Flexible Resource Adequacy Criteria and Must-Offer Obligation

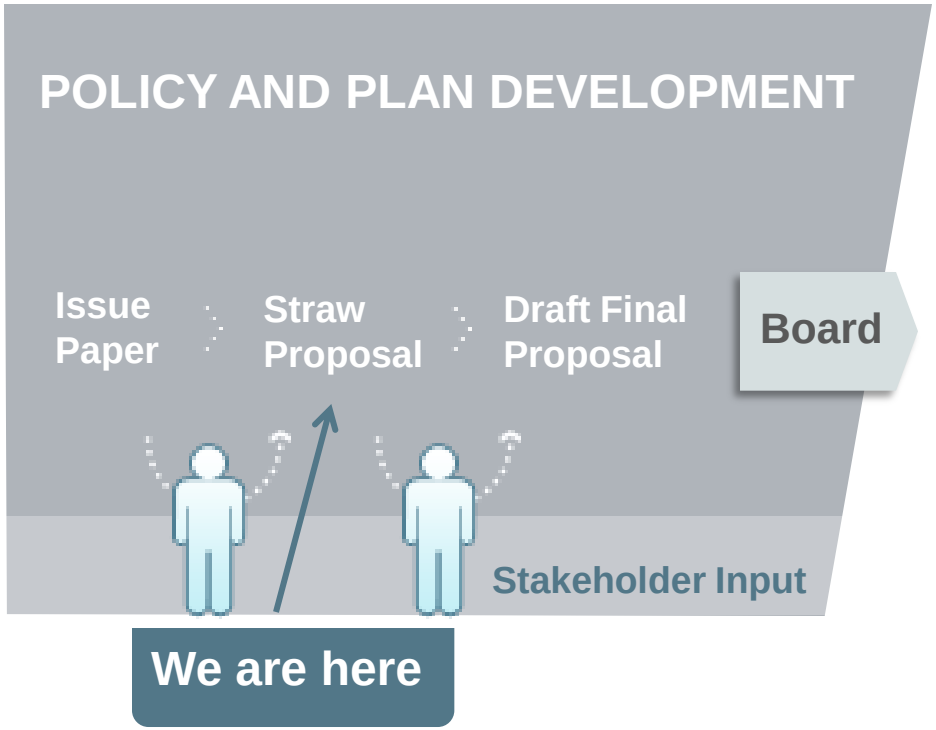
August 1, 2013

Karl Meeusen, Ph.D.
Market Design and Regulatory Policy Lead

Stakeholder Meeting – Agenda – 08/01/13

Time	Topic	Presenter
10:00 – 10:05	Introduction	Tom Cuccia
10:05 – 10:15	Overview and Meeting Objective	Karl Meeusen
10:15 – 10:45	Process and Study Methodology for Determining Flexible Capacity Procurement Requirements	
10:45 – 12:00	Proposal for Allocating ISO System Flexible Capacity Requirements	
12:00 – 1:00	Lunch	
1:00 – 2:15	Flexible Capacity Must-Offer Obligation	Karl Meeusen
2:15 – 2:30	Break	
2:30 – 2:50	Proposed Flexible Capacity Backstop Procurement Authority	Brad Cooper
2:50 – 3:50	Flexible Capacity Availability Incentive Mechanism	
3:50 – 4:00	Next Steps	Tom Cuccia

ISO Policy Initiative Stakeholder Process



California ISO
Shaping a Renewed Future

Flexible Resource Adequacy Criteria and Must-Offer Obligation: Revised Straw Proposal

Karl Meeusen, Ph.D.
Market Design and Regulatory Policy Lead

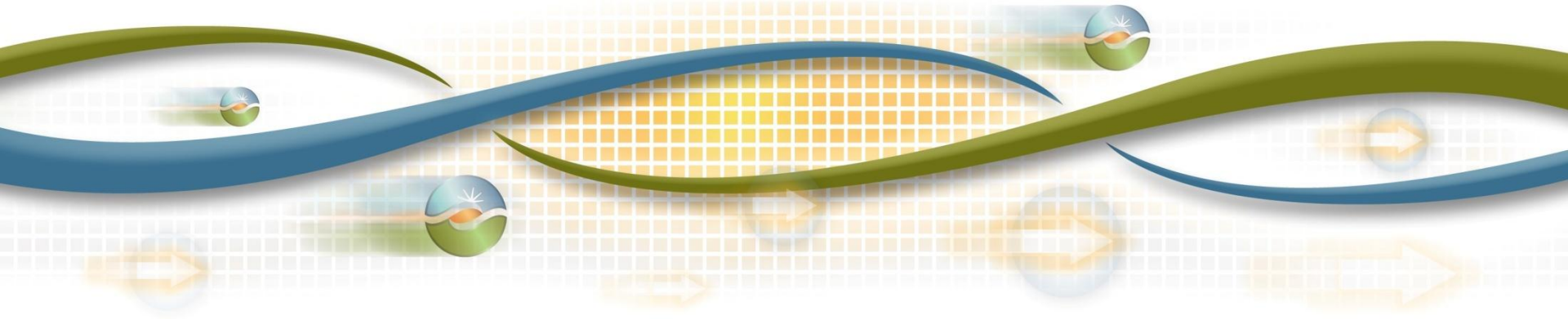
Overview and Meeting Objectives

Initiative scope includes ISO tariff changes to address ISO system flexible capacity requirements

