Flexible Ramping Products Straw Proposal

Incorporating FMM and EIM

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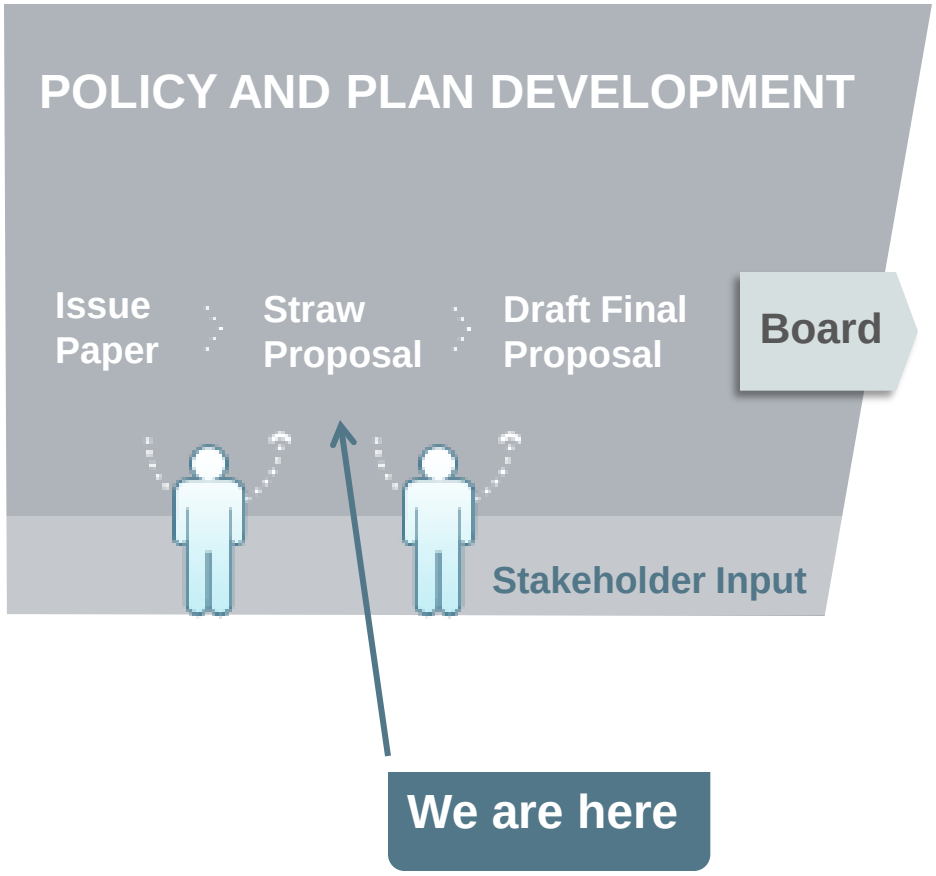
Agenda

Time	Topic	Presenter
10:00 – 10:15	Introduction	Kristina Osborne
10:15 – 11:00	Changes from Straw Proposal	Don Tretheway
11:00 – 12:00	Bidding and Must Offer Obligation	Don Tretheway
12:00 – 1:00	Lunch	
1:00 – 2:30	Requirement Calculation	Don Tretheway
2:30 – 3:15	Demand Curve Calculation	Lin Xu
3:15 – 3:50	Cost Allocation Proposal	Don Tretheway
3:50 – 4:00	Wrap-up and Next Steps	Kristina Osborne

ISO Policy Initiative Stakeholder Process



Flexibility is how the fleet moves from hourly schedules to meet actual real-time system conditions

