required in tariff section 30.4.1.1.1. Since the transition is a start-up, there is no transition cost when transitioning to a lower configuration just like there is no start-up cost when shutting down.[23] Stakeholders should comment on whether the ISO's interpretation is correct and if there are any other costs that should be considered in transition costs.

Start-up costs can reflect major maintenance adders

The ISO will allow major maintenance costs for each configuration to be reflected in the start-up cost for each configuration. The ISO calculates a start-up cost for each configuration regardless if the resource can start directly into that configuration or not.

Figure 9 below is reproduced from the sample transition cost calculation spreadsheet posted on the ISO website.[24] The figure shows a four configuration resource that can start directly into configurations 1 and 3 but not into 2 or 4. The fields in yellow are based on information provided by the scheduling coordinators (or otherwise stored in the Master File). The ISO expects the data provided for the heat input, configuration Pmin and configuration start-up time to reflect the resource's actual unit-specific performance parameters and may be different for each configuration. On the other hand, the monthly GPI (gas price index), GHG (greenhouse gas) price and emission rate and the GMC (grid management charge) are the same for all configurations. The 10 percent cost adder in the last column is a calculation embedded in the spreadsheet. Lastly, the major maintenance adder column should be populated based on costs submitted to and approved by the ISO pursuant to the processes and rules in Appendix L of the Market Instruments business practice manual (incorporating the recent changes to be made as discussed in Section 9). Once the major maintenance adders have been approved, they will be stored in the Master File.

[23] However, there are resources that have explicit shut-down costs.
[24] "See Multi Stage Generating Resource Transition Cost Validation Sample Spreadsheet v2" available at: http://www.caiso.com/market/Pages/NetworkandResourceModeling/Default.aspx

Figure 9
Sample start-up cost calculation for multi-stage generator

STEP 1:	Calculate proxy start-up values for each configuration, and apply a 10% adder											
	The values in cells highlighted in yellow are supplied by the SC.											
		Configuration Proxy Start-Up Costs – For validation of rule 1 ONLY										
	Enter Configuration IDs	Configuration	Start-able	Heat Input (MMBtu)	Monthly GPI ($/MMBtu)	Monthly GHG Price	GHG Emission Rate	Major Maint. Adder	Configuration Pmin	Config Startup Time	GMC	Cost + 10%
	Config 1	1 - Startable	Y								0.3626	$ -
	Config 2	2	N		$0.00	$0.00	0				0.3626	$ -
	Config 3	3 - Startable	Y		$0.00	$0.00	0				0.3626	$ -
	Config 4	4	N		$0.00	$0.00	0				0.3626	$ -

Eliminate cost boundary rules

Currently the ISO relies on two separate rules to bound transition costs:

> Rule 1: Constrains the transition costs along each feasible path from offline to each configuration such that their sum is between 100 percent and 125 percent of the cost (plus 10 percent) associated with starting up directly to that configuration.
>
> Rule 2: Limits transition costs between configurations such that the sum of nested transition costs is between 100 percent and 125 percent of the direct transition.

The ISO proposes to eliminate both rules.[25] Instead, the transition and start-up costs will be calculated and treated as follows:[26]

- Scheduling coordinators will need to provide to Master File the fuel input (a new Master File field may be needed to house this data) to transition between configurations. Today, the ISO requests a dollar amount and then converts this to a fuel requirement. This policy change will eliminate this additional step. We do not expect this fuel input amount to change much over time.
- The transition fuel input amount, plus a greenhouse gas cost adder as appropriate, will be multiplied with the gas price index on a daily basis to produce the transition costs (in dollars).
- Scheduling coordinators may bid up to 125 percent of the transition costs on a daily basis, just like the proxy start-up cost. This will require new bidding and verification functionality.
- The ISO assumes that start-up costs for increasing configurations also increase. For example, the total start-up cost for configuration 2 is equal to or greater than configuration 1. When a resource transitions to a higher configuration, it will incur a

[25] Policy change.
[26] Policy change.

transition cost as well as the incremental start-up cost, calculated as the difference between the higher and lower configurations' start-up costs. This incremental start-up cost is calculated regardless if the configuration is "start-upable" or not. The ISO is not proposing to calculate costs for a downward transition. Unlike minimum load costs, once the resource has started, the start-up cost has been incurred.

8. Greenhouse gas costs

In response to Assembly Bill 32, California's Air Resources Board established the state's market-based cap-and-trade program to reduce greenhouse gas emissions. "Covered entities," such as thermal generators, emitting more than 25,000 metric tons of carbon dioxide equivalents (MTCO2e) per year are required to comply. The program began on January 1, 2013 with phased compliance obligations for different parts of the economy. Thermal electric generating sources have already begun compliance.

Starting January 1, 2015, natural gas suppliers will also be considered covered entities for the amount of gas delivered to California end-users, net of the amount delivered to existing covered entities.[27]

The ISO currently allows covered entities to reflect greenhouse gas costs in commitment costs. Thermal resources that have not reached the 25,000 MTCO2e threshold cannot include a greenhouse gas cost or will have to voluntarily enroll in the cap-and-trade program. When natural gas suppliers become covered entities, the greenhouse gas costs incurred may be passed on to natural gas-fired generators that do not meet the emission threshold. Therefore, all natural gas-fired resources will have greenhouse gas costs. Correspondingly, the ISO proposes to allow all natural gas-fired resources to reflect greenhouse gas costs in commitment costs. This assumes that greenhouse gas costs are *not* reflected in the gas price indices used.[28]

The California Public Utilities Commission is currently assessing the impact of greenhouse gas compliance on natural gas suppliers.[29] In its scoping memo, the Commission noted that a proposed decision will not be issued on the matter until November 2014 at the earliest.[30] It is also unclear whether the gas price indices in future will reflect greenhouse gas costs.

The ISO seeks stakeholder feedback on the current proposal noting that any policy will need to consider Commission decisions and whether gas trades include greenhouse gas costs. The outcome of this proposal will impact commitment cost and opportunity cost calculations.

[27] California Public Utilities Commission, *Scoping Memo and Ruling of the Assigned Commissioner and Administrative Law Judge*, Rulemaking 14-03-003, July 7, 2014, p. 3.
[28] Policy change.
[29] See California Public Utilities Commission, Rulemaking 14-03-003, filed March 13, 2014.
[30] California Public Utilities Commission, Scoping Memo and Ruling of the Assigned Commissioner and Administrative Law Judge, Rulemaking 14-03-003, July 7, 2014, p. 7.

9. Additional business practice manual clarifications

Costs for non-thermal resources

The ISO will make a clarification in the Market Instruments manual that non-thermal resources will be allowed to use the "fuel cost" field in the Master File to reflect non-fuel costs, such as pumping costs for pumped storage resources.[31] The ISO recognizes that much of the ISO's systems were created with thermal resources in mind and that some categories do not specifically meet non-thermal resources' needs.

Major maintenance adders

The ISO will make a clarification in Appendix L of the Market Instruments manual outlining the documentation required and the methodology used to calculate major maintenance adders.[32]

10. Next Steps

The ISO will discuss this straw proposal with stakeholders on a conference call on November 12, 2014. Stakeholders should submit written comments by November 19, 2014 to ComCosts2@caiso.com.

[31] Existing BPM clarifications. The change has not been made at the time of this straw proposal publication.

[32] Existing BPM clarifications. See PRR 782 available at: http://bpmcm.caiso.com/pages/default.aspx