- Stakeholder process targeted to be completed by December 2013 for 2015 RA Compliance
- Initiative scope includes:
  - ISO study process and methodology to determine flexible capacity requirements
  - Allocation of flexible capacity requirements
  - RA showings of flexible capacity to the ISO
  - Flexible capacity must-offer obligation (availability requirements)
  - Backstop procurement of flexible capacity
  - Flexible capacity availability incentive mechanism

California ISO
Shaping a Renewed Future

Process and Study Methodology for Determining Flexible Capacity Procurement Requirements



Flexible capacity requirement assessment process

January

- Receive CEC load forecast used for TPP expansion plan
- Receive updated RPS build-out data from the LSEs
- Publish annual FCR assumptions paper

February

- ISO stakeholder meeting to discuss assumptions Stakeholder comments, and posting of comments with ISO response

March

- Draft LCR and FCR study completed (including EFC list of eligible flexible capacity resources) followed by Local & flexible capacity needs stakeholder meeting
- Publish draft final LCR & FCR needs study

April

- ISO stakeholder meeting to discuss LCR / FCR results followed by stakeholders comments

May/June

- Final 2014 LCR & FCR study posted
- CPUC proposed and final annual RA decision incorporating LCR and FCR procurement obligations

July

- LSEs receive Year-Ahead obligation

August

- Revised load forecasts for following RA compliance year

September

- LSEs receive revised RA and flexible capacity obligation

October

- Year-ahead showing of system, local, and flexible capacity (show 100% local and 90% system and flexible)

Monthly Showings

- T-45 days: Month-ahead showings, including local and flexible true-up
- T-25 days: ISO notifies LSEs and suppliers of any deficiencies of system, local, and or flexible capacity
- T-11 days: Final opportunity for LSEs to demonstrate to the ISO that any identified deficiencies have been cured

LSEs will make annual and monthly flexible capacity procurement demonstrations

- LSEs required to demonstrate
  - 90 percent monthly flexibility procurement obligations year-ahead
    - Future needs may require LSEs demonstrate that 100 percent of their flexible capacity has been procured year-ahead
  - 100 percent of flexibility procurement obligation in monthly showing
- Submission to ISO in addition to local regulatory authority
- The ISO is not proposing changes to existing resource adequacy replacement requirement for planned generator outages at this time

The specific study assumption will be considered in the ISO's annual flexible capacity requirement assessment

- The flexible capacity requirement assessment will consider:
  - Load forecasts
  - Renewable portfolio build-outs
  - Production profiles for intermittent resources
  - Load modifying demand side programs (i.e. DR not bid into the ISO and impacts of dynamic rates)

LSE's will submit intermittent contract data to ISO

- The publically available list should include:
  - Aggregated data regarding all contracts with intermittent resources, both existing and planned.
    - Total contracted installed capacity by CREZ by technology type.
      - Aggregation of CREZs is permissible to mask confidential information.
    - How much of the balancing services are provided by other BAA
    - If there any special provisions associated with contracted resources
- The confidential list should include the same information as the aggregated list, but on a resource-by-resource basis.

The ISO has updated expected IOU RPS portfolio build-out to reflect 2014 and beyond RPS forecasts

- The three IOUs provided their latest RPS data
  - Data based on IOU 2012 RPS Compliance Reports
  - The ISO obtained public version of contracted MW of RPS plans
- Information collected on resources included:
  - Location
  - Contracted capacity
  - On-line date
  - Technology
- The ISO will calculate monthly maximum 3-hour net-load ramps using, in part, this new data for each year moving forward

ISO flexible capacity requirement calculation

- Methodology

$$\text{Flexibility Requirement}_{MTHy} = \text{Max}[(3RR_{HRx})_{MTHy}] + \text{Max}(MSSC, 3.5\% * E(PL_{MTHy})) + \varepsilon$$

Where:

$\text{Max}[(3RR_{HRx})_{MTHy}]$ = Largest three hour contiguous ramp starting in hour x for month y

E(PL) = Expected peak load

MTHy = Month y

MSSC = Most Severe Single Contingency

ε = Annually adjustable error term to account for load forecast errors and variability

Flexible capacity counting rules

Start-up time greater than 90 minutes

EFC = Minimum of (NQC-Pmin) or (180 min * RRavg)

Start-up time less than 90 minutes

EFC = Minimum of (NQC) or (Pmin + (180 min – SUT) * RRavg)

Where:

EFC: Effective Flexible Capacity

NQC: Net Qualifying Capacity

SUT: Start up Time

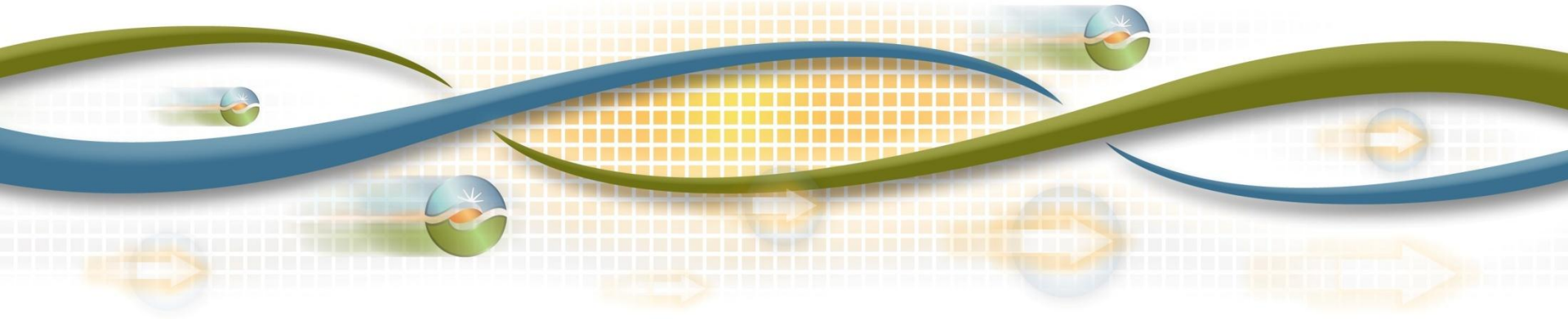
RRavg: Average Ramp Rate

Additional flexible capacity counting rules

- MSG resources measured based on 1x1 configuration
- Hydro resources qualify if physical storage capacity to provide energy equivalent to output at Pmax for 6 hours
- Demand response resources must be able to provide at least 3 hours of load reduction.

California ISO
Shaping a Renewed Future

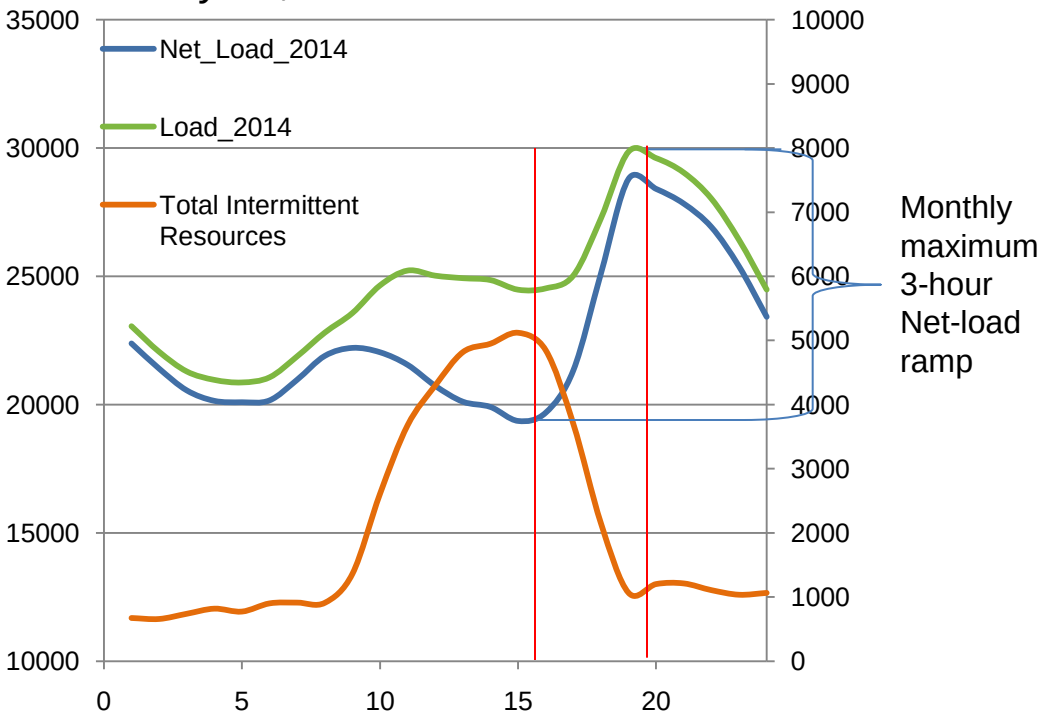
Proposal for Allocating ISO System Flexible Capacity Requirements



Allocating flexible is based on contribution to system's monthly maximum 3-hour net-load ramp

- 3-maximum ramp used is the coincident 3-hour maximum ramp
  - Not each individual LSE's or LRA's maximum 3-hour ramp
- ISO must assess the proper level of granularity to use when determining each LSE's contribution to requirement
  - Reach an equitable allocation at a reasonable cost

Forecasted Load and Net load Curves: January 15, 2014



Flexible capacity requirement is split into its two component parts to determine the allocation

- Maximum of the Most Severe Single Contingency or 3.5 percent of forecasted coincident peak
  - Allocated to LRA based on peak-load ratio share
- The maximum 3-hour net load ramp using changes in
  - Load
  - Wind output
  - Solar PV
  - Solar thermal
  - Distributed energy resources

The ISO will decompose the largest 3-hour net load ramp into five components to determine the LRA's final allocation