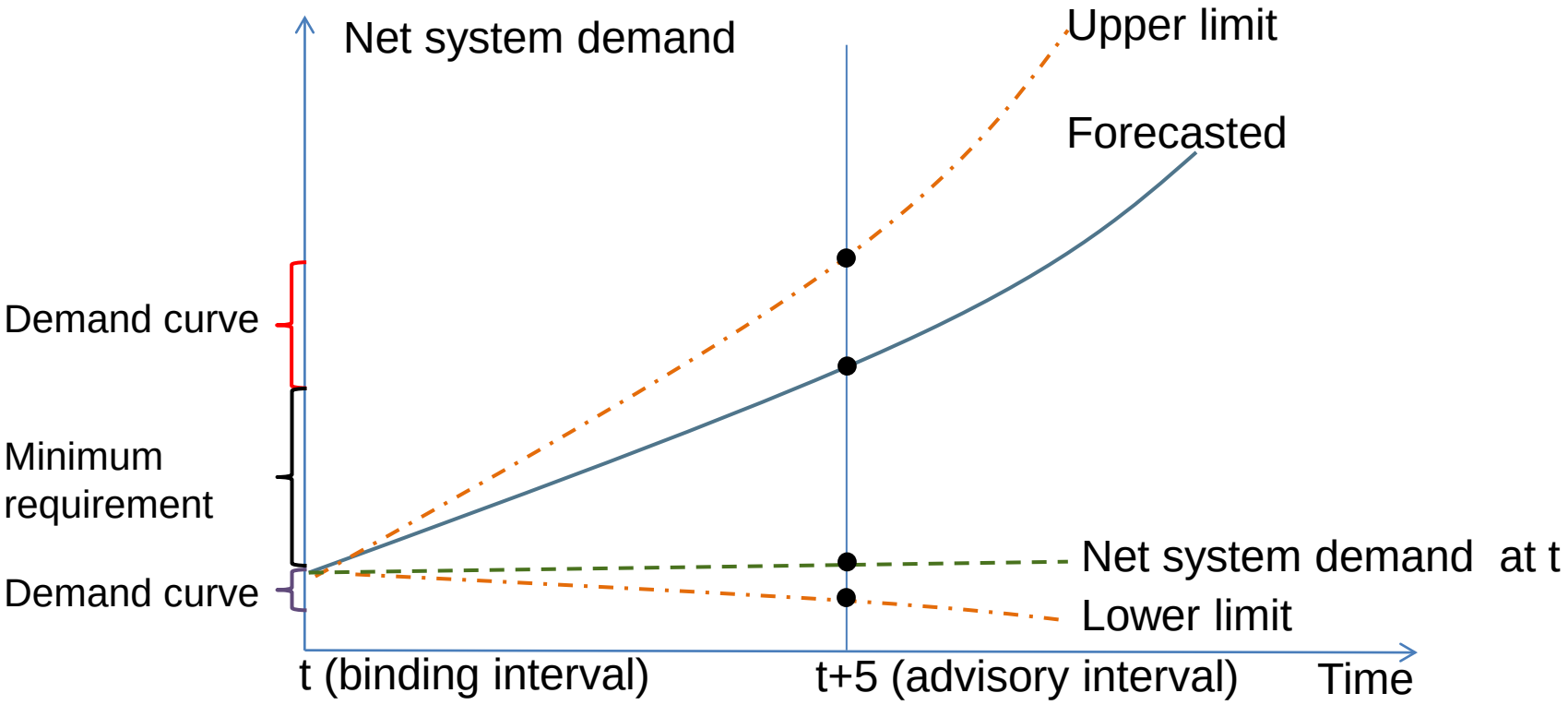
- Real-time economic bids
- FMM
  - Real-time unit commitment
  - 15-minute intertie scheduling
- RTD
  - Flexible ramping product
- Regulation

Flexible ramping product ensures sufficient ramping capability in RTD 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)

Changes to straw proposal (1 of 3)

- In the day-ahead market, the bid price for all resources is set at $0.00. Scheduling coordinators can enter a zero MW bid to prevent the resource from being awarded flexible ramping products in the day-ahead market.

- Modified the day-ahead market must offer obligation for resource capacity used to meet flexible capacity resource adequacy requirements. Resources with resource adequacy flexible capacity must bid a MW quantity in IFM greater than or equal to its amount of resource adequacy flexible capacity.

Changes to straw proposal (2 of 3)

- Added a forward looking approach to establish price points on flexible ramping product demand curve.
- Provided more detailed discussion on the process for setting flexible ramping requirements in the IFM, FMM and RTD.
- Clarified the settlement of energy resulting from re-dispatch necessary to support a flexible ramping award. This energy will be settled at the LMP, unlike ramping energy which is settled at bid.

Changes to straw proposal (3 of 3)

- Modified treatment of modeled ramps in RTD resulting from real-time unit commitment and economically bid 15-minute market import/exports in determining the flexible ramping requirement and cost allocation.

- Included additional cost allocation discussion of the monthly resettlement process, added day-ahead procurement costs from ISO resources in cost allocation of EIM constraints, and developed rule if initial hourly cost allocation to categories cannot be made.

