Commitment Cost Enhancements Phase 3 Board follow-up workshop

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Market Design and Regulatory Policy

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Scope of today's workshop

- ISO committed to work with demand response and storage community to address outstanding concerns with CCE3 as approved by the Board.
  - June 15th workshop identified issues and concerns to address

- Continue discussions from previous workshop focusing on use-limitation registration process, opportunity cost methodology, and outage cards.
  - Comparison between RSI1 and CCE3 paradigms

- Work product: Based on stakeholder comments, ISO will create an action plan to address each concern identified.

Agenda

Time	Topic	Presenter
10:00 – 10:10	Introduction	Kristina Osborne
10:10 – 12:00	• Review modifications and updates from June workshop • Use limited application/registration process • Cost and bid structure in ISO markets • Opportunity cost methodology	Kallie Wells
12:00 – 1:00	Lunch Break	
1:00 – 3:50	• Opportunity cost methodology • Example PDR resources – Part A • RAAIM treatment and outage cards • Example PDR resources - Part B • Recap of Issues Matrix	Kallie Wells
3:50 – 4:00	Wrap-Up and Next Steps	Kristina Osborne

Clarifications provided from previous workshop

- PDR resources can apply for use-limited status via use-limited application/registration process.
- Performance criteria for PDR resources as specified in programs/contracts would be considered a design limitation.
  - Masterfile market based max daily start field can reflect 1 start per day if specified in program
  - Design limitation under use-limited definition
- PDR resource will continue to be exempt from RAAIM if monthly and/or annual limitation reached, for an interim period.
- After interim period, PDR will be non-exempt from RAAIM starting the first day of subsequent month for which the annual use-limitation was reached.

Use-limit registration and data submission process

Use-limited status

	RSI1 (Nov 2016 – Fall 2017)	CCE3 (Fall 2017 onward)
Use limited status	Default - no need to apply for use-limited status.	No longer default - can apply for use-limited status

- Criteria used to qualify for use-limited status will be based on the proposed revised definition of use-limited under CCE3.
- Resource performance criteria, e.g., events per year or month, as stated in the PDR program will be considered a design limitation under the revised definition of use-limited, provided sufficient supporting documentation is submitted to the ISO.

Use-limited application process

	RSI1 (Nov 2016 – Fall 2017)	CCE3 (Fall 2017 onward)
Use limited application process	• Submit CIDI ticket requesting use-limited status. • Submit documentation and data required per Tariff section 40.6.4.1. • ISO will respond to request within 5 business days.	• Similar process as RSI1 • Submit documentation supporting use-limited status and limitations as provided in the use-limit plan data template. • Evaluating the need of all data requirements as currently stated in the Tariff.

Use-limitation data submission

Use-Limit data	RSI1 (Nov 2016 – Fall 2017)	CCE3 (Fall 2017 onward)
Use limitation data submission	Use limit plan data template (ULPDT)	Use limit plan data template (ULPDT)

- Currently, all use-limited resources submit annual use-plans, independent of default designation.
- Use-limit plan data template (ULPDT) with RSI1 implementation is replacing the current excel file use-plans.
- PDR resources must submit use-limit plan data template (ULPDT) annually, per RSI1 (PRR887), and will continue to submit post CCE3.
  - RSI1 uses data to apply appropriate RAAIM assessment
  - CCE3 will utilize same data for opportunity cost calculation

