Flexible Ramping Products Straw Proposal

Incorporating FMM and EIM

Lin Xu, Ph.D.
Lead Market Development Engineer

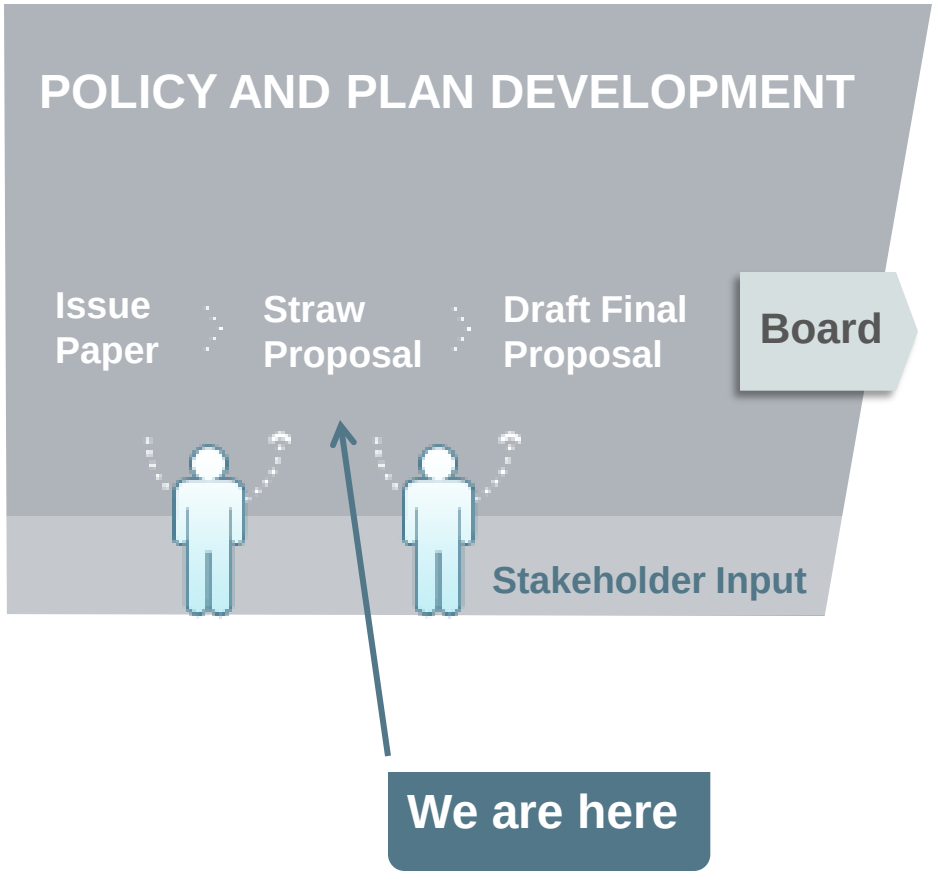
Don Tretheway
Lead Market Design and Policy Specialist

June 9, 2014

Agenda

Time	Topic	Presenter
10:00 – 10:15	Introduction	Kristina Osborne
10:15 – 12:00	Market Design Overview	Don Tretheway
12:00 – 1:00	Lunch	
1:00 – 2:45	Up and Down Examples	Lin Xu
2:45 – 3:15	Cost Allocation Proposal	Don Tretheway
3:15 – 3:50	EIM Downward Sufficiency Test	Don Tretheway
3:50 – 4:00	Wrap-up and Next Steps	Kristina Osborne