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Bidding rules

Flexible ramping product bidding

- If resource provides flexible RA, must bid MW quantity for flexible ramping up and flexible ramping down in IFM
  - Minimum MW = flexible RA award that is dispatchable in RTD
  - Price is $0.00
  - FRP is limited to the MW bid, which can be less than the bid range
- No bidding in FMM and RTD
  - Entire bid range is available for FRP
- No self-provision of flexible ramping products

Example for IFM

- Resource Assumptions
  - 300MW Pmax
  - 100MW Pmin
  - System RA = 250MW
  - Flexible RA = 150MW (Note: Pmin counts)
- Minimum Flexible Ramping Product MW bid = 50MW
  - Pmin is not available for RTD
  - So, 150MW – 100MW = 50MW
- SC can bid up to 200MW of FRP

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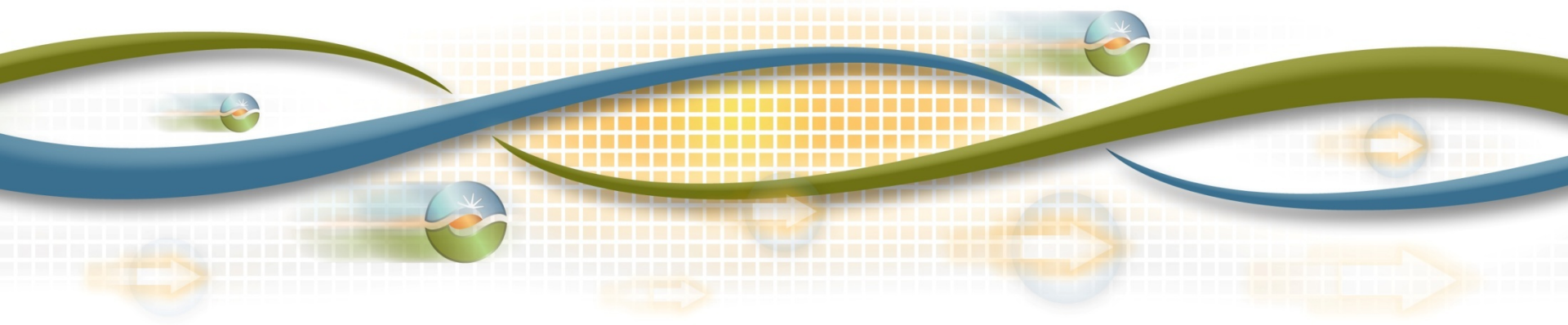
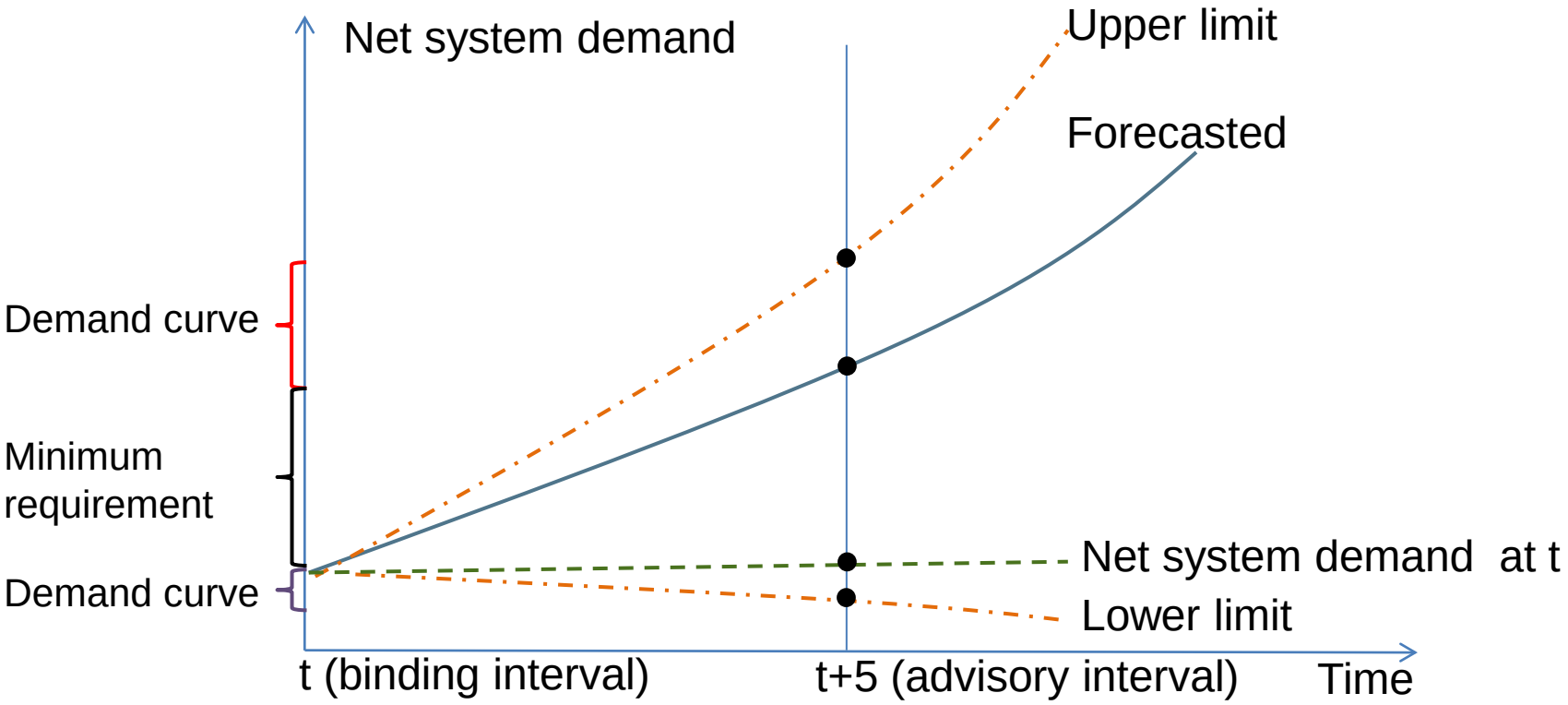
Procurement Requirement Calculation