Use-limitation data submission

SC ID	Resource ID	Use Limit Type	Granularity	Effective Start Date	Effective End Date	Limitation Number	Minimum Capacity Level	Maximum Capacity Level	Documentation Name
SC_ID	RES_ID	USE_LIMIT_TYPE	GRANULARITY	PLAN_STRT_DT_TM	PLAN_END_DT_TM	LIMITATION	MIN_USE_LIMIT	MAX_USE_LIMIT	DOC_NAME
Delete this row before uploading the template						*The number or amount of the limitation for the granularity period (e.g. number of starts for the year)*			
SCID	*Existing, active resource provisioned to the SC uploading the ULPDT*	*START, RUNHOURS, ENERGY, OTHER*	*DAILY, MONTHLY, ANNUALLY, OTHER*	*Date this use limitation becomes effective (MM/DD/YYYY)*	*Date this use limitation expires. This date must be provided. (MM/DD/YYYY)*		*Minimum capacity level for which the limitation applies (optional)*	*Maximum capacity level for which the limitation applies (optional)*	*Documentation name, page number, CIDI Ticket #*
SC123	PDR ResA	RUNHOURS	ANNUALLY	1/1/2017	12/31/2017	150	0	5	PDR Program A, 10, 12345
SC123	PDR ResB	START	ANNUALLY	1/1/2017	12/31/2017	25	0	5	PDR Program B, 5, 67890

- Each row represents one limitation (type and granularity) for the resource.
- Must be at the resource ID granularity

- What type(s) of documentation exists that can be provided to support limitations?

NOTE: Use-plan data template can be found under Implementation at
http://www.caiso.com/informed/Pages/StakeholderProcesses/ReliabilityServices.aspx

Maintaining use-limited status

- To maintain use-limited status, resources must
  - Submit Use-limit plan data template annually
  - If no changes have been made to limitations and/or supporting documentation from prior year, submit an affidavit attesting that documentation continues to support limitations and need for use-limited status.
  - If changes have been made to limitations and/or supporting documentation, submit updated documents

Cost and bid structure in CAISO markets

Cost structure

- ISO has a three part cost structure, each of which correspond to a bid component.
- No difference in cost structure between RSI1 and CCE3

	Cost type	Description	Corresponding bid component
	Energy cost	$/MWh for each MW segment above minimum load.	• Hourly energy bids • Can update bids until T-75.
Commitment costs	Start-up cost	$/start (event) of the resource.	• Start-up bid • Daily bid in day-ahead and real-time markets
Commitment costs	Minimum load cost	$/hour to curtail at the PDR minimum load level.	• Minimum load bid • Daily bid in day-ahead and real-time markets

Cost Structure – stakeholder feedback requested

- Are there demonstrable costs that exist for PDR that may be analogous to a start-up or minimum load cost for a traditional generator?
  - Excluding opportunity costs
  - Storage and Demand Response

Bid cap structure - overview

- Each bid component subject to a bid cap.

Bid Cap	RSI1 (Nov 2016 – Fall 2017)	CCE3 (Fall 2017 onward)
Energy bid cap	$1,000/MWh	$1,000/MWh
Start-up bid cap	125% of daily proxy cost calculation, OR 150% of monthly proxy cost calculation	125% of daily proxy cost calculation + 100% opportunity cost calculation
Minimum load bid cap	125% of daily proxy cost calculation, OR 150% of monthly proxy cost calculation	125% of daily proxy cost calculation + 100% opportunity cost calculation

- RSI1 initiated transition towards only having daily proxy cost calculation (proxy cost option).
  - Only use-limited resources have both options until opportunity cost methodology implemented.
  - CCE3 completes the transition.

Bid cap structure – proxy cost formulation

- Commitment cost bid caps are based on an estimated cost calculation performed by the ISO.
  - RSI1: based on proxy cost formula
  - CCE3: based on proxy cost and estimated opportunity cost.

Cost type	Proxy cost formula for Non Gas-Fired
Start-up cost	RDT Start up fuel or fuel equivalent cost + start up GMC adder + start up Major Maintenance Adder + Greenhouse gas cost
Minimum load cost	RDT Min load fuel or fuel equivalent cost + min load GMC adder + min load Major Maintenance Adder + O&M + Greenhouse gas cost

- Estimated opportunity costs determined via CCE3 methodology

Cost and bid structure – recap

- 3 part cost structure (start-up, minimum load, and energy)
- Each cost type corresponds to bid component
  - Hourly energy bids
  - Daily commitment cost bids
- Each bid component subject to a bid cap
  - Energy = $1,000
  - Pre CCE3, commitment costs for use-limited resources capped at 150% of monthly calculated proxy cost, or 125% of daily calculated proxy cost
  - Post CCE3, commitment costs for use-limited resources capped at 125% daily calculated proxy cost plus 100% estimated opportunity cost

