2016 Fall Release Training - Flexible Ramping Product

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External Training Team

Target audience

- Staff that view and respond to ADS instructions
- Settlements analysts
- Staff that monitor and respond to EIM flex requirement sufficiency evaluations

Acronyms

- ADS – Automated Dispatch System
- BAA – Balancing Authority Area
- BSAP – Base Schedule Aggregation Portal
- CC – Charge Code
- CMRI – Customer Market Results Interface
- EIM – Energy Imbalance Market
- FMM – Fifteen Minute Market
- FRD – Flex Ramp Down
- FRDP – Flex Ramp Down Price

Acronyms

- FRDP – Flex Ramp Down Price
- FRP – Flexible Ramping Product
- FRU – Flex Ramp Up
- FRUP – Flex Ramp Up Price
- LMP – Locational Marginal Price
- RTD – Real-Time Dispatch
- RTPD – Real-Time Pre-dispatch
- SC – Scheduling Coordinator
- SIBR – Scheduling Infrastructure Business Rules Application
- UIE – Uninstructed Imbalance Energy

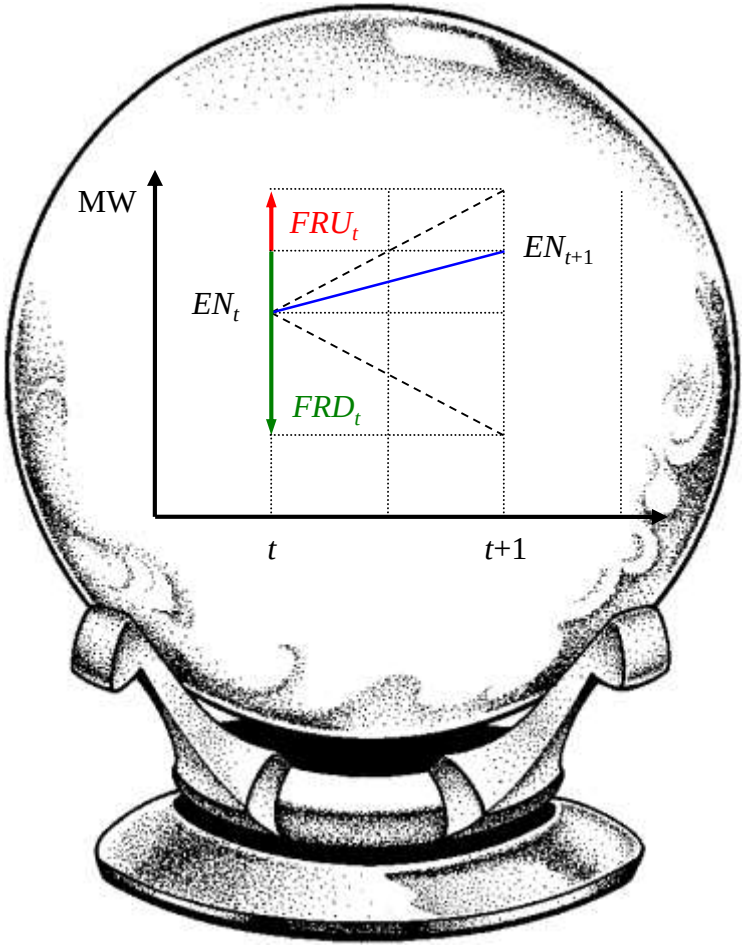
New and updated CMRI reports for flexible ramping product

Item	Project	Report name
1	Flex Ramp	Real-Time Dispatch (RTD) Resource Movement Points
2	Flex Ramp	Fifteen Minute Market (FMM) Resource Movement Energy
3	Flex Ramp	DA Ancillary Service Market Results,
4	Flex Ramp	DA Generation Market Results
5	Flex Ramp	DA Demand Market Results
6	Flex Ramp	DA Import Export Schedules
7	Flex Ramp	Real-Time Unit Commitment (RTUC) Advisory Schedules
8	Flex Ramp	Real-Time Dispatch (RTD) Advisory Schedules
9	Flex Ramp	Fifteen-Minute Market (FMM) Schedules
10	Flex Ramp	Real-Time Dispatch (RTD) Schedules
11	Flex Ramp	Flexible Ramp Requirement Sufficiency Test Results
12	Flex Ramp	Bid Range Capacity Test Results
13	Flex Ramp	Balancing Test Results
14	Flex Ramp	Real-Time Dispatch (RTD) Flexible Ramp Price Breakdown

*More information will be provided in regarding these reports and the OASIS reports in the next few weeks.

What are you going to learn?

- Concepts and terminology related to flexible ramping product
- Keys to understanding how to find details when your resource provides ramping capacity
- The meaning of the flexible ramping requirement sufficiency evaluation and the BSAP flex requirement screen (EIM)
- How flexible ramping product is settled



Background

Objective of this section

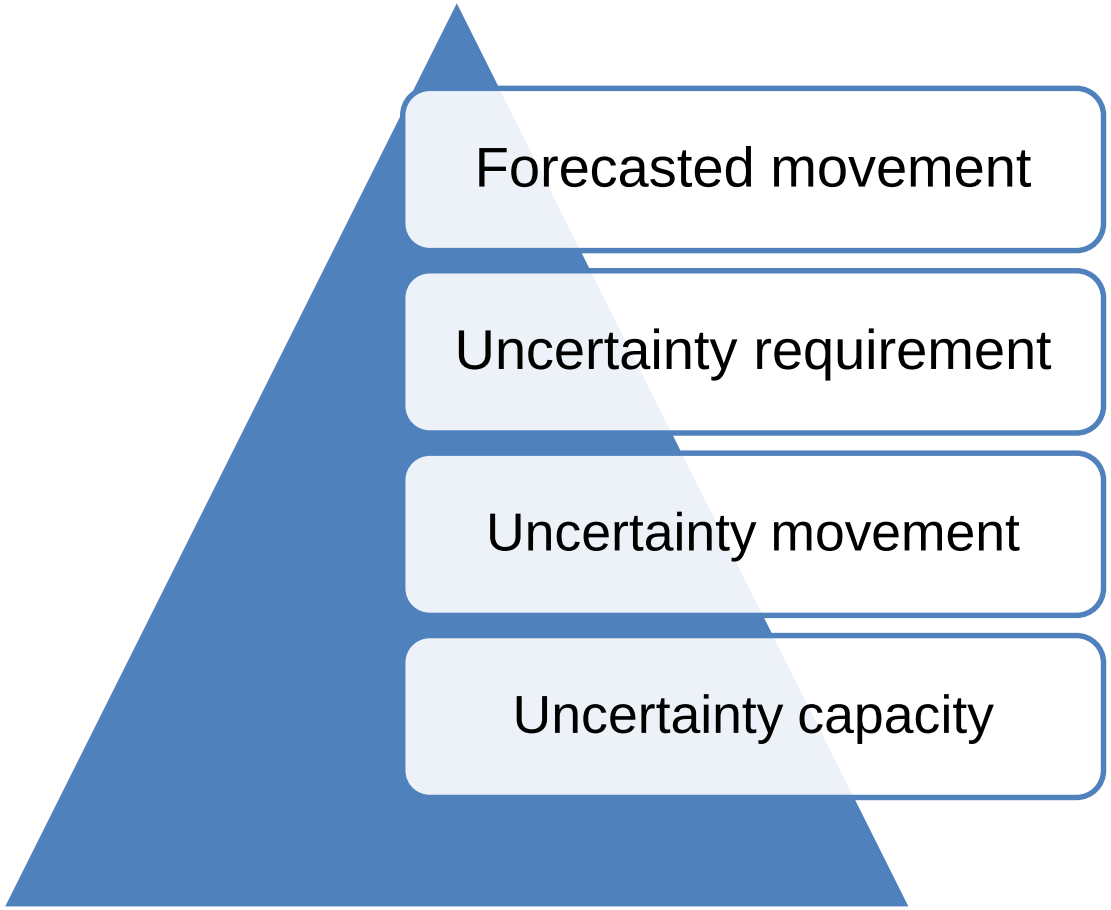
Given that the new flexible ramping product will be implemented in the fall release participants will:

- Learn the reason for flexible ramping product
- Understand terminology used to describe features of this new product
- See an example of how the optimization awards uncertainty movement and forecasted movement

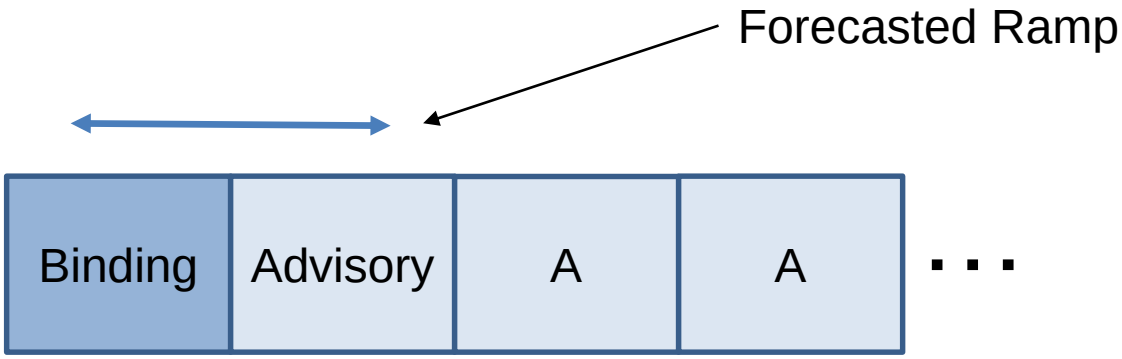
Flexible ramping product makes important changes to the real-time market.

