Flexible Ramping Products

Revised Draft Final Proposal

August 16, 2012

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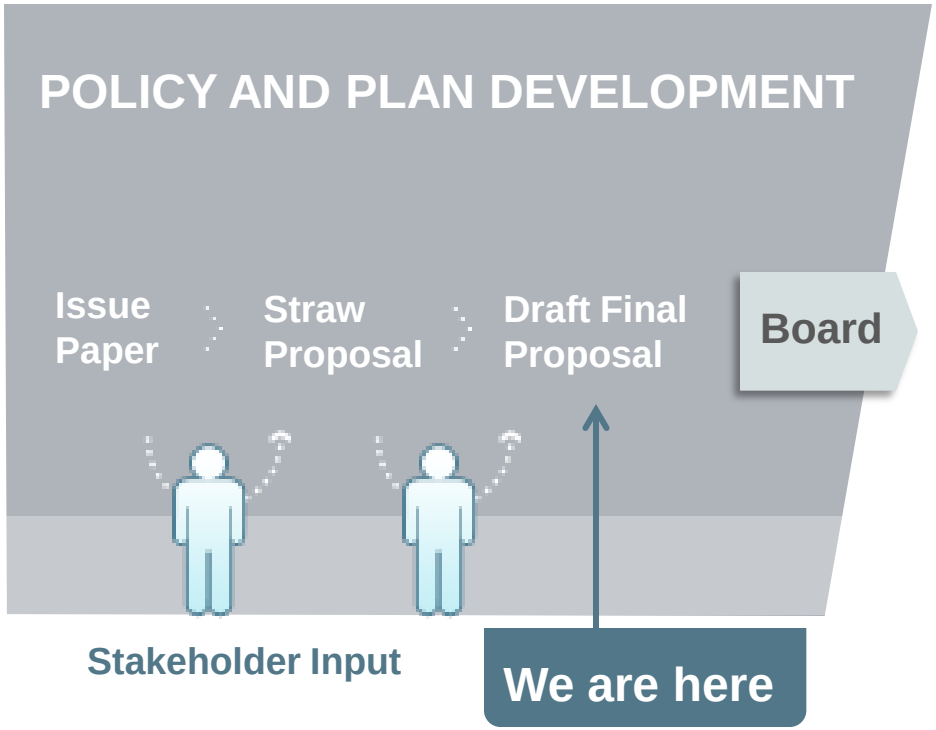
Agenda

Time	Topic	Presenter
10:00 – 10:10	Introduction	Chris Kirsten
10:10 – 12:00	Product Design	Lin Xu
12:00 – 1:00	Lunch Break	
1:00 – 2:15	Product Design (continued)	Lin Xu
2:15 – 3.00	PIRP Decremental Bidding	Don Tretheway
3:00 – 3:45	Cost Allocation	Don Tretheway
3:45 – 4:00	Wrap-up and Next Steps	Chris Kirsten

ISO Policy Initiative Stakeholder Process



Design decisions in the revised draft final proposal

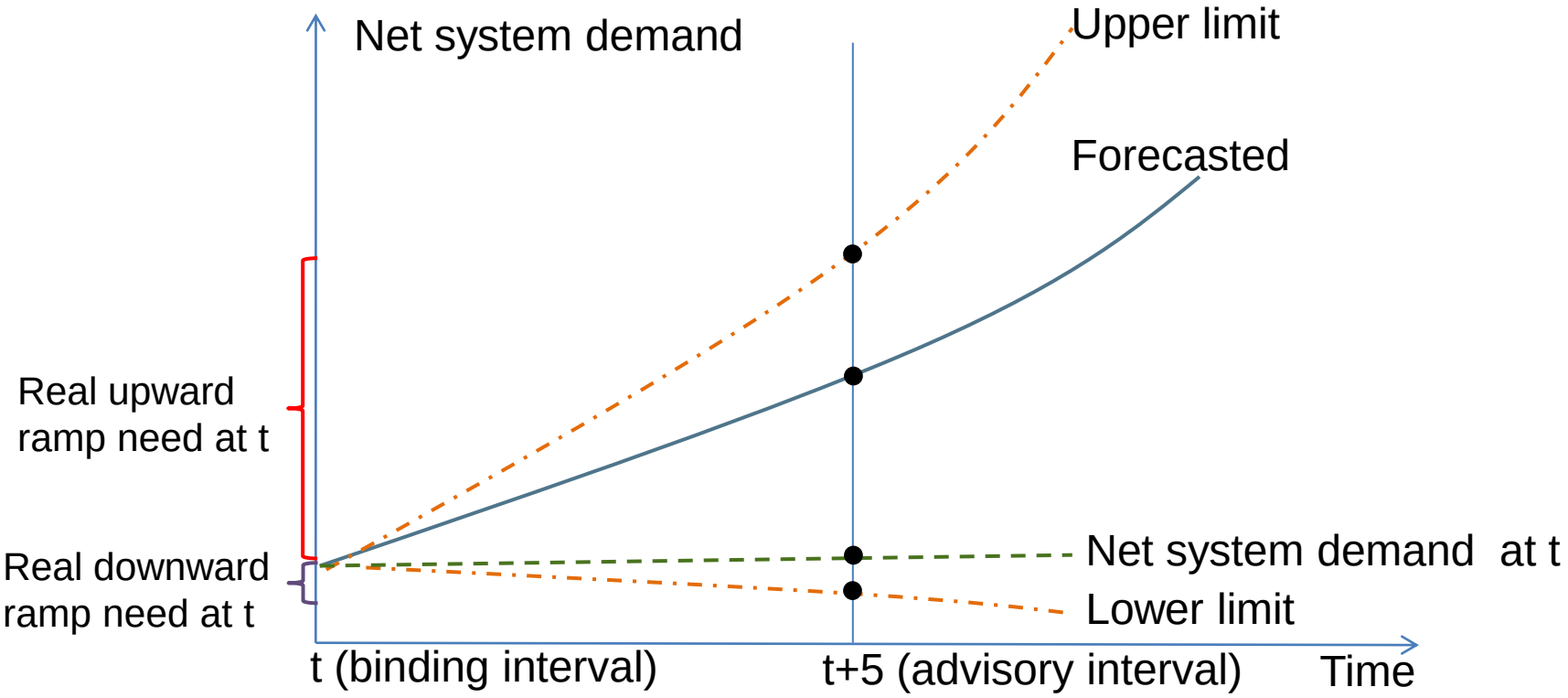
- Real ramping need
- Requirement and demand curve
- Between interval ramping capability constraint
- Regulation service participating as flexible ramping
- Economic buyback in real-time market
- No self provision for flex ramp
- No energy bid factored into flex ramp bid cost
- PIRP dec bidding
- Cost allocation aligned with real ramping need