Opportunity cost methodology per CCE3

Opportunity cost estimate – CCE3 methodology

- CCE3 developed an opportunity cost methodology to estimate opportunity cost for each limitation type, i.e., run hours, starts/events, and MWh.
  - Opportunity cost represents potential foregone profits if resource had one less run hour, start, or MWh.
- Resulting opportunity cost further increases bid cap of corresponding bid component.
  - Limit on run hours ⟹ minimum load cost bid cap
  - Limit on starts/events ⟹ start-up cost bid cap
  - Limit on MWh ⟹ default energy bid (not applicable to PDR)
  - Currently, not applicable to NGR (no commitment costs, not mitigated)
  - Provides flexibility to reflect opportunity cost in market bids
- *Enables market based optimal use of resource provided its limitations.*

Opportunity cost estimate – illustrative example

- 1MW PDR can be called 3 times from June 1 to Sept 30
- Assume $0 commitment costs, and energy cost of $35/MWh.
- On June 2, 3, and 4, average LMP was $40/MWh.
  - Market would use PDR for each day and the resource has no more calls. (Post CCE3 transition period, the PDR RA would need to be replaced starting in July.)
- If the optimization could forecast, based on historical prices, that the 3 highest priced days are $90/MWh, $95/MWh, and $110/MWh during June 1- Sept 30, then opportunity cost is $55 ($90/MWh - $35/MWh).
- Total bid cap is ($0 x 125%) + $55 = $55/MWh
- Actual calculations more complicated, see following slides

Opportunity cost estimate – CCE3 methodology

- Develop and run a resource specific profit maximizing model for the upcoming year, respecting resource characteristics and limitations.

Model inputs	Opportunity cost model	Model outputs
• **Estimated LMPs** • **Use plan limitations** • **Unit characteristics (Pmin, Pmax, Minimum on time, minimum down time)** • **Energy and commitment costs**	Unit commitment model over future time period (e.g., month, year) 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.

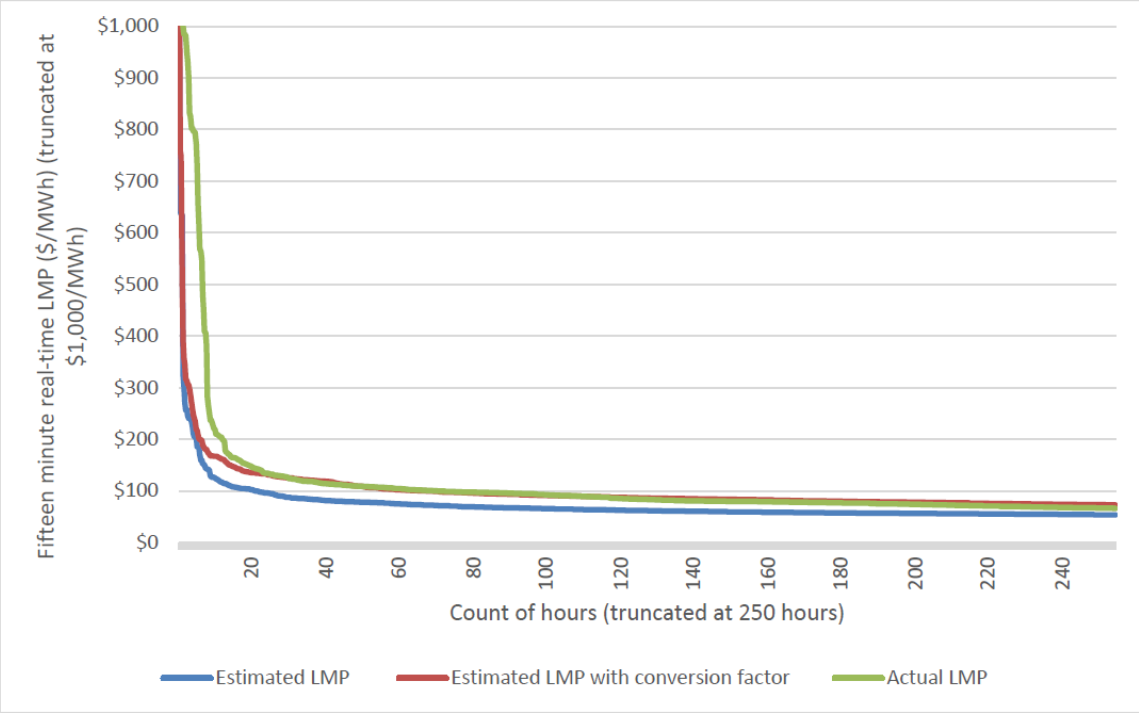
- Upcoming slides go through each step in the process with more details and examples.