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)

Procurement requirement calculation (1 of 7)

1. Develop a 5-minute granular forecast of gross load, wind/solar production and hourly interchange schedules.
   - The model will also have the capability to exclude variable energy resources that submit economic bids from this step and consider them separately since they can be dispatched in RTD.

2. Determine the resource specific 5-minute ramps that result from RTUC that will be modeled in RTD
   - Such as unit start-up/shutdown and multi-stage generation transitions.
   - This also includes the 10-minute ramp from 15-minute economically scheduled imports/exports.

Procurement requirement calculation (2 of 7)

3. Determine a 5-minute RTD imbalance requirement by netting the gross load forecast by the wind/solar production forecasts, hourly interchange schedules and excluding the generation and 15-minute intertie modeled ramps in RTD.

4. Develop a series of 5-minute RTD imbalance requirement by introducing forecast error uncertainty based on historical forecast error pattern for each 5-minute interval of the day.
   - Propose a rolling 30 days, with adjustments for weekends and holidays, to evaluate historical advisory RTD imbalance requirement error pattern.
   - The look back period will be configurable.

Procurement requirement calculation (3 of 7)

5. Develop a distribution of the changes in the 5-minute RTD imbalance requirement by calculating the difference between the advisory RTD imbalance requirement at time (t+5 minute) by the binding RTD imbalance requirement at time (t) for each 5-minute interval of the day.

6. Analyze the distribution of changes in 5-minute RTD imbalance requirement and identify the +/-X% confidence level of the distribution for each 5-minute interval of the day.
   - The ISO has proposed a 90%-95% confidence level as the appropriate level for establishing the upper and lower limits

Procurement requirement calculation (4 of 7)

7. The above process is performed individually for each BAA and in aggregate for the combined EIM footprint.

8. In the financially binding interval of RTD, the flexible ramping up
   - Total requirement will be equal to the upper limit less the RTD imbalance energy in the binding interval, but cannot be less than zero.
   - Assuming the total up requirement is positive, the minimum requirement is the RTD imbalance energy in the advisory interval less the RTD imbalance energy in the binding interval.
   - The demand curve requirement is the upper limit less RTD imbalance energy in the advisory interval.

Procurement requirement calculation (5 of 7)

9. In the financially binding interval of RTD, the flexible ramping down
   - Total requirement will be equal to the RTD imbalance energy in the binding interval less the lower limit, but cannot be less than zero.
   - Assuming the total down requirement is positive, the minimum requirement is the RTD imbalance energy in the binding interval less the RTD imbalance energy in the advisory interval.
   - The demand curve requirement is the RTD imbalance energy in the advisory interval less the lower limit.