- Secures ramping capability in the fifteen-minute market and real-time dispatch
- Accounts for upward and downward ramping needs
- Compensates resources who provide ramping and charges those that consume ramping capability
- Procures ramping capability for uncertainty when expected value greater than cost
- Aligns cost allocation with those who benefit from additional ramping capability to meet net load uncertainty

Key terms


Forecasted movement
Uncertainty requirement
Uncertainty movement
Uncertainty capacity

Forecasted movement

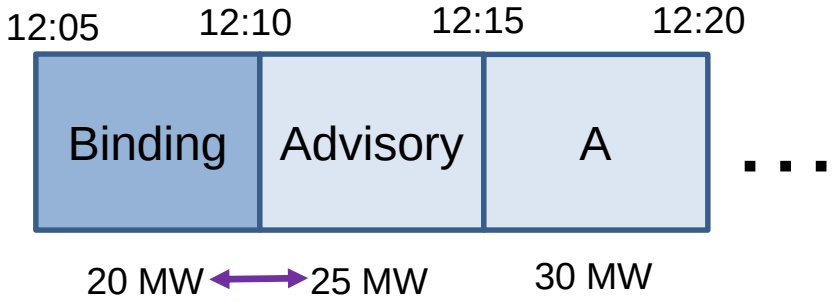


The MW difference between the first advisory interval and the binding interval in the same market run.

Example 1 – RTD forecasted movement

RTD1

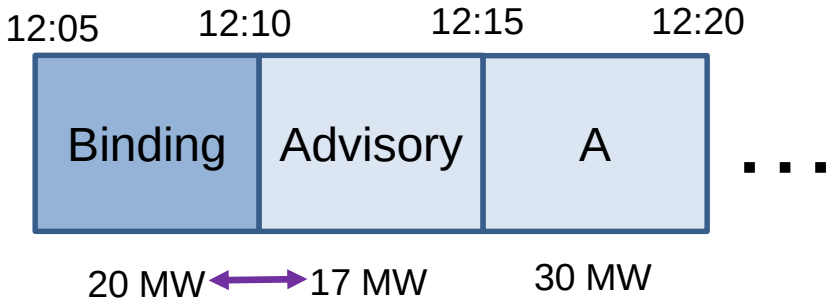
Run time
11:57.5 for 12:05



Forecasted movement = 25 MW – 20 MW = 5 MW (upward)

RTD1

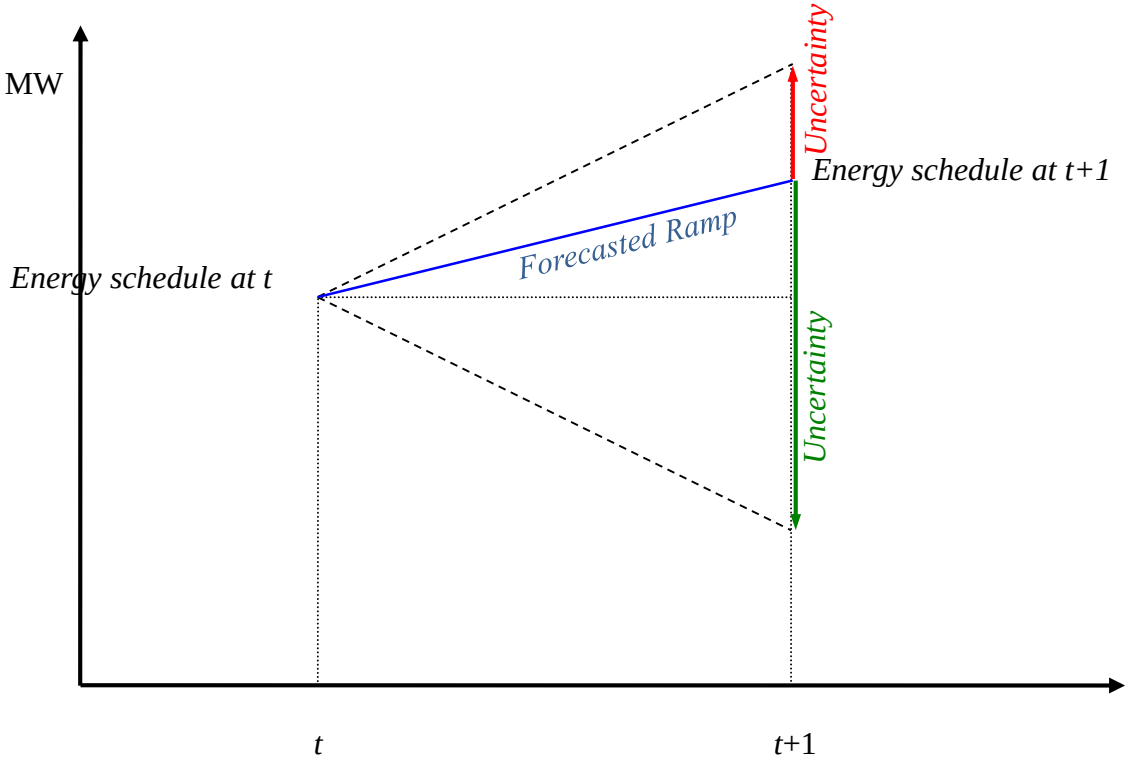
Run time
11:57.5 for 12:05



Forecasted movement = 17 MW – 20 MW = -3 MW (downward)

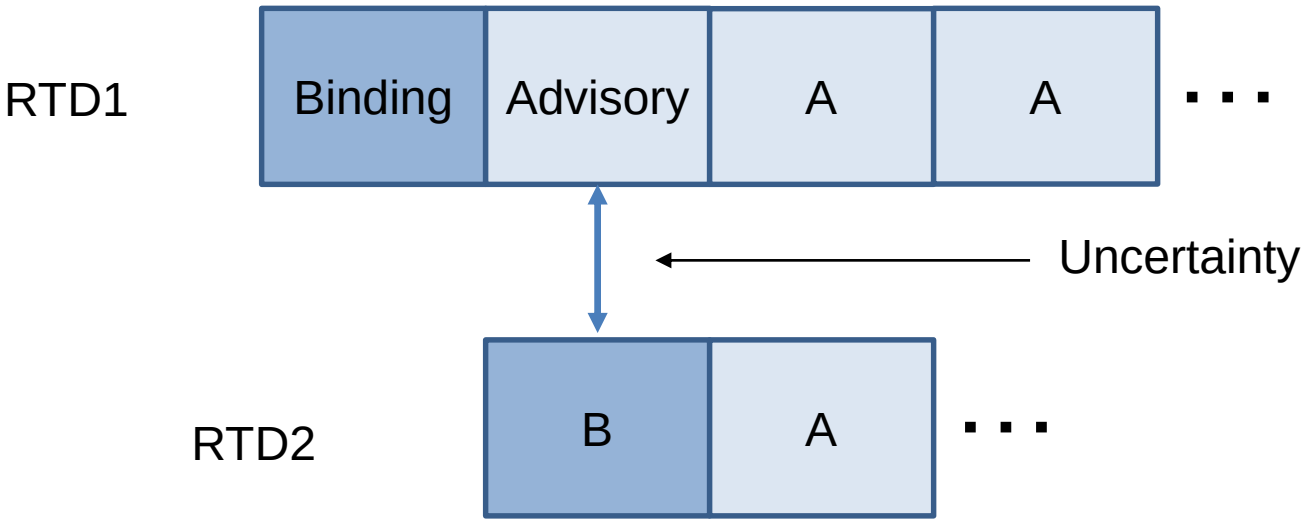
Uncertainty requirement

Forecasting is not an exact science.



Based on historical information, the ISO determines additional upward or downward capacity that may be needed. This amount makes up the "uncertainty requirement."

Uncertainty movement

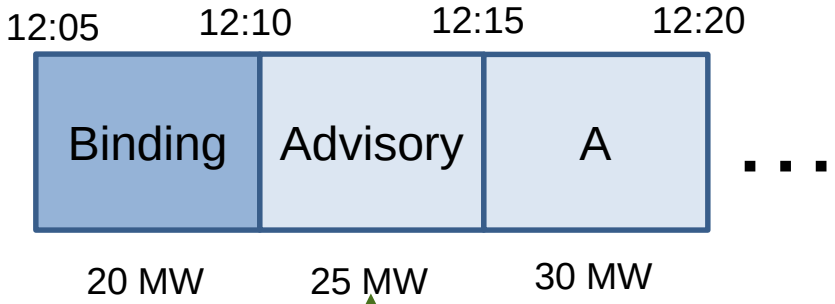


The MW difference between the binding interval in the next market run and the first advisory of the current market run.