Opportunity cost estimate - inputs

- Estimated LMPs
  - Project 15 minute LMPs based on previous years' 15 minute nodal prices, forecasted out using future gas, greenhouse gas, and power prices

Figure 2 Distribution of estimated and actual fifteen minute LMPs for Resource B

(top 1,000 intervals)



Opportunity cost estimate - inputs

- Masterfile data
  - Pmin, Pmax, Minimum on time, Minimum down time
- Use-limitation data (ULPDT)
  - Limitations by type and granularity
    - Type: starts, run-hours, and output
    - Granularity: daily, monthly, annual
    - CCE3 policy states no opportunity costs will be calculated for daily limitations, however necessary to include in ULPDT to be reflected in model.
  - Limitation effective dates
- Cost estimates
  - Energy costs based average cost curve values as submitted in Masterfile.
    - Consider applying a lower bound of the net benefits test?
  - Commitment costs based on proxy cost formulation, projected using future prices where applicable

Opportunity cost estimate - inputs

- Seeking feedback on the following questions:
  1. Are there other resources characteristics necessary to include in the model?
  2. Can all limitations be captured by the types and granularities noted above? If not, what else exists that warrant an opportunity cost?

Opportunity cost estimate: model

- Opportunity cost model determines optimal dispatch for the use-limited resource over, at a minimum, the limitation horizon.
  - Example: Run for a year for annual, and monthly limitations.
- Model formulation

  Objective function: Maximize resource-specific profits over the limitation horizon

  Subject to:

  SUM(Startups) <= 90% of maximum allowed starts

  SUM(Commitment hours) <= 90% of maximum allowed run hours

  SUM(MWh) <= 90% of maximum allowed generated energy

  Dispatched MWh >= minimum generation level if committed

  Dispatched MWh <= maximum generation level if committed

  Minimum up time constraint

  Minimum down time constraint

Opportunity cost estimate: model

An opportunity cost is determined for each limitation type (start, run hours, MWh)

Start-up opportunity cost:

1. Run model with maximum starts = 90% of start limitation
2. Run model with maximum starts = 90% of start limitation – 1
3. Start-up opportunity cost = Profits1 – Profits2

Run hours opportunity cost:

1. Run model with maximum run hours = 90% of hour limitation
2. Run model with maximum run hours = 90% of hour limitation – 1
3. Run hour opportunity cost = Profits1 – Profits2

Generation opportunity cost:

1. Run model with maximum generation = 90% energy limitation
2. Run model with maximum generation = 90% energy limitation – 1MWh
3. Run hour opportunity cost = $Profits_1 – Profits_2$

Opportunity cost estimate: model results

- Annual limitations
  - Model will take the difference in estimated profits of the two model runs over the year.
  - Results in one opportunity cost per limit type, valid for the year, subject to updates
- Monthly limitations
  - Model will take the difference in estimated profits of the two model runs for each month.
  - Results in twelve opportunity costs per limit type, each valid for the corresponding month, subject to updates.

Opportunity cost estimate: updates

- Opportunity costs valid for the upcoming calendar year will be estimated prior to Jan 1.
- As the year progresses, the opportunity cost estimates will be updated monthly based on actual use of the resource.
- For example, a resource with 100 starts per year, starts 20 times in January. The limitation in the model run for Feb through Dec will set the max annual start limit to 72 starts (72 = 90%*(100 – 20)).