- Δ Load – Monthly average load factor x total change in load
- Δ Wind Output – Percent of total wind contracted x total change in wind output
- Δ Solar PV – Percent of total solar PV contracted x total change in solar PV output
- Δ Solar Thermal – Percent of total solar thermal contracted x total change in solar thermal output
- Δ Distributed Energy Resources – Percent of total intermittent DG x total change in DG output

Allocation = Δ Load – Δ Wind Output – Δ Solar PV
– Δ Solar Thermal – Δ Distributed Energy Resources

Example of Allocated 3-hour net load ramp: Evening Ramp

ISO flexible capacity needs assessment	
Δ load	4,000
Δ wind	-2,000
Δ solar PV	-2,500
Δ solar thermal	-1,000
Δ DG output	-500
Total flexible capacity need	10,000

	LRA 1	LRA 2	LRA 3	LRA 4
Monthly average load factor	35%	30%	20%	15%
% of total wind contracted	40%	20%	25%	15%
% of total Solar PV contracted	30%	35%	15%	20%
% of total Solar Thermal contracted	70%	20%	0%	10%
% of total intermittent DG	35%	30%	20%	15%

LSE	Load contribution	Wind contribution	Solar PV contribution	Solar Thermal contribution	DG contribution	Total contribution
LRA 1	.35 x 4,000 = **1,400 MW**	.40 x -2,000 = **-800 MW**	.30 x -2,500 = **-750 MW**	.70 x -1,000 = **-700 MW**	.35 x -500 = **-175 MW**	1,400+800+750+700+175= **3,825**
LRA 2	.30 x 4,000 = **1,200 MW**	.20 x -2,000 = **-400 MW**	.35 x -2,500 = **-875 MW**	.20 x -1,000 = **-200 MW**	.30 x -500 = **-150 MW**	1,200+400+875+200+150= **2,825**
LRA 3	.20 x 4,000 = **800 MW**	.25 x -2,000 = **-500 MW**	.15 x -2,500 = **-375 MW**	.00 x -1,000 = **0 MW**	.20 x -500 = **-100 MW**	800+500+375+0+100= **1,775**
LRA 4	.15 x 4,000 = **600 MW**	.15 x -2,000 = **-300 MW**	.20 x -2,500 = **-500 MW**	.10 x -1,000 = **-100 MW**	.15 x -500 = **-75 MW**	600+300+500+100+75= **1,575**
Total	4,000	-2,000	-2,500	-1,000	-500	10,000

Example of Allocated 3-hour net load ramp: Morning Ramp

ISO flexible capacity needs assessment	
Δ load	8,000
Δ wind	-2,000
Δ solar PV	2,500
Δ solar thermal	1,000
Δ DG output	500
Total flexible capacity need	6,000

	LRA 1	LRA 2	LRA 3	LRA 4
Peak Load Ratio Share	35%	30%	20%	15%
% of total wind contracted	40%	20%	25%	15%
% of total Solar PV contracted	30%	35%	15%	20%
% of total Solar Thermal contracted	70%	20%	0%	10%
% of total intermittent DG	35%	30%	20%	15%

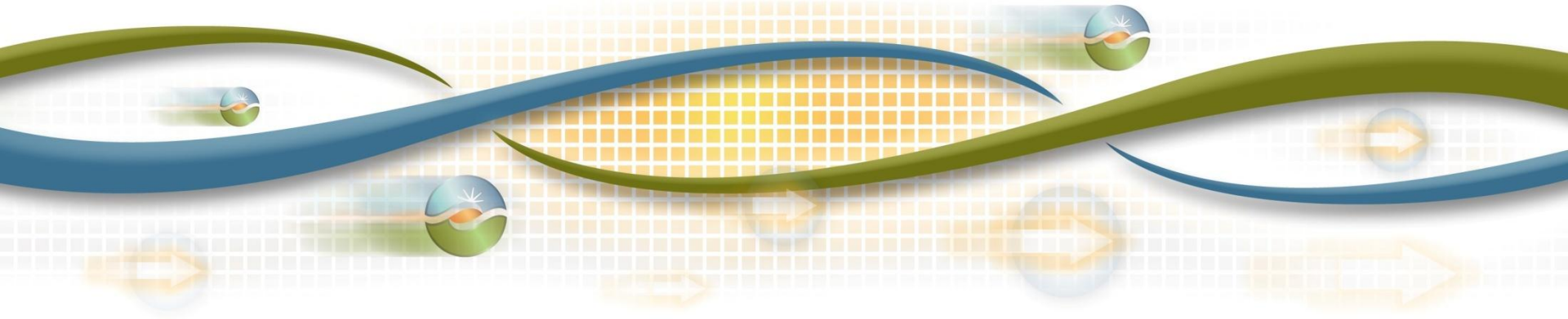
LSE	Load contribution	Wind contribution	Solar PV contribution	Solar Thermal contribution	DG contribution	Total contribution
LRA 1	.35 x 4,000 = **1,400 MW**	.40 x -2,000 = **-800 MW**	.30 x 2,500 = **750 MW**	.70 x 1,000 = **700 MW**	.35 x 500 = **175 MW**	1,400+800-750-700-175= **2,225**
LRA 2	.30 x 4,000 = **1,200 MW**	.20 x -2,000 = **-400 MW**	.35 x 2,500 = **875 MW**	.20 x 1,000 = **200 MW**	.30 x 500 = **150 MW**	1,200+400-875-200-150= **2,025**
LRA 3	.20 x 4,000 = **800 MW**	.25 x -2,000 = **-500 MW**	.15 x 2,500 = **375 MW**	.00 x 1,000 = **0 MW**	.20 x 500 = **100 MW**	800+500-375-0-100= **775**
LRA 4	.15 x 4,000 = **600 MW**	.15 x -2,000 = **-300 MW**	.20 x 2,500 = **500 MW**	.10 x -1,000 = **100 MW**	.15 x -500 = **75 MW**	600+300-500-100-75= **975**
Total	4,000	-2,000	2,500	1,000	500	6,000