Example 1 – RTD upward movement

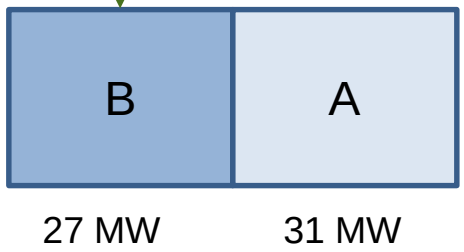
RTD1

Run time
11:57.5 for 12:05



RTD2

Run time
12:02.5 for 12:10

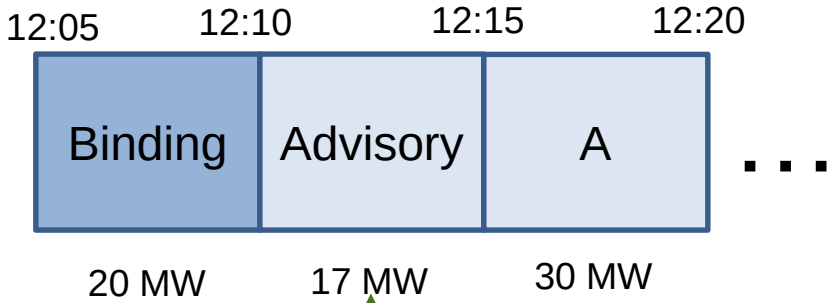


Uncertainty movement = 27 MW – 25 MW = 2 MW (upward)

Example 2 – RTD downward movement

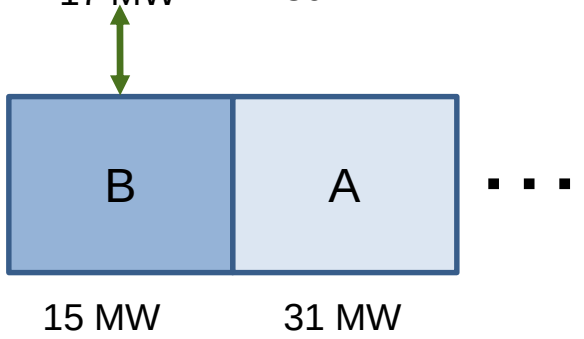
RTD1

Run time
11:57.5 for 12:05



RTD2

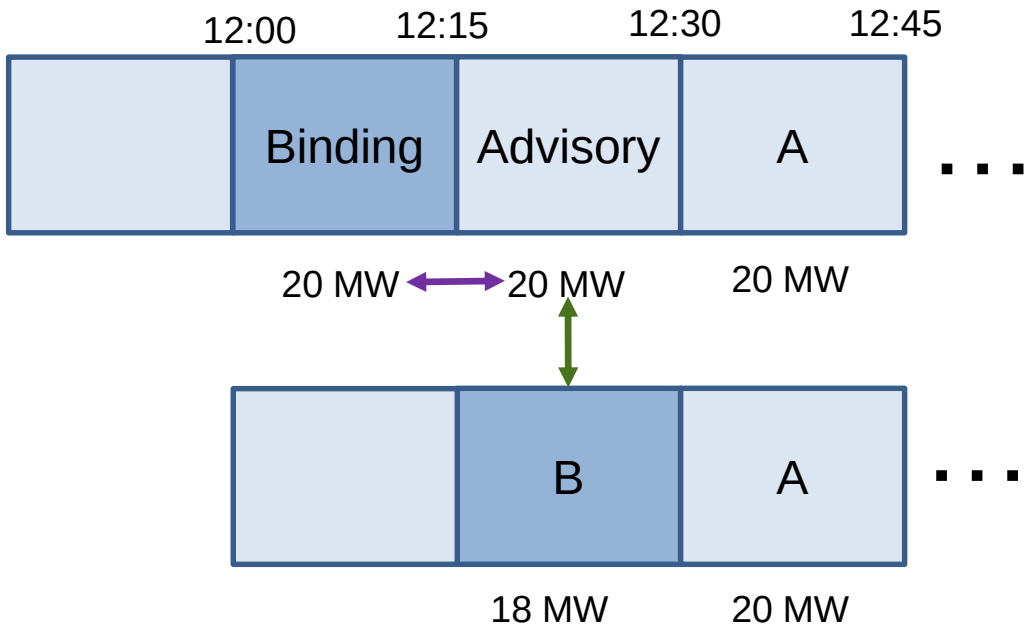
Run time
12:02.5 for 12:10



Uncertainty movement = 15 MW – 17 MW = -2 MW (downward)

Example 3 – RTPD Intertie example

RTPD1 Run time 11:22.5 for 12:00



RTPD2 Run time 11.37.5 for 12:15

Forecasted movement = 20 MW – 20 MW = 0 MW

Uncertainty movement = 18 MW – 20 MW = -2 MW (downward)

Uncertainty capacity

- This is used to resolve the uncertainty requirement
- Resources will be settled for their uncertainty capacity
- Flexible ramping uncertainty allocation will be based on uncertainty movement
- All resources that demonstrate movement will be considered, but only those resource that are 5 minute dispatchable are eligible for uncertainty capacity (aka awards)

Example – flexible ramping product optimization

Assume two generators:

Resource	Pmin	Pmax	Ramp Rate	Energy Bid
G1	0	500	100	$25
G2	0	500	10	$30

If we needed to serve 1 more MW of load, it would come from G1 at a cost of $25 so the LMP is $25.

Resource	Binding Interval			
Load	420			
G1	420			
G2				
LMP	**$25**			

Example – flexible ramping product optimization

Assume two generators:

Resource	Pmin	Pmax	Ramp Rate	Energy Bid
G1	0	500	100	$25
G2	0	500	10	$30

But, if we look at the next advisory interval, we see that G1 does not have enough capacity to meet the load forecast so we will need MW from G2. Because of G2's ramping requirement, we must dispatch it in the binding interval.

Resource	Bi… Interval	Advisory Interval		
Load	420	590		
G1	420			
G2				
LMP	**$25**			

Example – flexible ramping product optimization

Assume two generators:

Resource	Pmin	Pmax	Ramp Rate	Energy Bid
G1	0	500	100	$25
G2	0	500	10	$30

To meet the 590 MW of load we will use 500 MW from G1 (most economic) and then 90 MW from G2.

Resource	Bi… Interva…	Advisory Interval		
Load	420	590		
G1		500		
G2		90		
LMP	**$25**			

Example – flexible ramping product optimization

Assume two generators:

Resource	Pmin	Pmax	Ramp Rate	Energy Bid
G1	0	500	100	$25
G2	0	500	10	$30

If we needed to serve 1 more MW of load, it would come from G2 at a cost of $30

Resource	Binding Interval	Advisory Interval		
Load	420	590		
G1		500		
G2		90		
LMP	**$25**	**$30**		

Example – flexible ramping product optimization

Assume two generators:

Resource	Pmin	Pmax	Ramp Rate	Energy Bid
			0	$25
				$30

The flexible ramping forecast has determined that the advisory interval could go up as high as 600 MW…

…so the market awards G2 with 10 MW of uncertainty capacity

Resource	Binding Interval	Advis Interv	Ur y	
Load	420	590		
G1		500		
G2		90	10	
LMP	**$25**	**$30**		

Example – flexible ramping product optimization

Assume two generators:

Resource	Pmin	Pmax	Ramp Rate	Energy Bid
G1	0	500	100	$25
G2	0	500	10	$30

With a ramp rate of 10 MW a minute G2 will need to be at 50 MW in the binding interval in order to provide 90 MW in the advisory interval and the potential uncertainty MW

Resource		Advisory Interval	Uncertainty	
Load		590		
G1		500		
G2	50	90	10	
LMP	**$25**	**$30**		

Example – flexible ramping product optimization

Assume two generators:

Resource	Pmin	Pmax	Ramp Rate	Energy Bid
G1	0	500	100	$25
G2	0	500	10	$30

Because we are getting 50 MW from G2 we will only need 370 MW from G1.

Resource	Binding Interval	Ad…rval	Uncertainty	
Load	420	590		
G1	370	500		
G2	50	90	10	
LMP	**$25**	**$30**		

Example – flexible ramping product optimization

Assume two generators:

Resource	Pmin	Pmax	Ramp Rate	Energy Bid
G1	0	500	100	$25
G2	0	500	10	$30

This price is based upon the out of merit dispatch of G2 in the binding interval
$5 = $30 -$25

Resource	Binding Interval	Advi… Interva…	…ncertainty	
Load	420	590		
G1	370	500		
G2	50	90	10	
LMP	**$25**	**$30**	**$5**	

Example – flexible ramping product optimization

Assume two generators:

			Ramp Rate	Energy Bid
G			100	$25
G			10	$30

The forecasted movement is the difference between the advisory interval and the binding interval
590 – 420 = 170
500 – 370 = 130
90 – 50 = 40

Resource	Binding Interval	Advisory Interval	Uncertainty	Forecasted Movement
Load	420	590		170
G1	370	500		130
G2	50	90	10	40
LMP	**$25**	**$30**	**$5**	

Example – flexible ramping product optimization

Assume two generators:

Resource	Pmin	Pmax	Ramp Rate	Energy Bid
G1	0	500	100	$25
G2	0	500	10	$30

The price for forecasted movement is always the same as the uncertainty price.

Resource	Binding Interval	Advisory Interval	ertainty	Forecasted Movement
Load	420	590		170
G1	370	500		130
G2	50	90	10	40
LMP	**$25**	**$30**	**$5**	**$5**

Key points

- A resource must have an energy bid to be eligible for flexible ramping product
- Every resource has forecasted movement
- A resource must be 5-minute dispatchable for an uncertainty award
- FRP is not an ancillary service

FRP is like the path of a hurricane.