Example resources: opportunity cost estimate

Opportunity cost estimate – recap of steps

- Gather model inputs (LMPs, MF characteristics, limitations).
- Run model to determine estimated annual/monthly profits.
- Run model with one less start/run-hour/MWh to determine estimated annual/monthly profits.
- Difference of two model runs is the opportunity cost for that limitation type.
- Opportunity cost increases bid cap for corresponding bid component.

Example opportunity cost estimate: sample resources

- PDR Res A
  - Pmin = 0 Pmax = 5
  - Limitation: 150 hours/year
  - Energy cost: $100/MWh
  - Start-up and minimum load costs: $0
- PDR Res B
  - Pmin = 0 Pmax = 3
  - Limitation: 25 events/year
  - Energy cost: $75/MWh
  - Start-up cost: $200/start
  - Minimum load cost: $0

Example opportunity cost estimate: Resource A

Max $\pi = \sum(LMP_i * MWh_i)/4 - \sum((MWh_i - Pmin_i) * \$100)/4$

Subject to:

$0 <= MWh_i <= 5$, when online	*Pmin/Pmax constraint*
$\sum$ (count i) <= 90%*(150*4), when i *indicates* resource is online	*Annual run hour limit*
$\sum$ (count i) >= 60mins/15, where the count starts with a start-up and ends with shut down	*Minimum on time*
$\sum$ (count i) >= 60mins/15, where the count starts with a shut down and ends with a start-up	*Minimum down time*

Example PDR resources: Part A Opportunity cost estimate

Resource A characteristics and costs

Pmin	Pmax	Start-up cost	Minimum load cost	Energy cost
0	5	$0/start	$0/hour	$100/MWh

Resource A limitations and mock model results

Run-hour limit	Estimated profits with 135 hrs/year	Estimated profits with 134 hrs/year	Opportunity cost
135 hrs/year (90% of 150)	$75,000	$74,950	$50 = $75,000-$74,950

Example opportunity cost estimate: Resource B

$$\text{Max } \pi = \sum(LMP_i * MWh_i)/4 - \sum((MWh_i - Pmin_i) * \$75)/4 - \$200 * \text{Count(SU)}$$

Subject to:

$0 <= MWh_i <= 3$, when online	*Pmin/Pmax constraint*
$\sum$ (count SU) <= 90%*25, SU indicates resource is started	*Annual start limitation*
$\sum$ (count i) >= 60mins/15, where the count starts with a start-up and ends with shut down	*Minimum on time*
$\sum$ (count i) >= 60mins/15, where the count starts with a shut down and ends with a start-up	*Minimum down time*

Example PDR resources: Part A Opportunity cost estimate

Resource B characteristics and costs

Pmin	Pmax	Start-up cost	Minimum load cost	Energy cost
0	3	$200/start	$0/hour	$75/MWh

Resource B limitations and mock model results

Event limit	Estimated profits with 23 events/year	Estimated profits with 22 events/year	Opportunity cost
23 events/year (90% of 25)	$32,500	$31,200	$1,300 = $32,500-$31,200

Example opportunity cost estimate: bid caps

	Resource A	Resource B
RSI1 (Nov 2016 through Fall 2017)		
Energy	$1,000	$1,000
Start-up	$0 (no costs)	125%*$200 (proxy option) or 150%*$200 (registered option)
Minimum load	$0 (no costs)	$0 (no costs)
CCE3 (Fall 2017 onward)		
Energy	$1,000	$1,000
Start-up	125%*$0	125%*$200 + O.C
Minimum load	125%*$0 + O.C	125%*$0

Opportunity cost estimate: recap process

- Estimate foregone profits of resource over limitation horizon, for each limitation type, if one less start/run-hour/MWh.
  - Becomes the opportunity cost for the limitation type
- Opportunity cost further increases bid cap for the corresponding bid component.
- Update opportunity costs monthly based on actual use of the resource.
- Market bids can reflect opportunity cost, thus enabling market to determine optimal use of resource over the limitation horizon.