The ISO is still considering other allocation options

- Allocate based on LSE resource portfolio
  - Reduces flexible capacity requirements for LSEs that minimize total within-day variability, may also provide signals for future RPS development
  - Requires additional data disaggregation and detail, may not result in significantly different allocation
- Allocate based on a single measurement
  - Allocation calculation significantly simplified
  - There may not be a single measurement that equitably allocate requirements
- Select a different allocation factors
  - Load factors or average load instead of peak load ratio share
  - Alternatives to percent of contracted capacity

California ISO
Shaping a Renewed Future

Flexible Capacity Must-Offer Obligation



Most flexible capacity will be required to submit economic bids into the day-ahead and real-time markets

- Must-offer obligation will:
  - Require submission of economic bids for energy in day-ahead and real-time markets from 5:00 AM – 10:00 PM
  - Will also be applied to most use-limited resources
    - The majority of use-limitations can be managed, through constraints modeled in the ISO market or appropriate default energy bids or start-up costs that reflect these constraints
- Flexible Capacity resources would still be subject to standard RA must-offer obligation from 10:00 PM through 5:00 AM
- DR, storage, and VERs will have specialized must-offer obligations

Daily use limits are already respected by the ISO markets

- ISO markets already respect resources' daily operational limits, for example:
  - Will not dispatch a resource with a maximum run-time of six hours beyond that time
  - Will not look to start a resource twice in a day if it is limited to a single start
- Consistent with the treatment of hydro resources
  - Must demonstrate the capability of producing a six hour energy equivalent and submit economic bids from 5:00 AM through 10:00 PM

Annual run limitations can be managed through negotiated default energy bids

- ISO rules allow a resource to establish a default energy bid that reflects resource's opportunity cost of limited operating hours
- Opportunity cost reflects anticipated LMPs in limited hours resource can operate
- Allows resource to bid in all hours required by flexible capacity must-offer obligation
  - Greatest system needs reflected in LMP
  - The ISO markets would dispatch the hours with the greatest need as reflected in the LMP
- Can be applied to resources with annual operating limits

The ISO proposes a four-step methodology for including opportunity cost into start-up cost for start-limited resources

1. For each day's set of 24 hours of prices and variable costs, determine the optimal commitment and dispatch for each day in the pertinent time frame
2. Calculate the gross margin (revenue minus cost, excluding opportunity cost) for each day.
3. Order the days in decreasing order of gross margin.
4. The gross margin on Day M in the order is the opportunity cost of a start. That is, one more start would mean that the unit could not be operated on Day M.

Example of calculating opportunity cost of start-limits

Generator Data: 60 MW Pmax, 1 start per day, and 50 starts per year

Pmin MW	Pmax Region 1 (MW)	Pmax Region 2 (MW)	Start Up Cost $	Pmin Cost PMINC ($/hr)	Variable Fuel Cost Operating Region 1 ($/MWh)	Variable Fuel Cost Operating Region 2 ($/MWh)
25	45	60	$800	$1500	$50	70

Hour h	Price $/MWh	Commitment decision u(h)	Start-up decision s(h)	MW output decision g2(h)	MW output decision g2(h)	Revenues	Costs
1	30	0	0	0	0	0	0
2	32	0	0	0	0	0	0
3	34	0	0	0	0	0	0
4	36	0	0	0	0	0	0
5	38	0	0	0	0	0	0
6	55	0	0	0	0	0	0
7	70	1	1	45	15	$4,200	$4,350
8	90	1	0	45	15	$5,400	$3,550
9	80	1	0	45	15	$4,800	$3,550
10	80	1	0	45	15	$4,800	$3,550
11	80	1	0	45	15	$4,800	$3,550
12	80	1	0	45	15	$4,800	$3,550
13	80	1	0	45	15	$4,800	$3,550
14	70	1	0	45	0	$3,150	$2,500
15	40	1	0	25	0	$1,000	$1,500
16	60	1	0	45	0	$2,700	$2,500
17	70	1	0	45	15	$4,200	$3,550
18	90	1	0	45	15	$5,400	$3,550
19	100	1	0	45	15	$6,000	$3,550
20	85	1	0	45	15	$5,100	$3,550
21	70	1	0	45	15	$4,200	$3,550
22	55	0	0	0	0	,0	0
23	40	0	0	0	0	0	0
24	35	0	0	0	0	0	0
					Total	$65,350	$49,900
					Gross Margin	Revenues - Costs	$15,450