ISO Policy Initiative Stakeholder Process

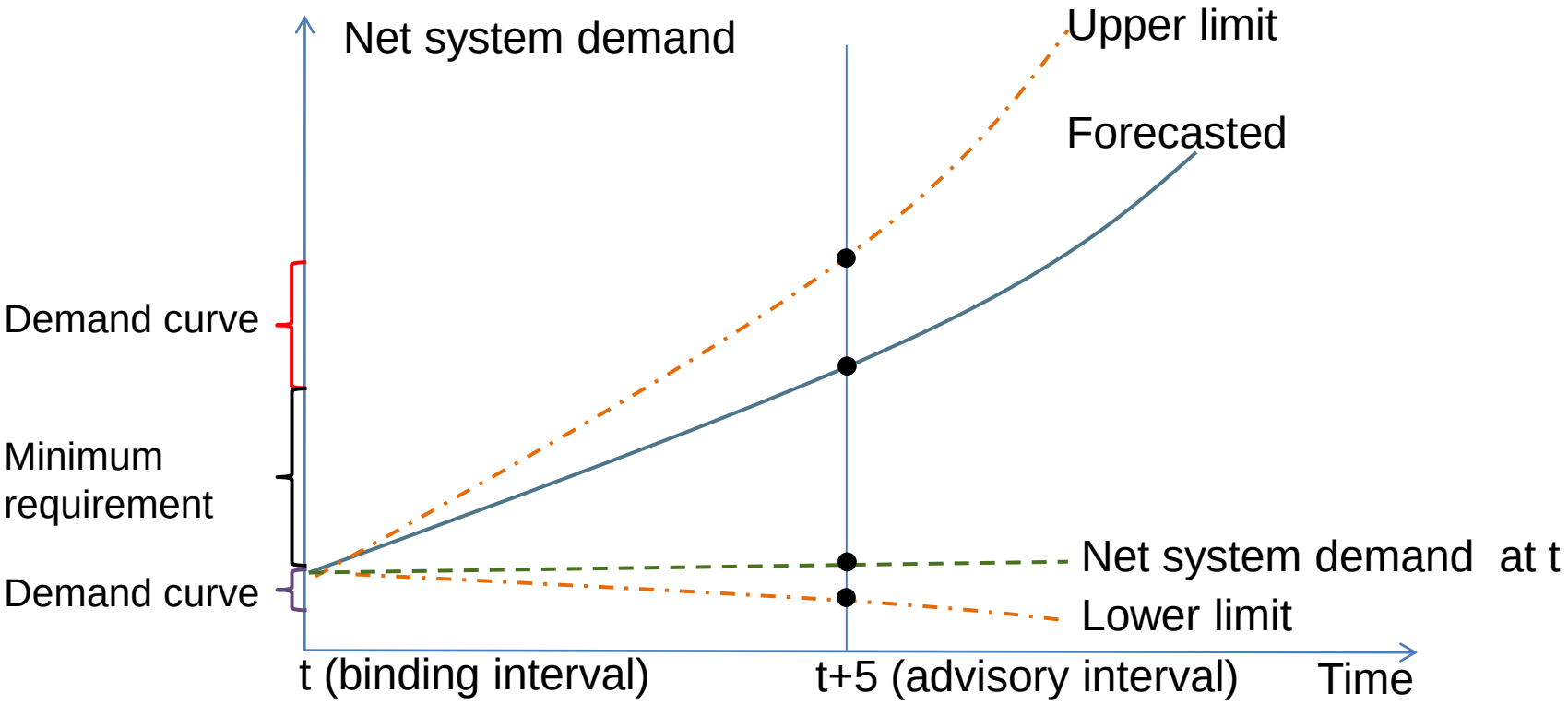


Flexible ramping product ensures sufficient ramping capability available to manage the grid

- Secures capacity in the day-ahead market, fifteen-minute market and real-time dispatch
- Compensates resources whose dispatch is held back in financially binding interval to meet future ramping needs
- Allocates costs to self-schedule movement and uninstructed imbalance energy who drive requirement
- Must procure real ramp between intervals, but use demand curves to meet variability and uncertainty

Flexible Ramping Product to meet Real Ramping Need

Net system demand = load + export – import – internal self-schedules - supply deviations