Procurement requirement calculation (6 of 7)

- For the purpose of procurement on a 15-minute basis in FMM
  - The maximum upper limit from the relevant three 5-minute intervals less the average 5-minute RTD imbalance energy from the prior 15-minute interval will establish the total flexible ramping up requirement.
  - The average 5-minute RTD imbalance energy from the prior 15-minute interval less the minimum lower limit from the relevant three 5-minute intervals establish the total flexible ramping down requirement.
  - Since the ISO load forecast is used in FMM and not bid in demand, will split the total requirement between the minimum requirement and demand curve requirement.

Procurement requirement calculation (7 of 7)

- For the purpose of procurement on a hourly basis in IFM, the entire requirement will be met through a demand curve.
  - The maximum upper limit from the relevant twelve 5-minute intervals less the average 5-minute RTD imbalance energy from the prior hour will establish the flexible ramping up requirement.
  - The average 5-minute RTD imbalance energy from the prior hour less the minimum lower limit from the relevant twelve 5-minute intervals establish the flexible ramping down requirement.

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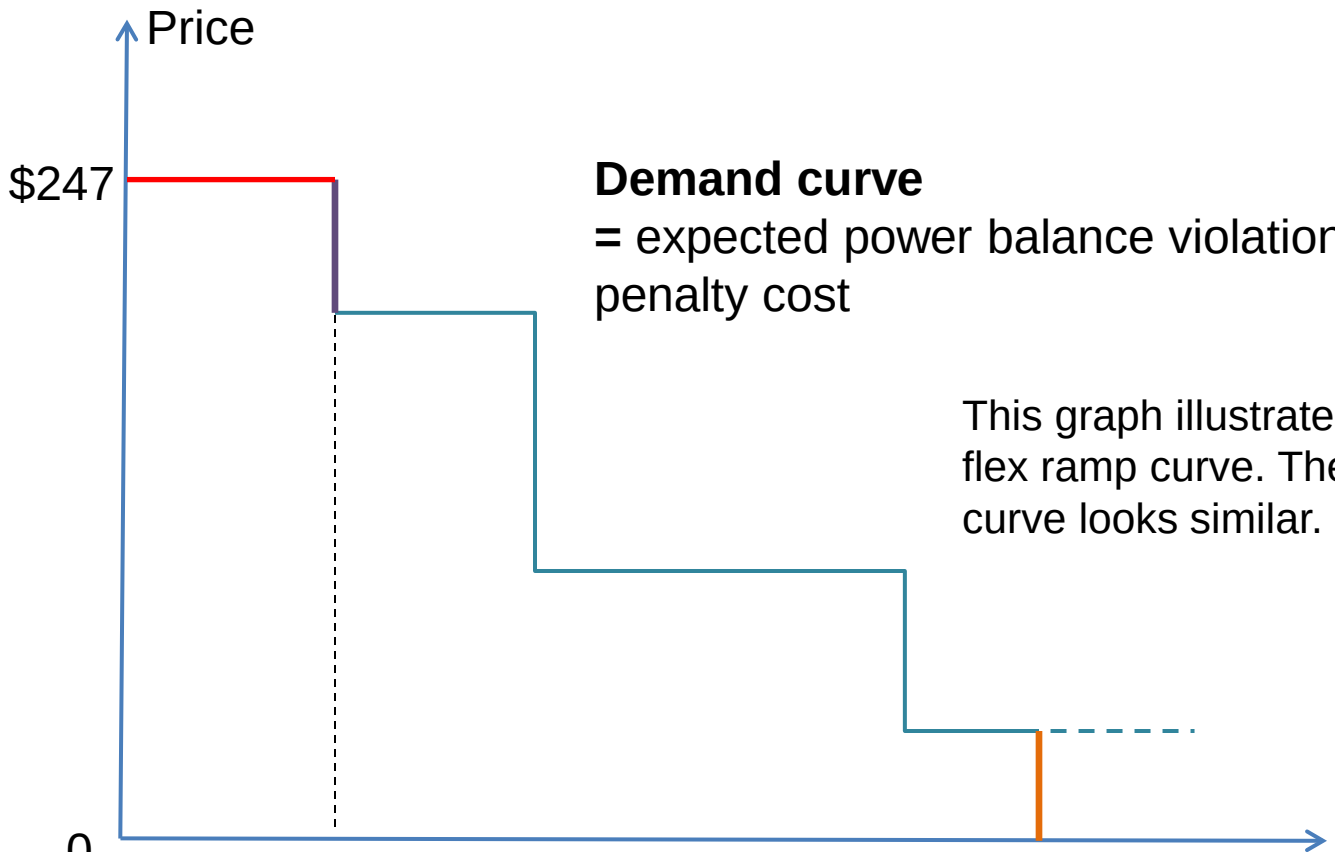
Demand Curve Calculation