Step 1: Determine optimal commitment

Step 2: Calculate Gross Margins for the day

- Step 3: Sort all gross margins for the year
- Step 4: 50th highest gross margin is the opportunity cost of using a start and can be included in start-up costs for resources

There are two potential options for managing the flexible capacity must offer obligation for long-start resources

- Option 1: Impose a start time cap for flexible capacity resources
  - If a resource cannot within a specified time, then it is not eligible to provide flexible capacity
- Option 2: Consider a resource's availability requirement fulfilled if it not scheduled in the IFM
  - If the resource is not scheduled in the IFM, then it has fulfilled its must-offer obligation and need not bid into the real-time market
- ISO proposes to adopt Option 2
- It may be necessary to consider limitations on quantity of long-start resources counting as flexible in the future

Demand response resources providing flexible capacity have a specialized must-offer obligation

- DR resources may have limited ability to reduce load during all hours between 5:00 AM and 10:00 PM
- The ISO proposes a specialized must-offer obligation for DR resources
  - Must submit economic bids into both day-ahead and real-time markets on all non-holiday weekdays for either
    - 6:00am through 11:00am or
    - 4:00pm through 9:00pm
  - Must be able to provide at least 3 hours of load reduction.

Demand response resources providing flexible capacity have a specialized must-offer obligation (cont.)

- Allows demand response resources to provide
  - Flexible capacity to the ISO based on the resource's underlying load and
  - Flexible capacity during the time ISO is most likely need the greatest quantity of flexible capacity.
- ISO markets will manage the flexible demand response capacity resource consistent with the identified use-limitations
  - SC must provide the ISO with all applicable use-limitations

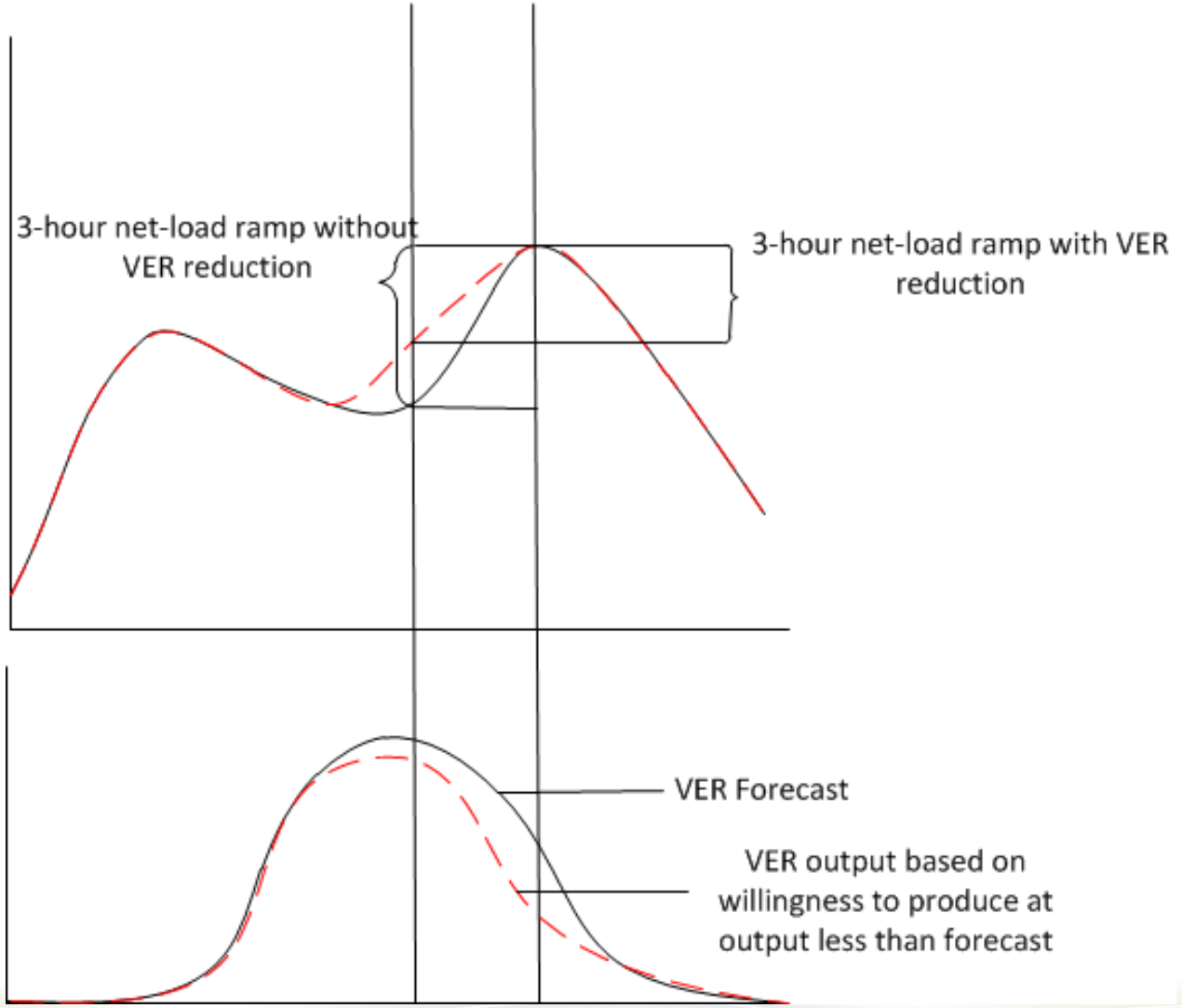
Storage resources providing flexible capacity have a specialized must-offer obligation