Outage cards and RAAIM treatment

RAAIM treatment

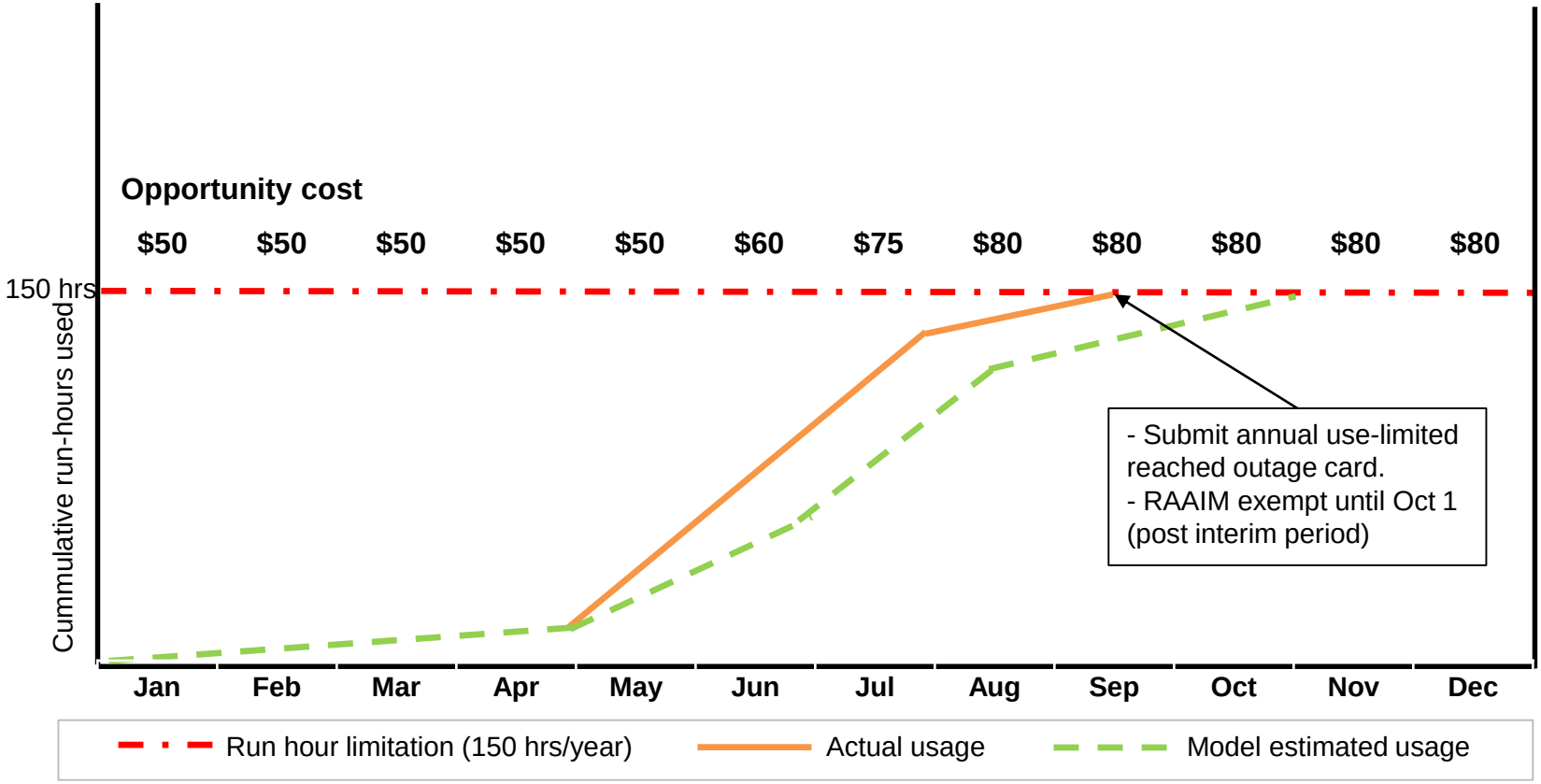
	RSI1 (Nov 2016 – Fall 2017)	CCE3 interim (Fall 2017 to date in 2018)	CCE3 post interim (2018 date onward)
Must offer obligation and RAAIM assessment hours	As determined under RSI1/FRACMOO.		
RAAIM treatment when limitation reached • Fatigue breaks • Monthly limit • Annual limit	• Exempt with outage card • Exempt with outage card • Exempt with outage card	• Exempt with outage card • Exempt with outage card • Exempt with outage card	• Exempt with outage card • Exempt with outage card • Non-exempt with outage card starting the first day of the subsequent month for which the annual limitation was reached