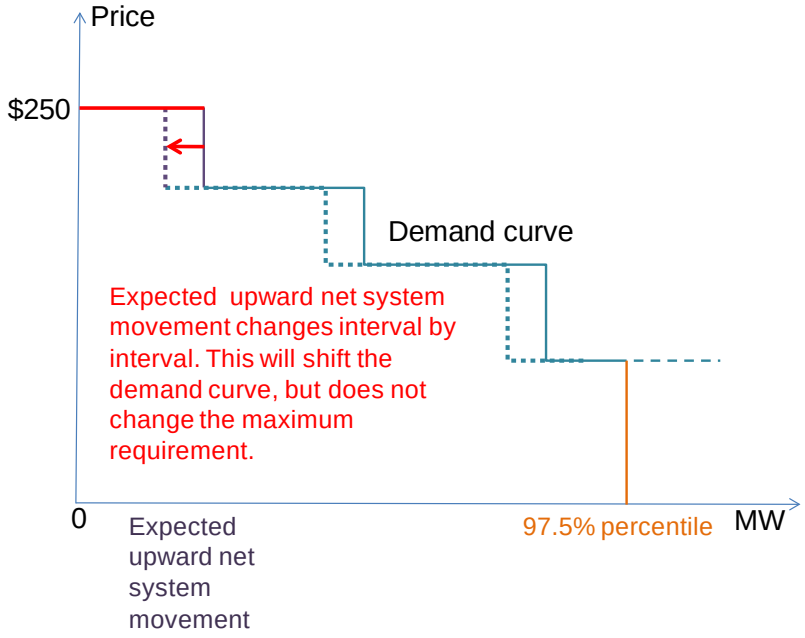


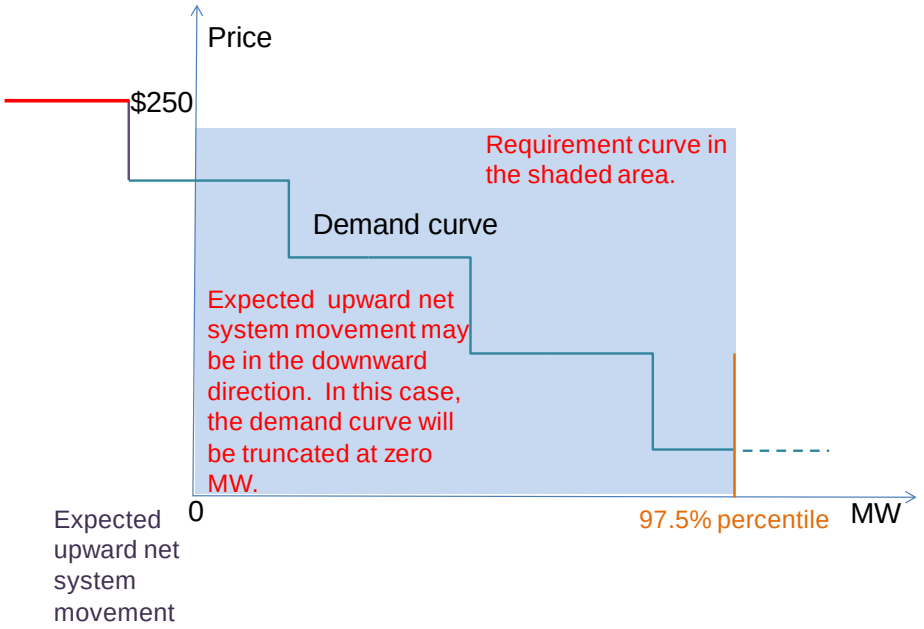
Real ramping need:

Potential net load change from interval t to interval t+5 (net system demand t+5 – net system demand t)

Use of demand curves to procure flexible ramping to meet uncertainty and variability of net load

Flexible Ramping Up Demand Curve





Upward Expected Ramp

Downward Expected Ramp

Traditional ancillary services are inefficient at meeting operational needs for flexibility