Forecasted movement?

Uncertainty movement?

Questions?

We covered:

- Reasons for flexible ramping product
- Flexible ramping product terminology
- Example of flexible ramping product optimization

Day-to-day processing

Objective

Given a dispatch in ADS with unanticipated values, locate potential deviations due to flexible ramping product in CMRI.

Interpret values in conjunction with SIBR inputs.

Impact of FRP in real-time

- If a resource's dispatch is inconsistent with the market award, it may be due to a flexible ramping award

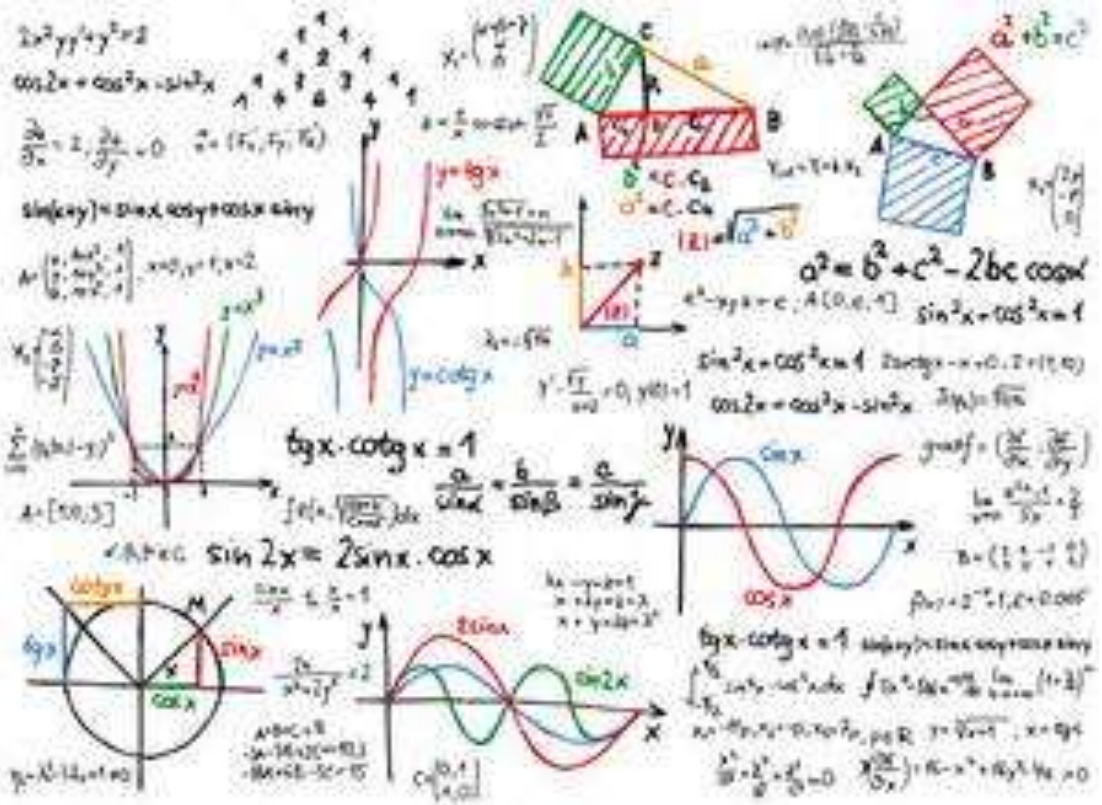
Example:

- An SC puts a bid in SIBR for resource G7
  - 20 MW for $30
- The market runs and clears at $40 for one interval
- For that interval, G7 is dispatched up 15 MW in ADS
- How can the SC find out if the remaining MW have a flexible ramping award?
  - View the Real-Time Dispatch Resource Schedules report in CMRI
  - New ADS as scheduled for Fall 2017

We covered:

- Finding a flexible ramping award

Questions?

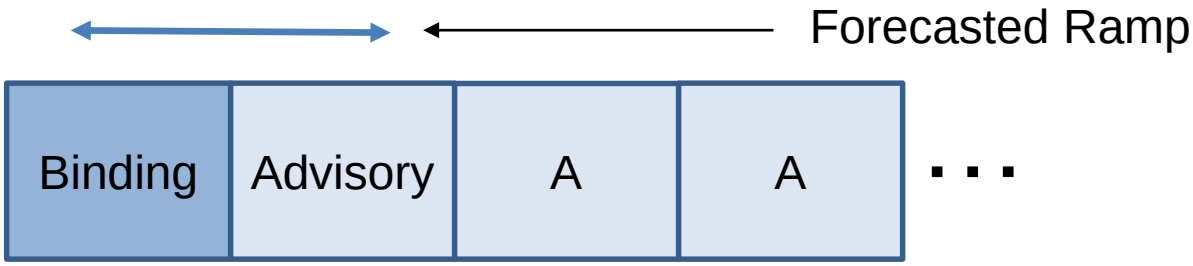


Settlements

Objective

Given new flexible ramping product charge codes, validate settlement output to ensure accuracy.

Settlement for forecasted movement



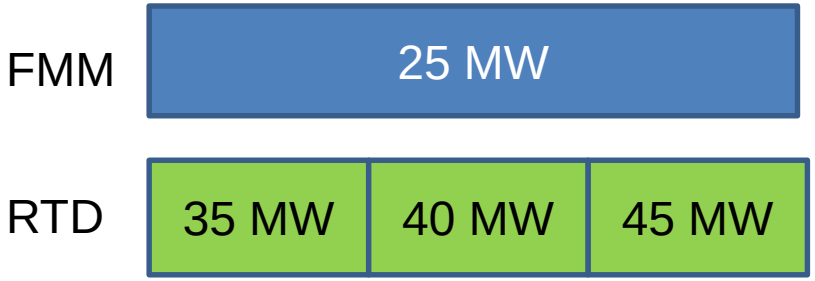
The MW difference between the first advisory interval and the binding interval in the same market run.

- **Charge code 7070** - Flexible Ramp Forecasted Movement Settlement

- **Charge code 7076** - Flexible Ramp Forecasted Movement Allocation

Forecasted movement quantity

Quantity = Market award (FMM + RTD)



Example is for one 15 minute interval

- FMM quantity
  - 25 MW / 12 = 2.083 MWh (converting to MWh)
- RTD quantity
  - 35 MW / 12 = 2.916 – 2.083 = .833 MWh
  - 40 MW / 12 = 3.333 – 2.083 = 1.25 MWh
  - 45 MW / 12 = 3.750 – 2.083 = 1.667 MWh

Forecasted movement price

Price = flex ramp up price – flex ramp down price
FRUP – FRDP

- Why? Here's an example:
  - Resource G3 is ramping up based on the forecast to resolve a ramping need. G3 will be paid for $15/MWh ramping up
  - We will also need to have ramp down capacity available in case the forecast was wrong. So when resource G3 is ramped up, we will also need downward ramping capacity.
  - G3 will be charged for the $10/MWh for downward ramping
  - $5 = $15/MWh - $10/MWh

Forecasted movement amount (no rescission)

Amount = price x quantity

Assume
FMM price = $5/MWh
RTD price = $7/MWh in all 3 intervals

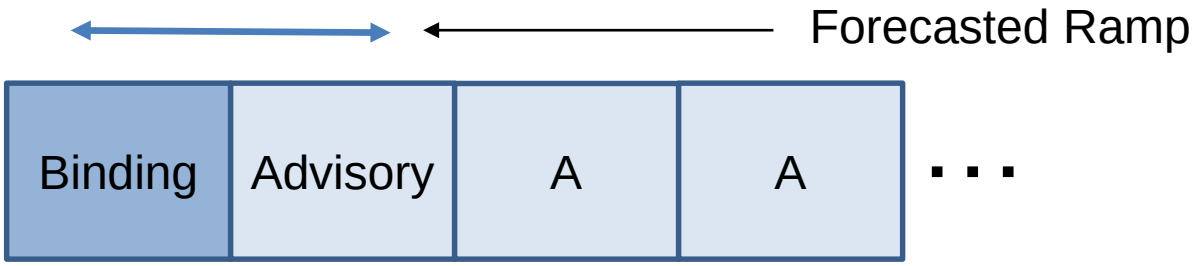
Quantity	Price	Amount
FMM		
2.083 MWh	$5/MWh	$10.415
2.083 MWh	$5/MWh	$10.415
2.083 MWh	$5/MWh	$10.415
RTD		
.833 MWh	$7/MWh	$ 5.831
1.250 MWh	$7/MWh	$ 8.750
1.667 MWh	$7/MWh	$11.669
Settlement in charge code 7070		**$57.495**

Rescission amount – what is it?

- An amount subtracted from the forecasted movement amount to avoid double payment of energy profits

- Example
  - G4's energy bid = $30/MWh
  - Market clearing price = $40/MWh
  - G4 is awarded flex ramp up; price = $10/MWh
  - G4 deviates from their binding dispatch, and gets paid $40/MWh in positive UIE. This is a double payment of $10/MWh for the uninstructed imbalance energy.
  - The settlement will subtract the payment in charge code 7070, although they will still get UIE in 6475.

Settlement for forecasted movement



The MW difference between the first advisory interval and the binding interval in the same market run.