Flex ramp demand curve



Demand curve
= expected power balance violation penalty cost

This graph illustrates the upward flex ramp curve. The downward curve looks similar.

Minimum requirement
= Expected upward net system movement

Maximum requirement
= 97.5% percentile

Determine the demand curve

- Inputs
  - The distribution of net load *NL* at t+5
  - The power balance violation penalties
- Expected power balance violation penalty conditional on flex ramp procurement
  - E(PPBC_penalty_cost|FRU=0) =

  $sum_y[prob(NL=y)*max(y-NL^{forecast},0)*PPBC\_penalty(y-NL^{forecast})]$.
  - Assuming x MW of flex ramp would reduce x MW of power balance violation, then

    E(PPBC_penalty_cost|FRU=x) =

  $sum_y[prob(NL=y)*max(y-NL^{forecast}-x,0)*PPBC\_penalty(y-NL^{forecast}-x)]$.
- Marginal value (in reducing power balance violations) of flex ramp
  - from x to x+Δx, the flex ramp marginal value is

    [E(PPBC_penalty_cost|FRU=x)–E(PPBC_penalty_cost|FRU=x+Δx)]/Δx

Example

- Power balance violation penalties
  - -$150 for negative PBC
  - $1000 for positive PBC
- Net load distribution

Net load–load forecast	Prob.	Avg. MW
–200-–100 MW	1%	–150
–100-0MW	2%	–50
0-100 MW	1%	50
100-200 MW	0.8%	150
200-300 MW	0.6%	250
300-400 MW	0.5%	350

Calculating the demand curve - upward

- Expected PPBC penalty conditional on flex ramp up procurement
  - E(PPBC_penalty_cost|FRU=0) = 0.01*50*1000 + 0.008*150*1000 + 0.006*250*1000 + 0.005*350*1000 = 4950
  - E(PPBC_penalty_cost|FRU=100) = 0.008*50*1000 + 0.006*150*1000 + 0.005*250*1000 = 2550
  - E(PPBC_penalty_cost|FRU=200) = 0.006*50*1000 + 0.005*150*1000 = 1050
  - E(PPBC_penalty_cost|FRU=300) = 0.005*50*1000 = 250
- FRU demand curve (step size = 100 MW)
  - from 0 to 100 MW, the FRU demand price is (4950–2550)/100 = $24
  - from 100 to 200 MW, the FRU demand price is (2550–1050)/100 = $15
  - from 200 to 300 MW, the FRU demand price is (1050–250)/100 = $8
  - from 300 to 400 MW, the FRU demand price is (250–0)/100 = $2.5
  - above 400 MW, the FRU demand price is $0.

Calculating the demand curve - downward

- Expected PPBC penalty conditional on flex ramp down procurement
  - E(NPBC_penalty_cost|FRD=0) = 0.02*(–50)*(–150) + 0.01*(–150)*(–150) = 375
  - E(NPBC_penalty_cost|FRD=100) = 0.01*(–50)*(–150) = 75
  - E(NPBC_penalty_cost|FRD=200) = 0

- FRD demand curve (step size = 100 MW)
  - from 0 to 100 MW, the FRD demand price is (375–75)/100 = $3
  - from 100 to 200 MW, the FRD demand price is (75–0)/100 = $0.75
  - above 200 MW, the FRD demand price is $0