- Regulation can address uncertainty, but should only be used for uncertainty that materializes after RTD
  - Uncertainty before RTD should be reflected in RTD price
  - Regulation is not available for dispatch, could make PBV worse
  - Regulation energy is paid the RTD price for energy
- Spinning reserves are dispatched to meet contingency events, flexible ramping routinely dispatched
  - Double payment since energy opportunity cost in A/S price

Day ahead procurement target

- ISO will procure forecast of real-time requirement in IFM with demand curves
- Allows commitment of long start units
- Integrated IFM/RUC will be a separate stakeholder initiative with implementation targeted for Fall 2016

Flexible ramping product bidding

- If resource provides RA, must bid $0.00 for flexible ramping up and flexible ramping down in IFM
- If bidding for non-RA resources allowed in IFM, then
  - Bid range between $0.00 and $250.00
- No self-provision of flexible ramping products
- No bidding in FMM and RTD

Flexible ramping settlement mechanics is similar to energy

- Day-ahead award settled at the DA price
- FMM award – DA award settled at the FMM price
- RTD award – FMM award settled at the RTD price

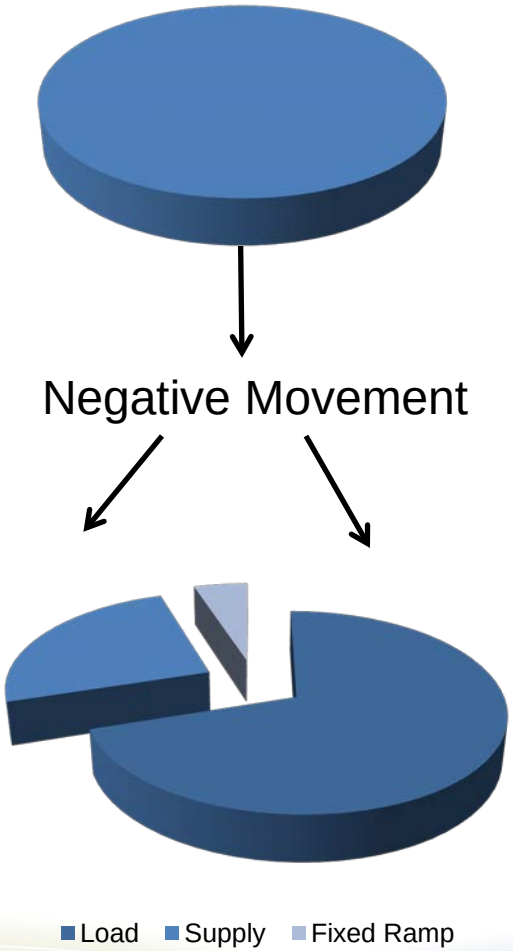
No-pay applies when ramp capability is not maintained

- Un-dispatchable capability
- Undelivered capability
- Unavailable capability
- Unsynchronized capability

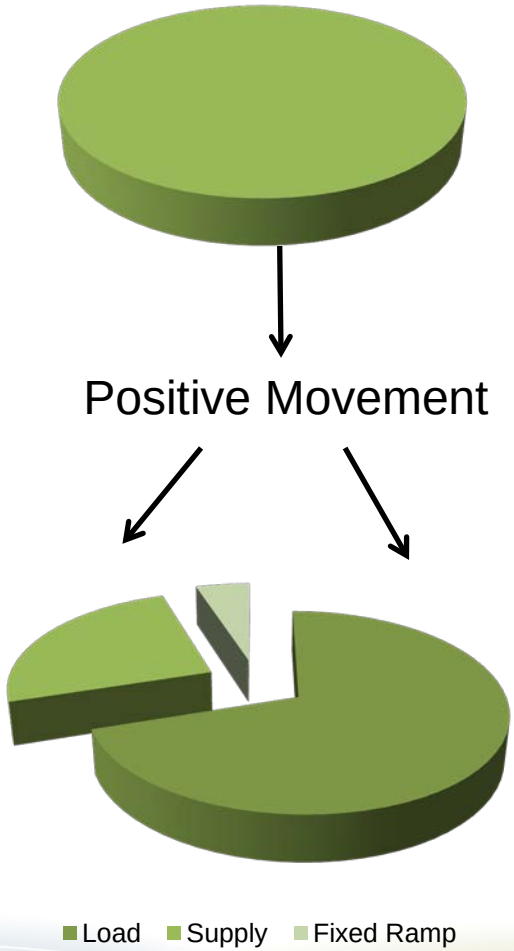
- No pay is credited against constraint costs prior to cost allocation