Outage cards

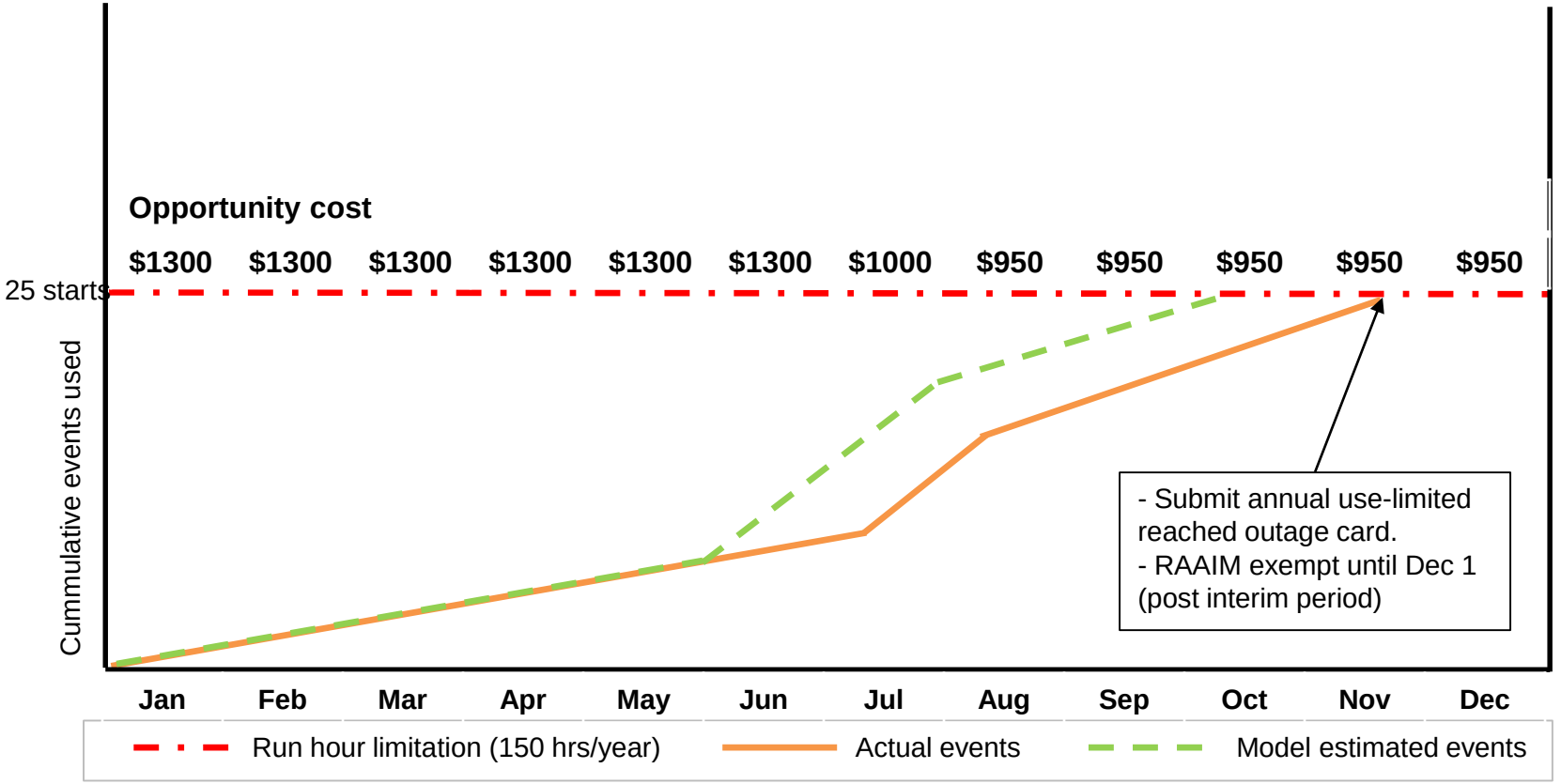
Outage card Nature of work	RSI1 (Nov 2016 – Fall 2017) (PDR is default use-limited)	CCE3 interim (Fall 2017 to date in 2018)	CCE3 post interim (2018 date onward)
Short term use-limited reached	Use-limited resources can use to manage limitations in absence of opportunity cost, and for PDR to reflect fatigue breaks.	PDR can use to reflect fatigue breaks, and for use-limited PDR, as a back-up mechanism to manage limitations with initial implementation of opportunity costs.	
Monthly use-limited reached	Use-limited resources submit when a monthly limitation has been reached.	Non use-limited PDR and use-limited resources submit when a monthly limitation has been reached.	
Annual use-limited reached	Use-limited resources submit when an annual limitation has been reached.	Non use-limited PDR and use-limited resources submit when an annual limitation has been reached.	
Other use-limited reached	Use-limited resources submit when an “other” limitation has been reached.	Non use-limited PDR and use-limited resources submit when an annual limitation has been reached.	