- The ISO proposes that storage resources (excluding pump storage) that provide flexible capacity either:
  - Submit economic regulation bids for the time period from 5:00am – 10:00pm as a regulation energy management resource, or
  - Select one of the must-offer obligations outlined for demand response resources.
- Options are designed to allow the SC of the resource to select the must-offer obligation that works best with the specific storage technology

Variable Energy Resources have a specialized must-offer obligation

- This is also an opportunity for variable energy resources to be a real part of the renewable integration solution.
  - For example, if a PV resource is willing to be scheduled below its forecasted output
- Not all dispatchable variable energy resources are able to provide flexibility during all hours.
  - Solar PV can only provide flexible capacity during the daytime hours.
- Setting a flexible capacity must-offer obligation from 5:00am – 10:00pm unworkable for these resources.
- This must-offer obligation would not apply to variable energy resources not listed as flexible RA capacity.

How VERs willingness to be dispatched at less then forecasted output provides flexibility

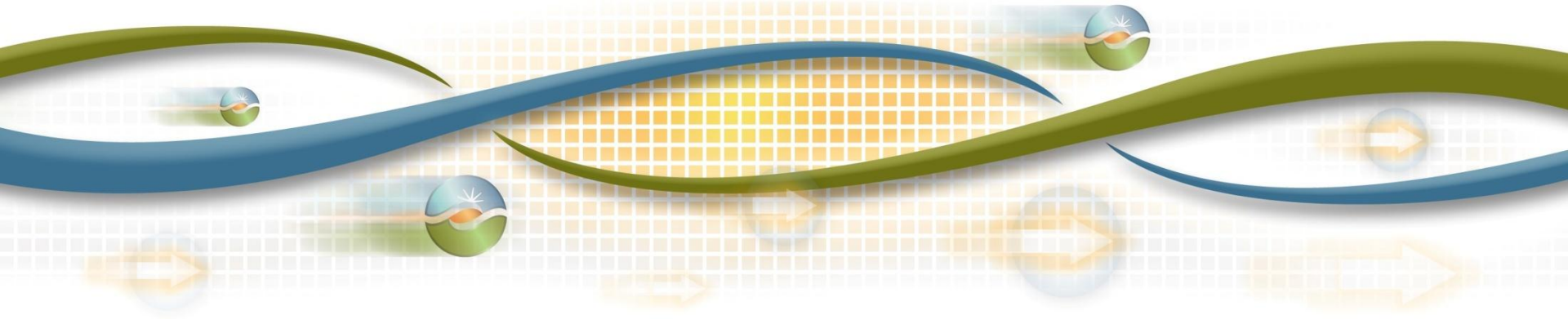


The flexible capacity must-offer obligations for dispatchable variable energy resources is based on the specific energy source and technology

Month	Solar PV	Solar Thermal	Wind
January	8:00am – 5:00pm	8:00am – 6:00pm	5:00am – 10:00pm
February	7:00am – 6:00pm	7:00am – 7:00pm	5:00am – 10:00pm
March	7:00am – 7:00pm	7:00am – 8:00pm	5:00am – 10:00pm
April	7:00am – 7:00pm	7:00am – 8:00pm	5:00am – 10:00pm
May	6:00am – 8:00pm	6:00am – 9:00pm	5:00am – 10:00pm
June	6:00am – 8:00pm	6:00am – 9:00pm	5:00am – 10:00pm
July	6:00am – 8:00pm	6:00am – 9:00pm	5:00am – 10:00pm
August	6:00am – 8:00pm	6:00am – 9:00pm	5:00am – 10:00pm
September	7:00am – 7:00pm	7:00am – 8:00pm	5:00am – 10:00pm
October	7:00am – 6:00pm	7:00am – 7:00pm	5:00am – 10:00pm
November	7:00am – 5:00pm	7:00am – 6:00pm	5:00am – 10:00pm
December	7:00am – 5:00pm	7:00am – 6:00pm	5:00am – 10:00pm

California ISO
Shaping a Renewed Future

Proposed Flexible Capacity Backstop Procurement Authority



New backstop procurement authority to address deficiencies in an LSE's flexible capacity requirement

- ISO proposes backstop procurement authority that allows for backstop designations when:
  - An LSE has insufficient flexible capacity in either its annual or monthly Resource Adequacy Plan and
  - There is an overall net deficiency in meeting the total system annual or monthly flexibility requirements

Backstop procurement will initially be through Capacity Procurement Mechanism (CPM)

- CPM expires February 2016
- Compensation will be at the existing CPM rate
  - Any incremental costs from economic bidding requirement should be included in energy bids
- Costs of backstop procurement will be allocated to deficient LSE(s)