Allocate flexible ramping product costs consistent with guiding principles

Flexible Ramping Up



Flexible Ramping Down

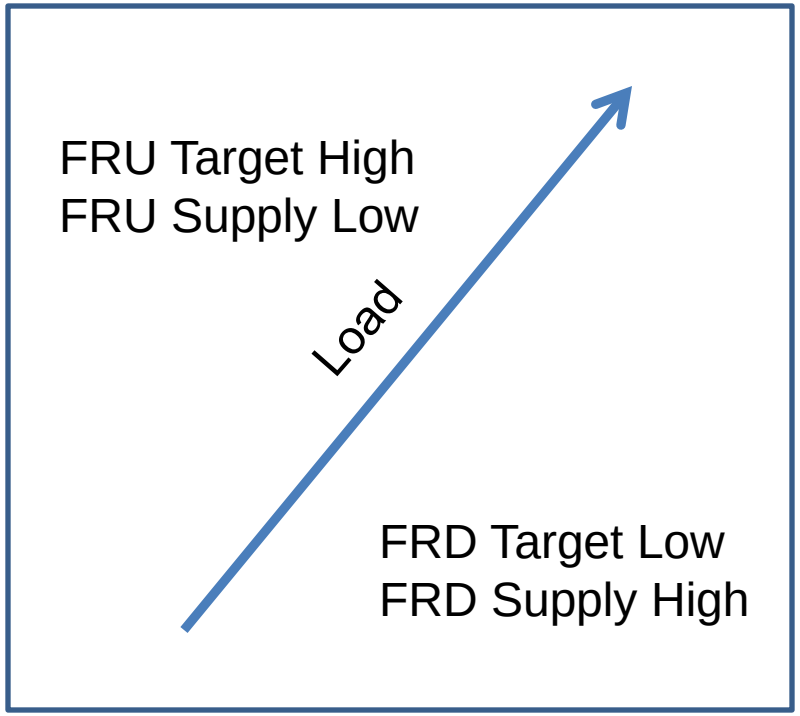


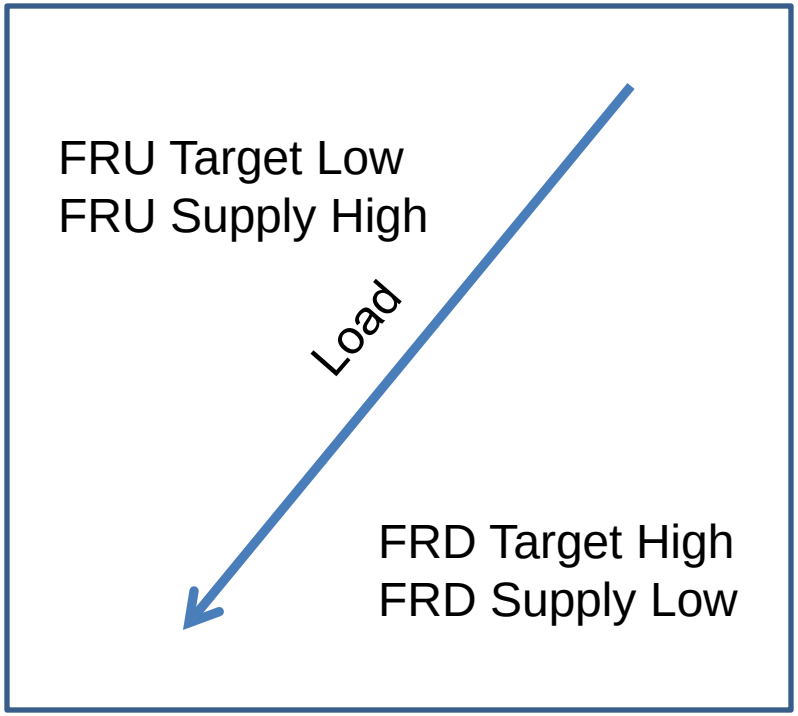
Movement is the 5 minute change

Initial Pie Slice

			Metric
1	Load	Net Across LSEs	Change in 5 Min Observed Load
2	Variable Energy Resource	Net Across all Supply	Change in 5 Min UIE + SS Delta
	Internal Generation		Change in 5 Min UIE + SS Delta
	Dynamic Transfers		Change in 5 Min UIE
3	Fixed Ramp – Static Interties & Self-Schedules	Net Across all SCs 20 Minute and 10 Minute Ramp Modeled	Change in MWh deemed delivered

Expectation of relative cost of flexible ramping up versus flexible ramping down





A resource following load should see lower relative cost allocation if deviation/movement in direction of load pull

Flexible ramping product ensures sufficient ramping capability available to manage the grid

- Secures capacity in the day-ahead market, fifteen-minute market and real-time dispatch
- Compensates resources whose dispatch is held back in financially binding interval to meet future ramping needs
- Allocates costs to self-schedule movement and uninstructed imbalance energy who drive requirement
- Must procure real ramp between intervals, but use demand curves to meet variability and uncertainty

Upward Scenario 1 and scenario 2

Generator data