Example resources: market participation with opportunity costs

Example PDR resources: Part B market processes Resource A



Example PDR resources: Part B market processes Resource B



Issues Matrix

Issue/Concern	Resolution status	Notes/Comments
RAAIM exemption in tariff	Pending.	Can consider putting date in tariff, pending determination of date via tariff process.
Continued exemption from bid insertion and mitigation	Resolved.	Existing policy under RSI1 and aligns with CCE3.
Can DR apply for Use-limited status?	Resolved.	CCE3 policy allows PDR to apply.
What criteria would be used to qualify PDR for use-limited.	Pending stakeholder feedback.	Based on proposed definition of use-limited. Data/documentation requirements will be detailed in BPM pending stakeholder feedback re: documents available to provide ISO.
How does a program with one event per day align with CCE3 policy regarding the exception to the minimum of two starts per day?	Resolved.	Aligns with CCE3 policy with supporting documentation provided to ISO.
How would the ISO calculate opportunity costs for PDR?	Pending stakeholder feedback.	CCE3 methodology can accommodate PDR.
How will the ISO optimize or allocate use of PDR resources through new market design?	Resolved.	CCE3 is the new market design intended to allocate these resources.

Issues Matrix

Issue/Concern	Resolution status	Notes/Comments
What would the contractual remedy be if a resource is dispatched more than provided for in the contract?	Resolved, CCE3 policy.	Contractual remedies outside of ISO business functions. CCE3 will provide PDR use-limited reached outage cards regardless of use-limited status.
How will storage resources with existing PDR contracts ensure they do not face significant RAAIM penalties?	Resolved, current policy under RSI1 to avoid RAAIM penalties.	Substitute capacity should be provided when resource is no longer available to avoid RAAIM penalties.
How to address RA replacement risk under CCE3?	Resolved, provided clarification.	Provided interim period for PDR providers to determine which party assumes risk.
If LSE is SC for PDR/NGR, is RAAIM exposure avoided?	Resolved, provided clarification.	No, RAAIM is assessed on a resource level. The SC of the resource is the responsible party.
NGR questions/concerns re:managing limitations	Pending discussions under ESDER	Prerequisite discussions have been initiative under ESDER Phase 2 to first better understand the limitations of NGR resources.

Next Steps

- Stakeholder comments deadline on workshop discussion and issues matrix is August 10, 2016
  - ISO will post updated issues matrix to the initiative webpage
  - Send comments to initiativecomments@caiso.com

- ISO will post a working action plan after consideration of comments, followed by a stakeholder call to discuss.