- **Charge code 7070** - Flexible Ramp Forecasted Movement Settlement

- **Charge code 7076** - Flexible Ramp Forecasted Movement Allocation

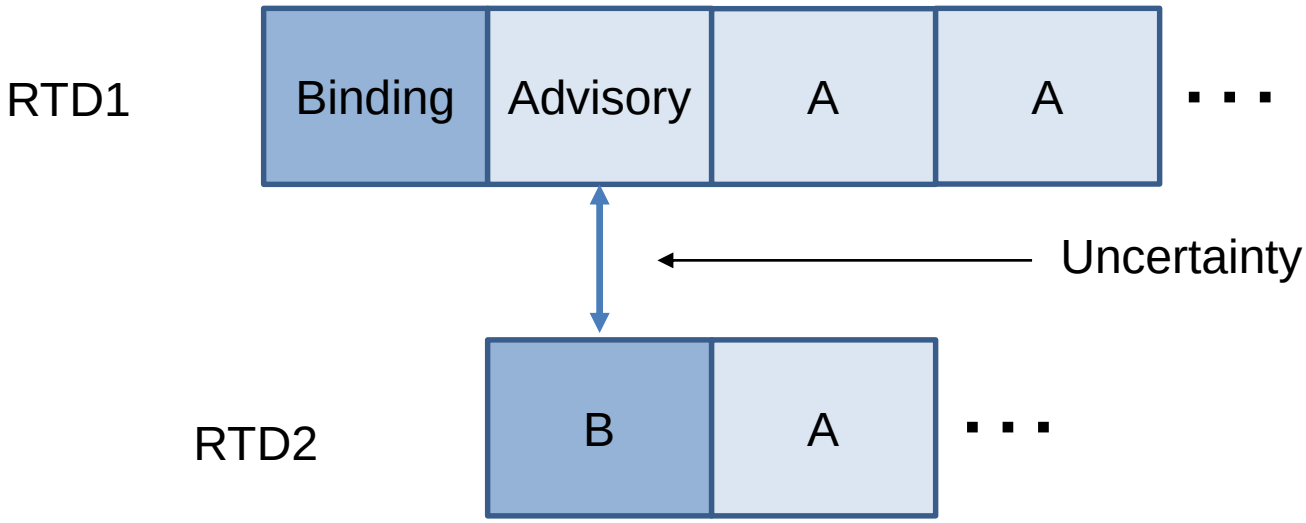
Charge Code 7076 - Flexible Ramp Forecasted Movement Allocation

- Allocates the flex ramp forecasted movement settlement amount to SCs with metered EIM demand or metered ISO demand in proportion to its share of the total EIM metered demand and total ISO metered demand

Example = Total to be allocated for one hour = $10,000

SC	Share of metered demand	Allocation
EIM SC 1	20%	$2,000
ISO SC 2	50%	$5,000
EIM SC 3	30%	$3,000

Uncertainty movement



The MW difference between the binding interval in the next market run and the first advisory of the current market run.

Uncertainty charge codes

Charge Code	
7071	Flexible Ramp Up Uncertainty Capacity Settlement
7077	Daily Flexible Ramp Up Uncertainty Allocation
7078	Monthly Flexible Ramp Up Uncertainty Award Allocation
7081	Flexible Ramp Down Uncertainty Capacity Settlement
7087	Daily Flexible Ramp Down Uncertainty Allocation
7088	Monthly Flexible Ramp Down Uncertainty Award Allocation

Charge Code 7071 – Flexible Ramp Up Uncertainty Capacity Settlement

- This charge code pays for uncertainty capacity, not uncertainty movement

Flex ramp up uncertainty capacity settlement example

- Uncertainty requirement = 1,000 MW in the upward direction for a HE1

- Resource G1 was awarded 100 MWh of uncertainty capacity up to help meet the requirement in the entire EIM area and the ISO BA

- The price was $15/MWh* and G1 was paid $1,500
  - The price was made up of $10/MWh for the entire EIM area and $5/MWh for the ISO BAA

* This is the same flex ramp up price that is used in the forecasted movement settlement (cc 7070)

Uncertainty charge codes

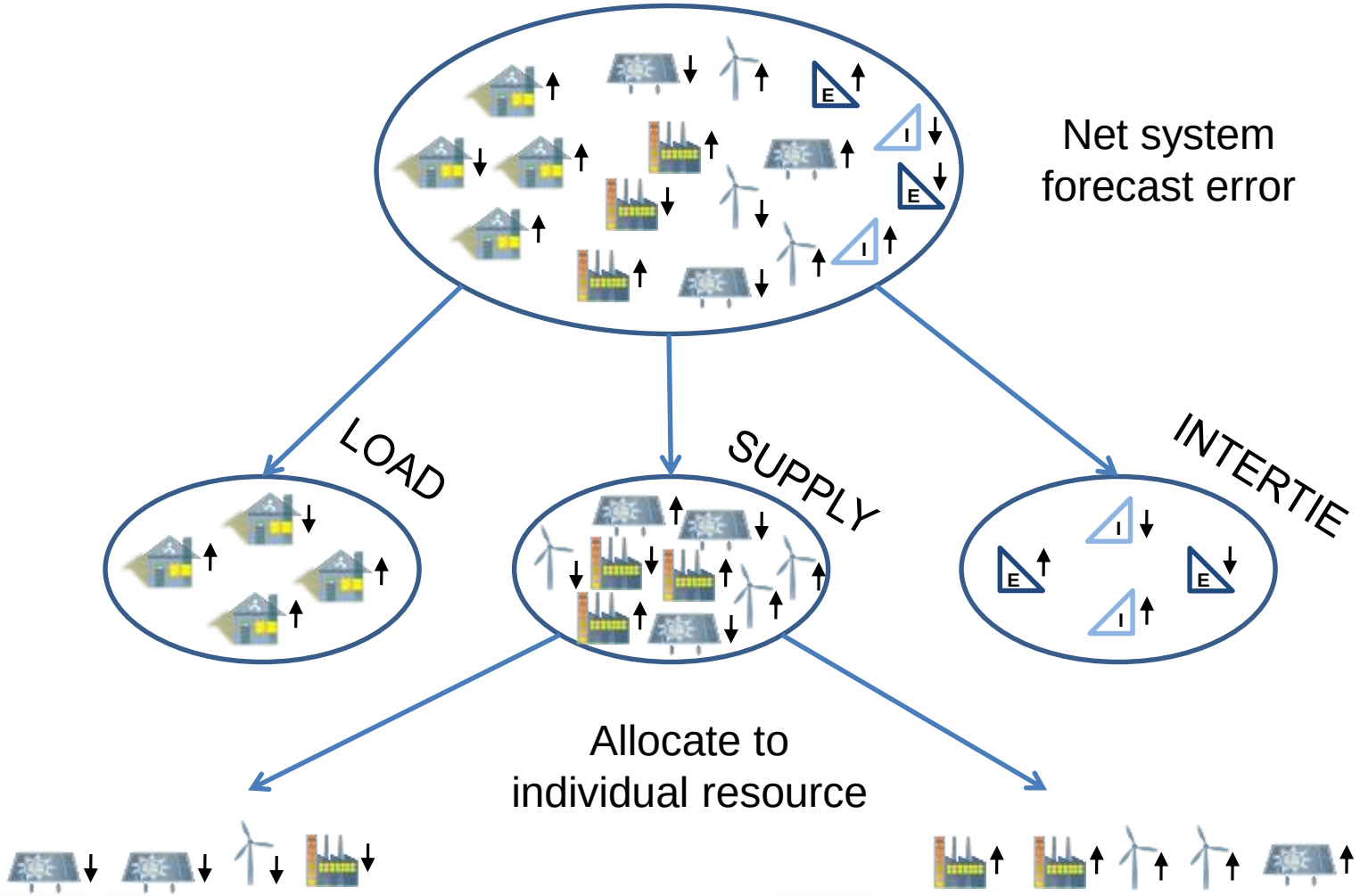
Charge Code	
7071	Flexible Ramp Up Uncertainty Capacity Settlement
7077	Daily Flexible Ramp Up Uncertainty Allocation
7078	Monthly Flexible Ramp Up Uncertainty Award Allocation
7081	Flexible Ramp Down Uncertainty Capacity Settlement
7087	Daily Flexible Ramp Down Uncertainty Allocation
7088	Monthly Flexible Ramp Down Uncertainty Award Allocation

Charge Code 7077 – Daily Flexible Ramp Up Uncertainty Allocation

- For each BAA and trading day, this charge code configuration will allocate the charges associated with the total flexible ramp up uncertainty capacity award settlement amounts (CC 7071)
  - There is a monthly re-settlement