Gen	EN Bid	FRU bid	FRD bid	En init	Ramp rate	Pmin	Pmax
G1	25	0	0	400	100	0	500
G2	30	0	0	0	10	0	500

EN – energy FRU – flexible ramping up FRD – flexible ramping

Scenario 1: no flex ramp

	Interval t (LMP=$25)		
gen	Energy	Flex-ramp up	Flex-ramp down
G1	420		
G2	0		

Scenario 2: with flex ramp

	Interval t (LMP=$30, FRUP=$5)		
gen	Energy	Flex-ramp up	Flex-ramp down
G1	380	120	
G2	40	50	

Upward Scenario 3: look ahead without flex ramp

	Interval t (LMP=$25)			Interval t+5 (LMP=$35)		
gen	Energy	Flex-ramp up	Flex-ramp down	Energy	Flex-ramp up	Flex-ramp down
G1	380			500		
G2	40			90		

- Price consistency
  - Price consistent with bid over the horizon, but not on single interval basis
  - How about price consistency over time (from interval t to t+5)?
    - If net system demand is slightly lower in RTD interval t+5, the binding RTD LMP for interval t+5 will be $30 set by G2. In this case, price is inconsistent for g2 ($25 in interval t and $30 in interval t+5), and needs bid cost recovery.
    - If net system demand is slightly higher in RTD interval t+5, the binding RTD LMP for interval t+5 will be $1000 due to power balance violation. In this case, we do not need bid cost recovery. However, we should have created more ramping capability in interval t at a much lower than $1000 to prevent the power balance violation. That is the value of having flex ramp.