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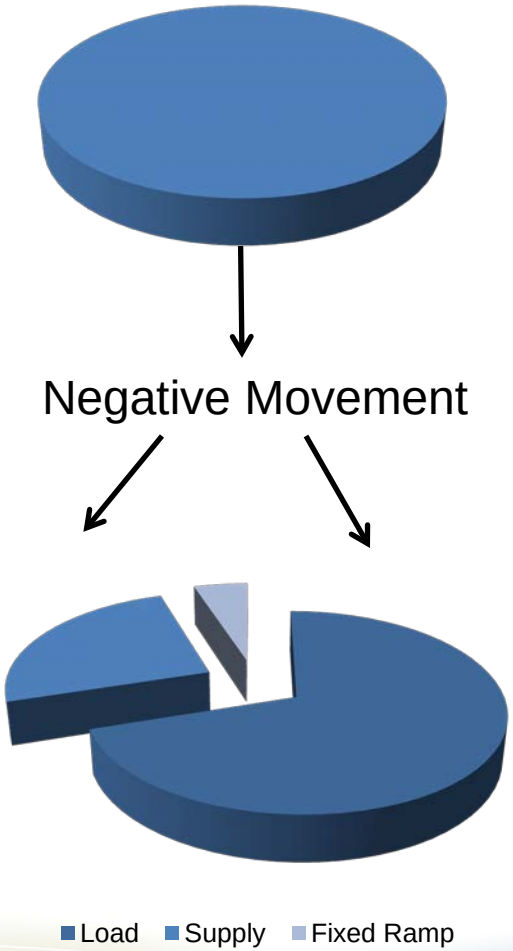
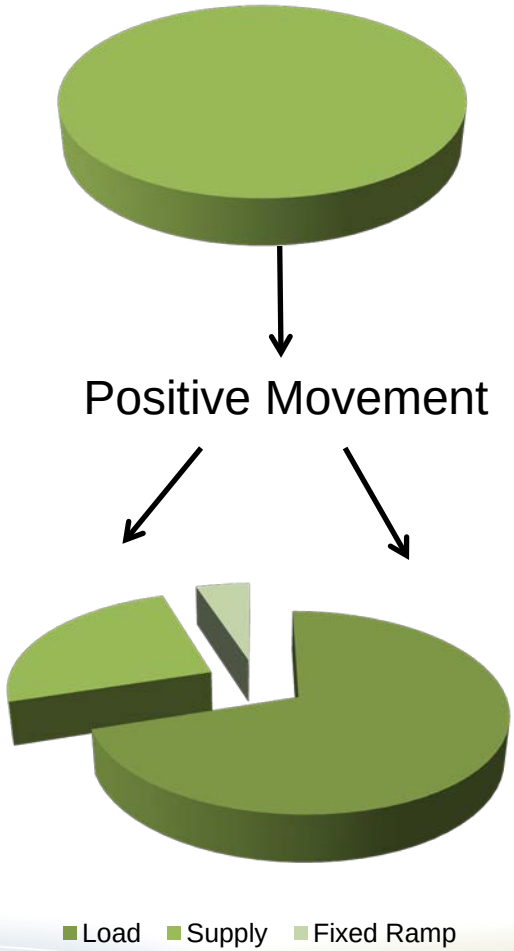
Cost Allocation Process

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 – Horuly Static Interties	Net Across all SCs 20 Minute	Change in MWh deemed delivered

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.

Review the cost allocation process (1 of 3)

- Step 1 – Determine hourly balancing authority area cost for the product.
  - This is calculated by summing the costs of all constraints across all markets.
  - This includes the BAA level constraint, any regional constraints within the balancing authority, and
  - The balancing authority area's share of combined constraints in the EIM.

- Step 2 – Determine the 5-minute gross movement for each category in the hour within the balancing authority area.
  - There is no netting of movement across 5-minute intervals.

Review the cost allocation process (2 of 3)

- Step 3 – Calculate costs of each category using its share of 5-minute movement for the relevant product.
- Step 4 – Allocate the hourly costs within the category according to the rules of that category using 5-minute data from that hour.
  - This initial allocation ensures the ISO is revenue neutral for day.
- Step 5 – At the end of the month, reverse all hourly settlements within the balancing authority area.

Review the cost allocation process (3 of 3)

- Step 6 – Sum product costs for each hour over the month.
- Step 7 – Sum the 5-minute gross movement for each category for each hour over the month.
- Step 8 – Calculate the monthly cost for each hour by using the category's share of the monthly 5-minute movement of the relevant product.
- Step 9 – Allocate the monthly costs within the category according to the rules of the category using 5-minute data summed for that hour over the month.

Next Steps

Item	Date
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 September 3