  (1) Determine LRA with shortage based on ISO's flexible capacity allocation methodology

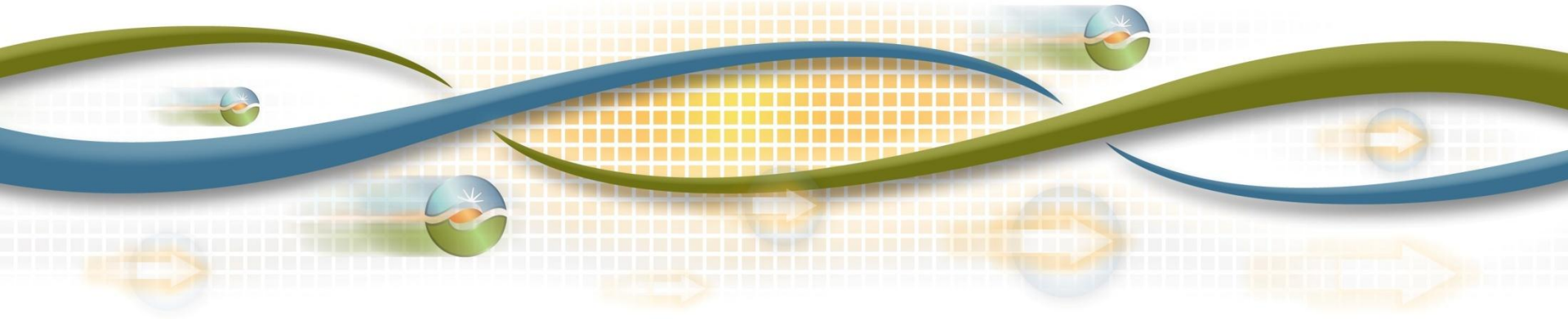
  (2) Allocate to specific LSE based on LRA's allocation mechanism

Reliability Services Action will ultimately be primary backstop procurement mechanism

- Would provide market based mechanism to procure flexible capacity shortfalls
- Will likely have to maintain mechanism similar to CPM for more limited circumstances

California ISO
Shaping a Renewed Future

Flexible Capacity Availability Incentive Mechanism



ISO believes availability incentive mechanism is superior approach to bid insertion rules for flexible capacity

- Incentive mechanism based on economic bids
- Compliance with must-offer obligation can be ensured through this mechanism
  - Positive affirmation flexible capacity is available, e.g. demand response bids
  - Allows for use limitations or need for self-scheduling that market cannot model
- Anticipate implementing no later than the 2016 RA compliance year

Separate availability incentive mechanism would apply to flexible capacity

- Existing availability incentive mechanism (SCP) measures an RA resource's availability during the peak periods of the day.
  - ISO's greatest demand for flexible capacity may not be during the times of peak demand
- Flexible capacity incentive mechanism:
  - Availability would be defined as having economic bids in the ISO's day ahead and real-time markets
  - Would not directly be based on forced outage rates
  - Would not be double penalty on top of existing SCP
- Threshold and incentive/penalty provisions would be similar to existing RA SCP

The funding and incentives for the flexible capacity availability incentive mechanism

- Flexible capacity availability incentive mechanism would be self-funded
  - Resources with availability measurements less than 2.5% of the monthly target charge the applicable flexible capacity backstop price
  - Resources that exceed monthly target flexible capacity availability value plus 2.5% will be credited from these charges based on their performance
- Flexible capacity incentive mechanism and existing SCP would be evaluated separately

Flexible capacity availability incentive mechanism must ensure flexible capacity is available in both day-ahead and real-time markets

- Compliance both day-ahead and real-time markets in each of these markets is important
  - Unit commitments in the day-ahead market
  - System balancing in the real-time market
- ISO proposes to place equal weight on each market
- Measurement based on resource's must-offer obligation
- Failure to submit an economic bid for the flexible capacity quantity for any reason will be considered non-compliant
- ISO welcomes refinements to this proposal

Flexible capacity availability incentive mechanism formula

- The ISO proposes to measure compliance with MOO using the following formula:
- FSCP =

$$\frac{(\Sigma \text{ Hourly MWh economically bid in DA market from resource in month}) + \Sigma \text{ Hourly MWh economically bid in RT market from resource in month})}{(\text{Total MW of RA flexible capacity provided by resource} * \text{Total “market hours” in the month})}$$

Example of flexible capacity availability incentive mechanism calculation

- Flexible capacity = 40 MW
- Short start resource

Hour	DA Economic Bid Quantity (MWh)	RT Economic Bid Quantity (MWh)	Total Both Markets (MWh)
1	40	20	
2	40	20	
3	40	20	
4	40	20	
5	40	20	
6	40	20	
7	40	20	
8	40	20	
9	40	20	
10	40	20	
Total Economic Bid (MWh)	400	200	600
Total Economic Bid Requirement (MWh)	400	400	800
Total availability incentive metric			0.75

Next Steps

- Comments on straw proposal
  - Comments Template posted August 1, 2013
  - Comments Due August 15, 2013
  - Submit comments to fcp@caiso.com

- Board of Governors
  - December 2013