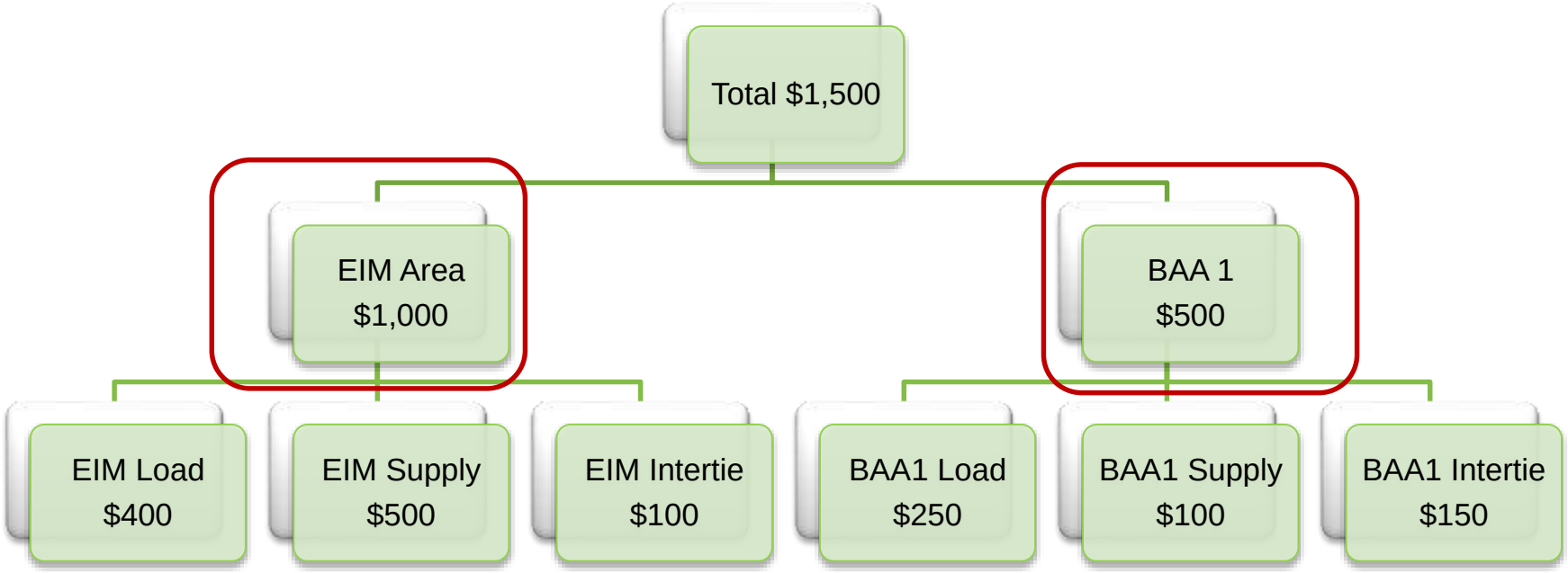
- We will allocate the $ paid for uncertainty awards relative to the uncertainty movement in the EIM area and each BAA in the EIM area

Uncertainty costs allocated to those who benefit for additional ramp: load, supply and interties monthly.



Daily flex ramp up allocation example

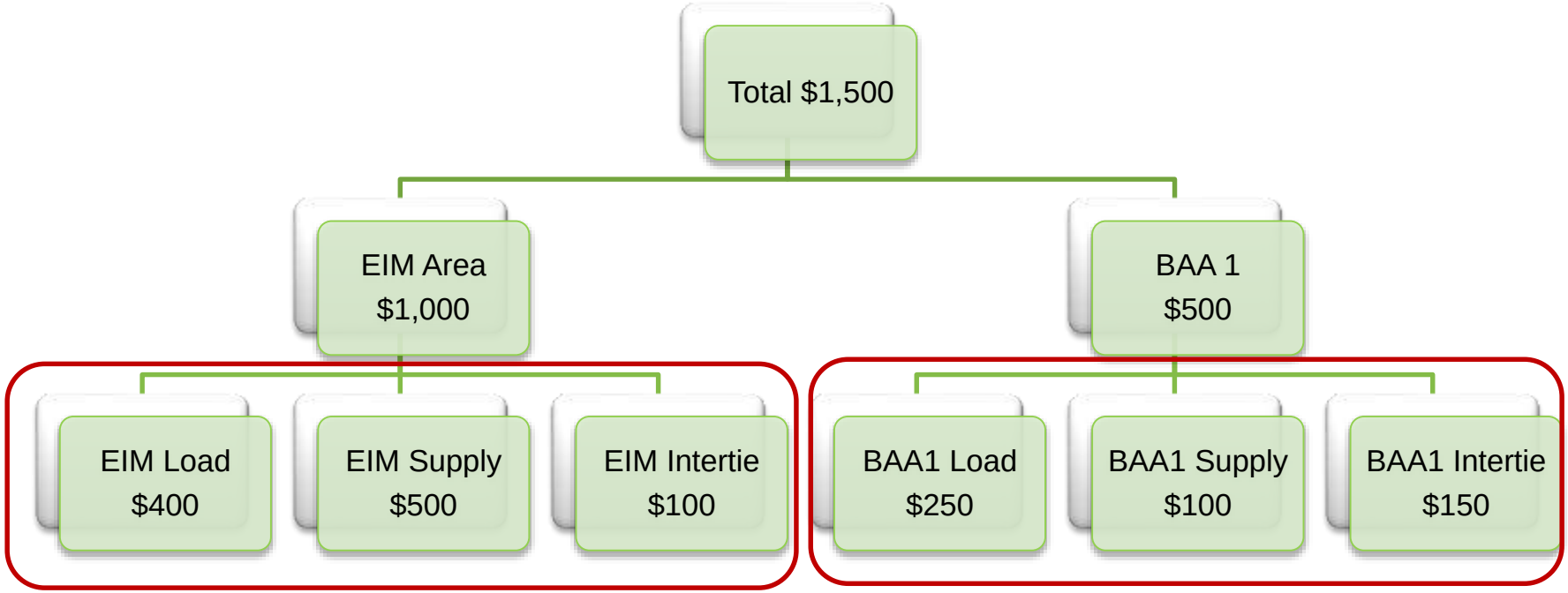
$1,500 = Total uncertainty awards paid in HE1



Total $ are allocated to EIM Area and BAAs based on the constraints a resource resolve. 100 MW x $10 for EIM area; 100 MW x $5 for BAA 1 (see previous example)

Daily flex ramp up allocation example

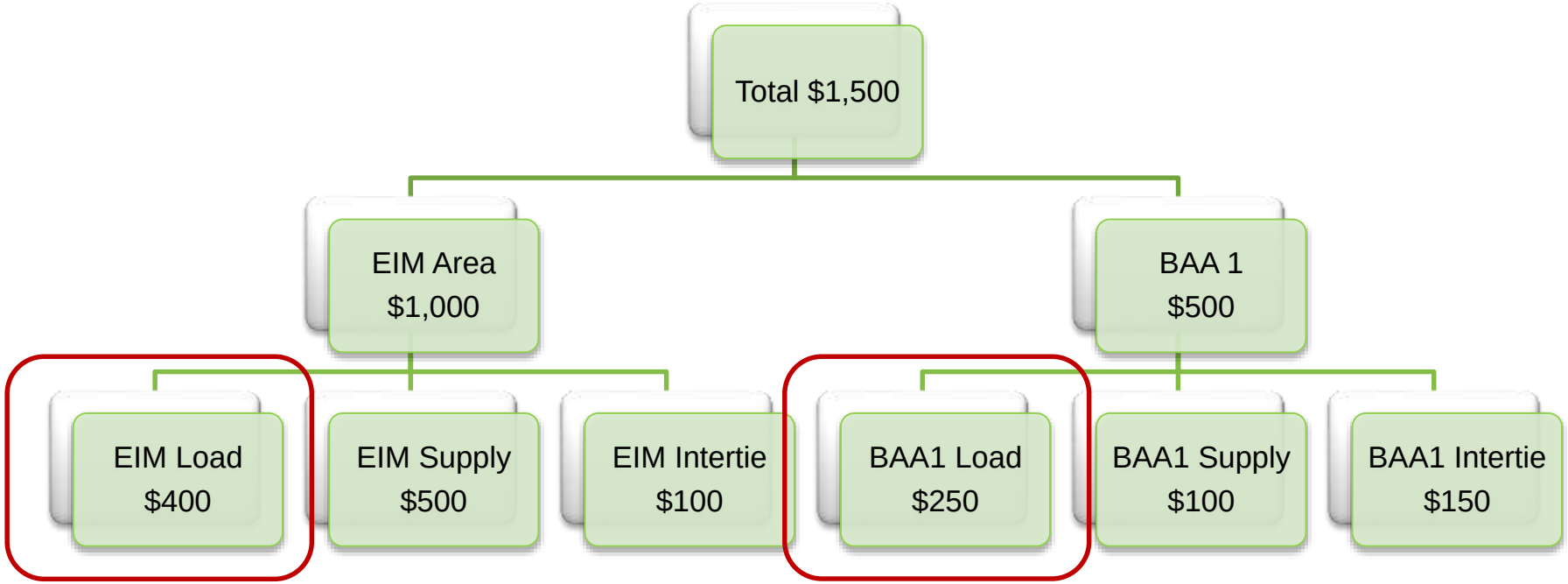
$1,500 = Total uncertainty awards paid in HE1



Relevant constraint costs are allocated to resource category uncertainty movement