Upward Scenario 4: look ahead with flex ramp

	Interval t (LMP=$30, FRUP=$5)			Interval t+5 (LMP=$30)		
gen	Energy	Flex-ramp up	Flex-ramp down	Energy	Flex-ramp up	Flex-ramp down
G1	379.99	120.01		500		
G2	40.01	50		90		

- Price consistency is maintained for both intervals with flex ramp requirement slightly higher than the expected system movement
  - How about price consistency over time (from interval t to t+5)?
    - If net system demand is slightly lower in RTD interval t+5, the binding RTD LMP for interval t+5 will be $30 set by G2. In this case, price ($30 in interval t and $30 in interval t+5) is consistent with bid over time.
    - If net system demand is slightly higher in RTD interval t+5, the higher demand can be met by the extra ramping capability from G1, and the binding RTD LMP for interval t+5 will still be $30. In this case, price is also consistent with bid over time without creating price spikes.
  - Of course, these benefits of flex ramp have associated cost ($5/MWh). We need to evaluate the cost against the benefit of reducing price spikes.

Downward Scenario 1 and scenario 2

Generator data

Gen	EN Bid	FRU bid	FRD bid	En init	Ramp rate	Pmin	Pmax
G1	25	0	0	300	10	0	500
G2	30	0	0	100	100	0	500

Scenario 1: no flex ramp

	Interval t (LMP=$30)		
gen	Energy	Flex-ramp up	Flex-ramp down
G1	350		
G2	30		

Scenario 2: with flex ramp

	Interval t (LMP=$30, FRUP=$5)		
gen	Energy	Flex-ramp up	Flex-ramp down
G1	380	120	
G2	40	50	

Downward Scenario 3: look ahead without flex ramp

	Interval t (LMP=$30)			Interval t+5 (LMP=$20)		
gen	Energy	Flex-ramp up	Flex-ramp down	Energy	Flex-ramp up	Flex-ramp down
G1	260			210		
G2	120			0		

- Price consistency
  - Price consistent with bid over the horizon, but not on single interval basis
  - How about price consistency over time (from interval t to t+5)?
    - If net system demand is slightly higher in RTD interval t+5, the binding RTD LMP for interval t+5 will be $25 set by G2. In this case, price ($30 in interval t and $25 in interval t+5) is higher than g1's bid.
    - If net system demand is slightly lower in RTD interval t+5, the binding RTD LMP for interval t+5 will be -$150 due to power balance violation. In this case, price is not consistent for G1 ($30 in interval t and -$150 in interval t+5), and we need bid cost recovery for G1.

Downward Scenario 4: look ahead with flex ramp

	Interval t (LMP=$25, FRDP=$5)			Interval t+5 (LMP=$25)		
gen	Energy	Flex-ramp up	Flex-ramp down	Energy	Flex-ramp up	Flex-ramp down
G1	259.99		50	210		
G2	120.01		120.01	0		

- Price consistency is maintained for both intervals with flex ramp requirement slightly higher than the expected system movement
  - How about price consistency over time (from interval t to t+5)?
    - If net system demand is slightly higher in RTD interval t+5, the binding RTD LMP for interval t+5 will be $25 set by G2. In this case, price ($25 in interval t and $25 in interval t+5) is consistent with bid over time.
    - If net system demand is slightly lower in RTD interval t+5, the lower demand can be met by the extra downward ramping capability, and the binding RTD LMP for interval t+5 will still be $25. In this case, price is also consistent with bid over time without creating price spikes or bid cost recovery.
  - Of course, these benefits of flex ramp have associated cost ($5/MWh). We need to evaluate the cost against the benefit of reducing price spikes.

Flexible ramping product settlement example

Similar to how energy is settled

G1	Schedule (MW)		Price ($/MWh)		Delta/unavailable FRU (MWh)		Settlement ($)		
Time	7:00	7:05	7:00	7:05	7:00	7:05	7:00	7:05	Total
IFM	20	20	5	5			8.33	8.33	16.67
FMM	15	15	6	6	–5/12	–5/12	–2.5	–2.5	–5
RTD	6	9	0	10	–9/12	–6/12	0	–5	–5
Actual	7	7	0	10	1/12	–2/12	0	–1.67	–1.67
Total									5

Cost Allocation – Align movement and metering

- DA, FMM, RT FRP costs initially split in to three categories based upon net movement
  - Day ahead costs only in ISO allocated to ISO
- Allocate each category according to rules for that category
- ISO resources, EIM participating resources and EIM non-participating resources all according to categories and within categories