Daily flex ramp up allocation example

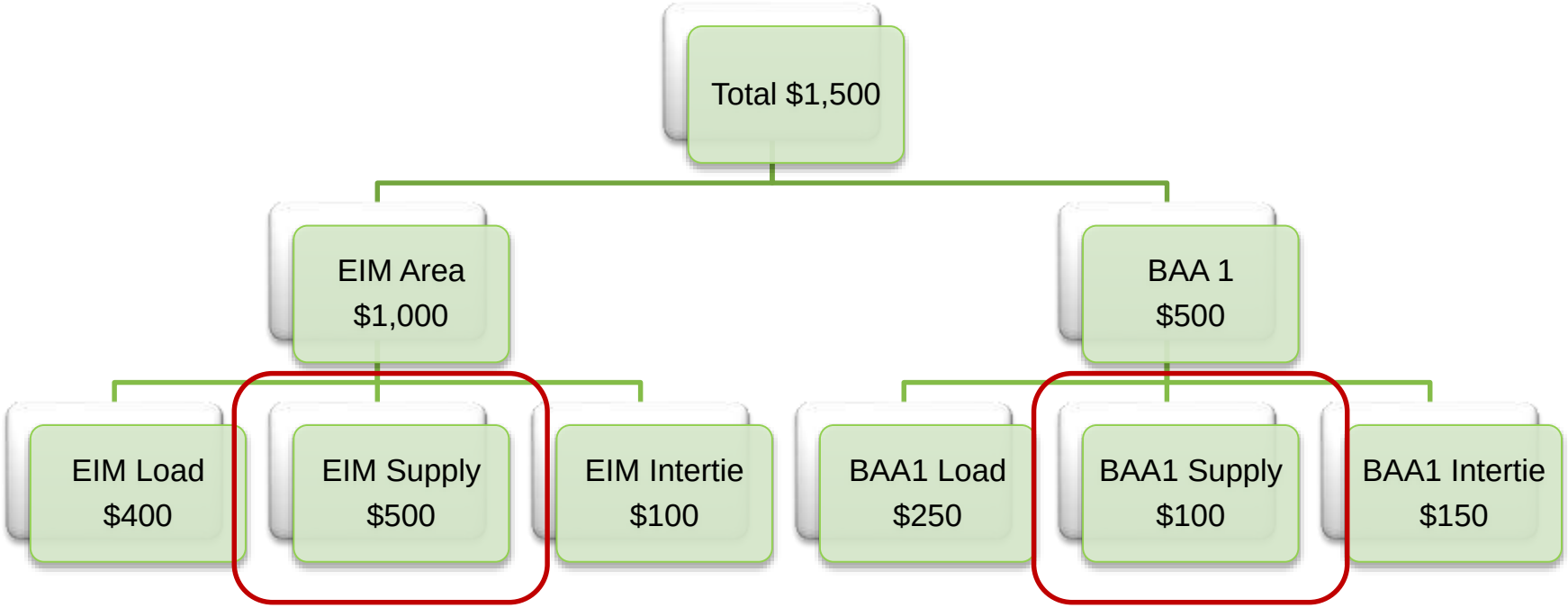
$1,500 = Total uncertainty awards paid in HE1



Uncertainty award cost is allocated in pro-ration to SCs non-participating load where the UIE represents that the metered Demand is greater than Day Ahead Load Schedule or Base Load Schedule

Daily flex ramp up allocation example

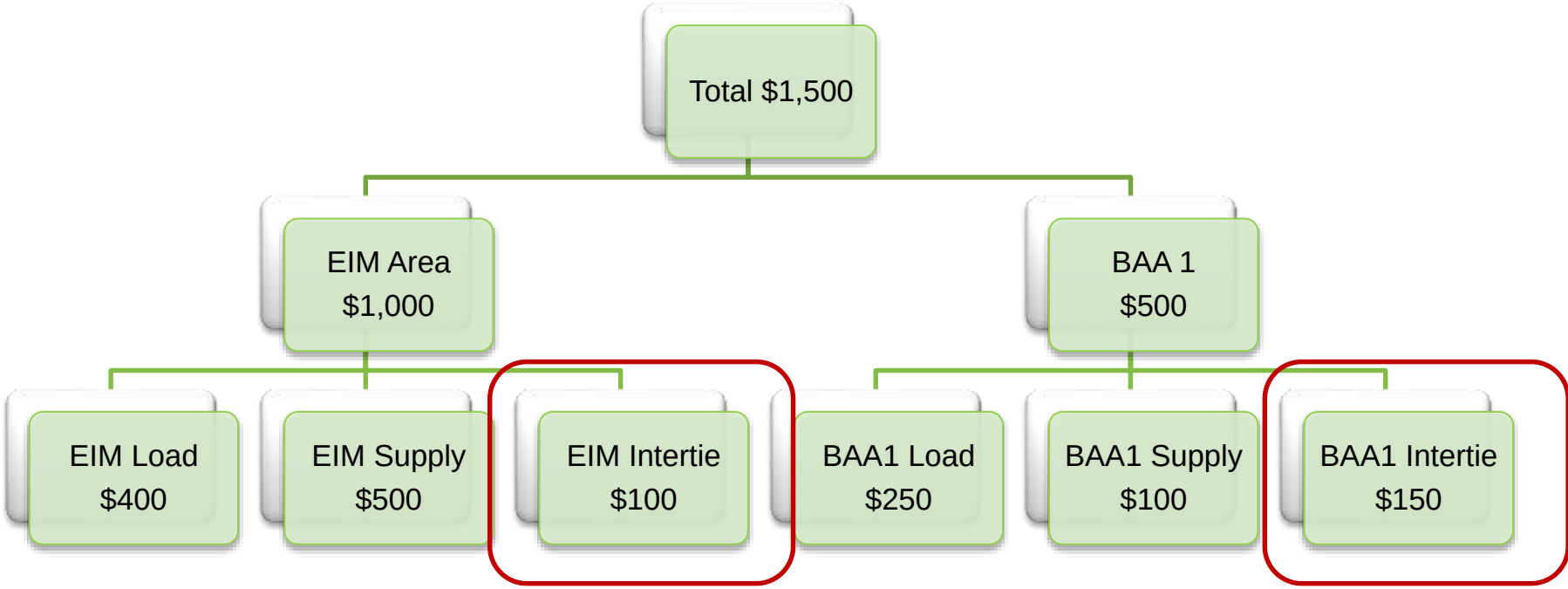
$1,500 = Total uncertainty awards paid in HE1



Uncertainty award cost is allocated to SCs in proportion to the sum of the resources' uncertainty movement and UIE where the total sum represents a decrease in Supply.

Daily flex ramp up allocation example

$1,500 = Total uncertainty awards paid in HE1



Uncertainty award cost is allocated in proration to resources operational adjustment where the operational adjustment represents either an decrease in Import or an increase in Export

Charge Code 7078 – Monthly Flexible Ramp Up Uncertainty Award Allocation

- Performs the same settlements as the daily flexible ramp up award allocation (CC 7077), but on a monthly basis

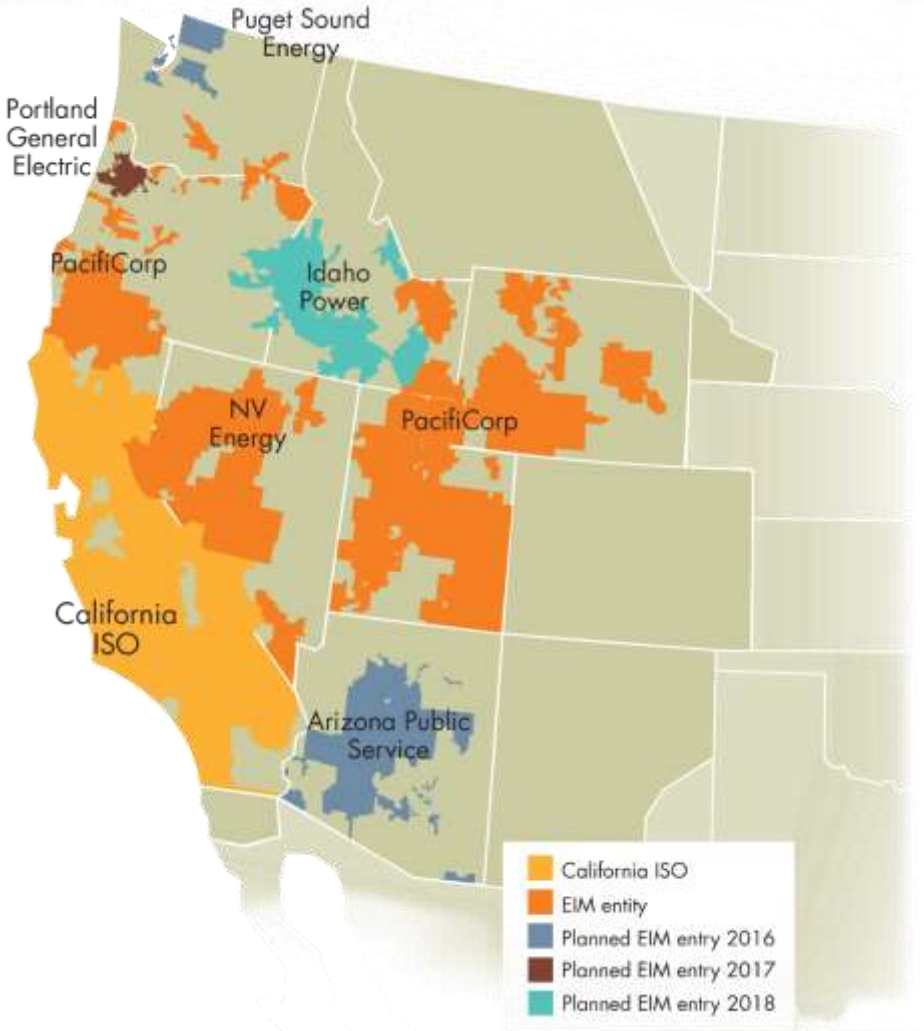
- Results in resettlement of daily allocation with separate monthly allocation amounts determined for peak flexible ramp hours and off-peak flexible ramp hours of the trading month
  - Peak flexible ramp hours - Trading hours from hour ending 7 through hour ending 22
  - Off peak flexible ramp hours - Trading hours from hour ending 1 through hour ending 6 and from hour ending 23 through hour ending 25.

Summary – new charge codes

Charge Code	
7070	Flexible Ramp Forecasted Movement Settlement
7076	Flexible Ramp Forecasted Movement Allocation
7071	Flexible Ramp Up Uncertainty Capacity Settlement
7077	Daily Flexible Ramp Up Uncertainty Allocation
7078	Monthly Flexible Ramp Up Uncertainty Award Allocation
7081	Flexible Ramp Down Uncertainty Capacity Settlement
7087	Daily Flexible Ramp Down Uncertainty Allocation
7088	Monthly Flexible Ramp Down Uncertainty Award Allocation

Summary- retiring charge codes

Charge Code	
7024	Flexible Ramp Up Capacity No Pay Charge
7050	Flexible Ramp Up Capacity Payment
7056	Flexible Ramp Cost Allocation
7057	Monthly Flexible Ramp Supply Cost Allocation Reversal
7058	Monthly Flexible Ramp Supply Cost Allocation


Puget Sound Energy
Portland General Electric
PacifiCorp
Idaho Power
NV Energy
PacifiCorp
California ISO
Arizona Public Service
California ISO
EIM entity
Planned EIM entry 2016
Planned EIM entry 2017
Planned EIM entry 2018

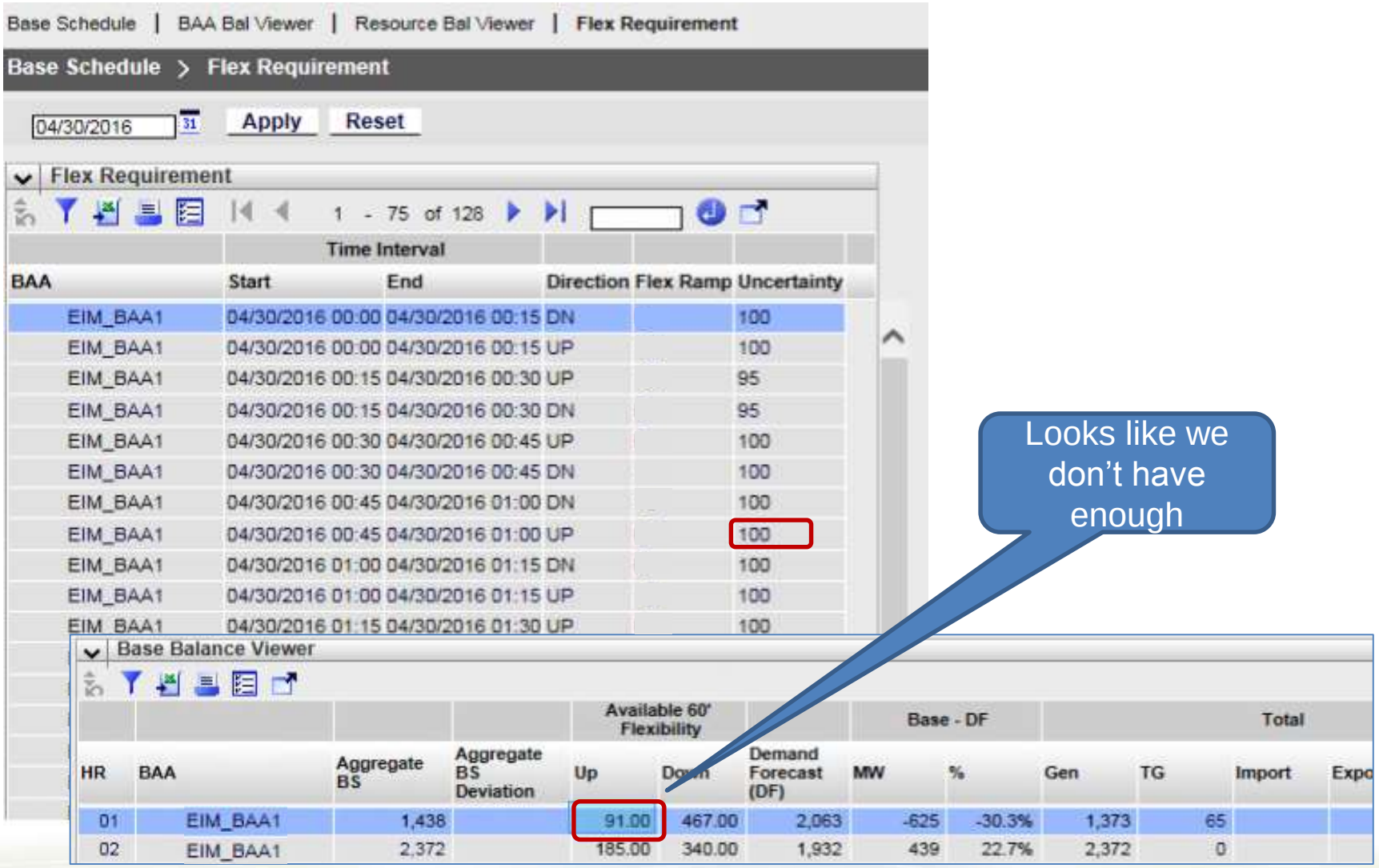
EIM changes

Objective

Given that there are submitted bids and base schedules for a future hour, interpret data to ensure there is adequate capacity to pass the flexible ramping sufficiency evaluation.

Adjust bids or base schedules according to ramping capabilities of available resources.

BSAP – Flex Requirement Screen & Base Balance Viewer

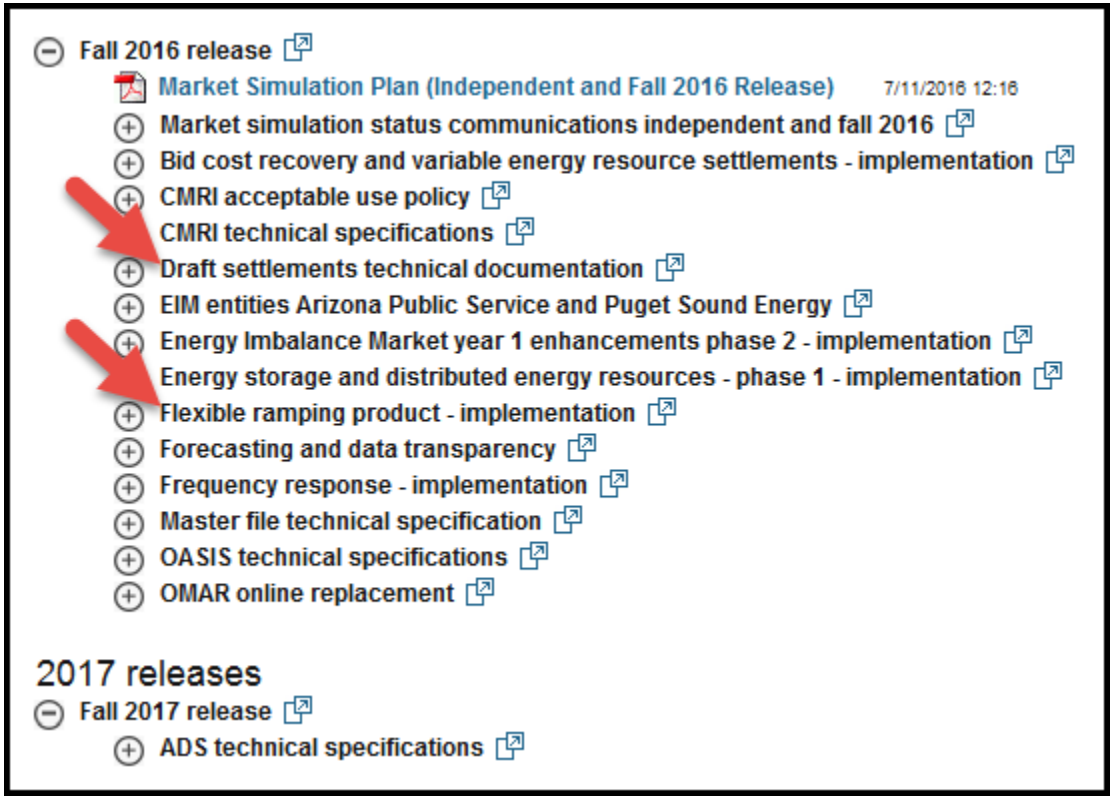


EIM summary

- In BSAP Flex Ramp screen shows you the forecasted movement and uncertainty for future hours.
  - Use this to determine if you have enough bids in to pass the flex ramping requirement sufficiency evaluation
- Flexible ramping requirements sufficiency evaluation
  - Test include both flex ramp up and flex ramp down
  - If you do not pass this test, the BA transfer will be held a the same level it had last hour
  - Prevents leaning on other BAs

For more information:

- Release Planning page on caiso.com
  - http://www.caiso.com/informed/Pages/ReleasePlanning/Default.aspx



Thank You