Other Design Elements

- Hourly rate and allocation
- Monthly resettlement at monthly, hourly rate
- Costs allocated at a BAA level
  - If sub-BAA constraints for deliverability, then summed for BAA
  - Shared EIM constraints split pro-rata based upon individual BAA requirement

Allocation of each category

		Baseline	Actual	Deviation	Allocation
1	Load	Day-Ahead Schedule	Metered Demand	UIE	Gross Deviation
2	Variable Energy Resource	Instruction	5 Minute Meter	Delta SS + UIE	Gross Deviation Outside Threshold
	Generation with Instructed Energy	Instruction	5 Minute Meter	UIE	Gross UIE Outside Threshold
	Generation with Self Schedule	N/A	N/A	Delta hourly SS + UIE	Gross Deviation Outside Threshold
	Dynamic Transfers	Instruction	5 Minute Meter	UIE	Gross UIE Outside Threshold
3	Fixed Ramp Interties	Ramp Modeled	Assumed Delivered	Net Movement + OA	Gross by SC

No netting across 5-minute settlement intervals.

Treatment of EIM flexible ramping hierarchical constraints (no change to current upward approach)

- Calculate the cost for each constraint
- Credit no-pay for each constraint
- Split costs of combined constraints pro-rata based upon individual BAA requirements

Each BAA has a flexible ramping requirement to meet their potential dispatch independently

- Ensures sufficient ramp capability is available in RTUC and manages ramp capability in RTD
  - Flexible ramping product is upward and downward
- Flexible ramping requirement for each EIM Entity BAA sufficiency test recognizes diversity benefit and EIM transfers out
  - Requirement must be met in the hourly resource plan
- Market optimization selects for most efficient resources to meet the system requirement
  - EIM Entity SC allocated the cost of meeting BAA constraints

Downward flexible ramping sufficiency test considers diversity benefit and EIM transfers in

- Performed for each EIM Entity BAA
  - After T−75', T−55', and T−40' for the Trading Hour starting at T
  - Data Used:
    - Initial schedules at T−7.5’
    - EIM resources energy bids and ramp rates
    - BAA flexible ramping requirement
      - Credit for diversity benefit up to export capability
      - Credit for EIM transfers in at T-7.5’
- Cumulative test for each 15' interval of the hour
  - 15' ramp from T−7.5' to T+7.5' (1st 15' interval)
  - 30' ramp from T−7.5' to T+22.5' (2nd 15' interval)
  - 45' ramp from T−7.5' to T+37.5' (3rd 15' interval)
  - 60' ramp from T−7.5' to T+52.5' (4th 15' interval)

Market optimization constraint formulation uses all available export capability to minimize system cost

- When Flexible Ramping Sufficiency Test Passes
  - Bottom-Up hierarchical constraints for all BAA combinations
  - BAA (w/o diversity benefit) requirement reduced by total available import capability
- When Downward Flexible Ramping Sufficiency Test Fails
  - Failed EIM BAA is excluded from group constraints for downward, can still pass upward
  - Net Export Interchange for failed EIM BAA is capped at last schedule for T−7.5‘
- Allow for loop flow through EIM Entities that fail Flexible Ramping Sufficiency Test

Next Steps

Item	Date
Post Straw Proposal	June 2, 2014
Stakeholder Meeting	June 9, 2014
Stakeholder Comments Due	June 23, 2014
Post Revised Straw Proposal	August 13, 2014
Stakeholder Meeting	August 20, 2014
Stakeholder Comments Due	September 3, 2014
Post Draft Final Proposal	September 23, 2014
Stakeholder Conference Call	September 30, 2014
Stakeholder Comments Due	October 14, 2014
Board of Governors Meeting	December 18-19, 2014

Please submit comments to FRP@caiso.com by June 23