Flexible ramping product

- What is flexible ramping product?
  - Ramping capability between market clearing intervals
- Benefits of flexible ramping product
  - Improve system reliability
    - Increase real-time ramping capability to meet net system movement between intervals
    - Reduce power balance violations
  - Improve market effectiveness
    - Produce transparent energy and ramping prices
    - Reduce real-time price volatility

Ramping need

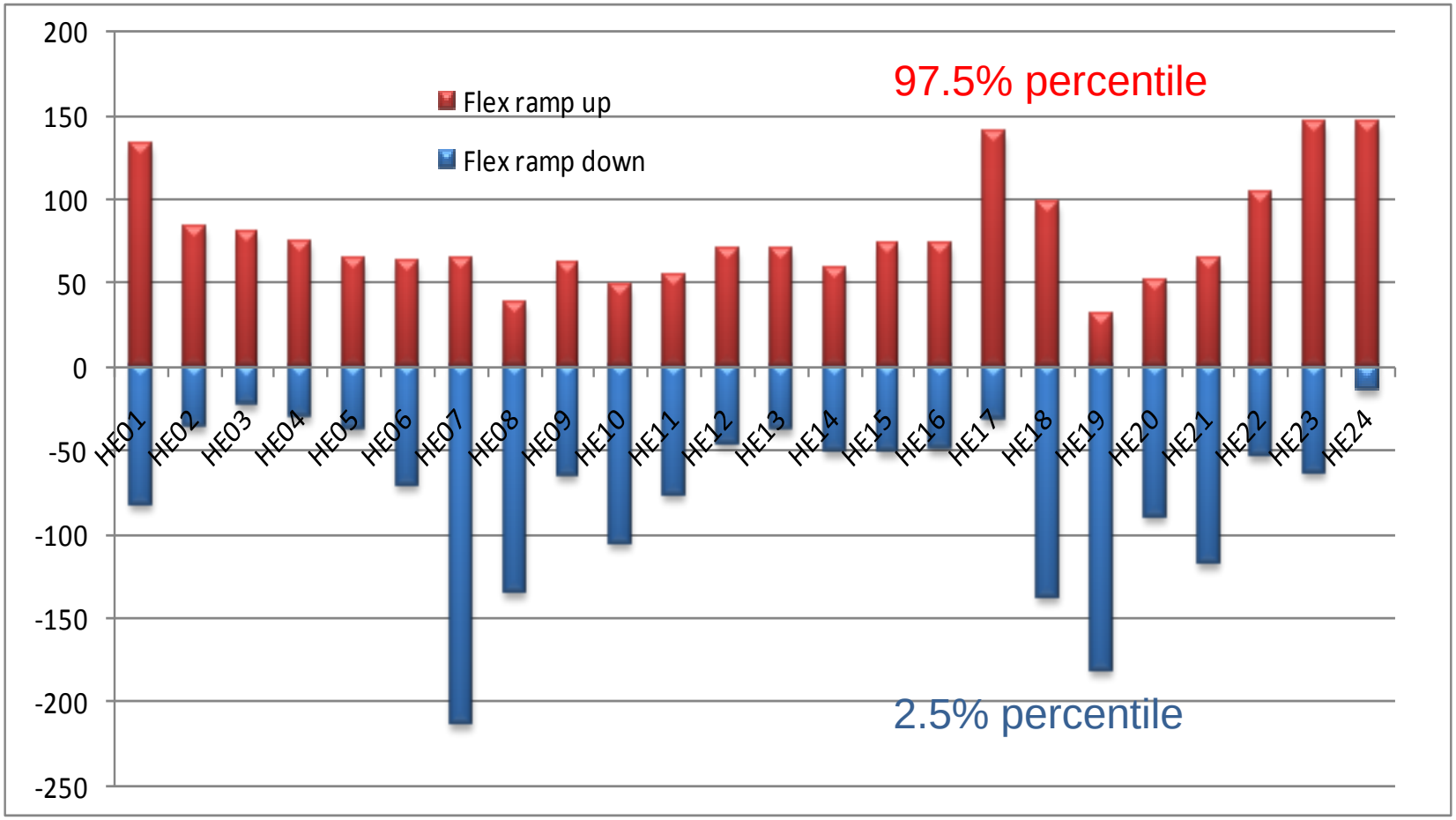
Net system demand = load + export – import – internal self-schedules - supply deviations



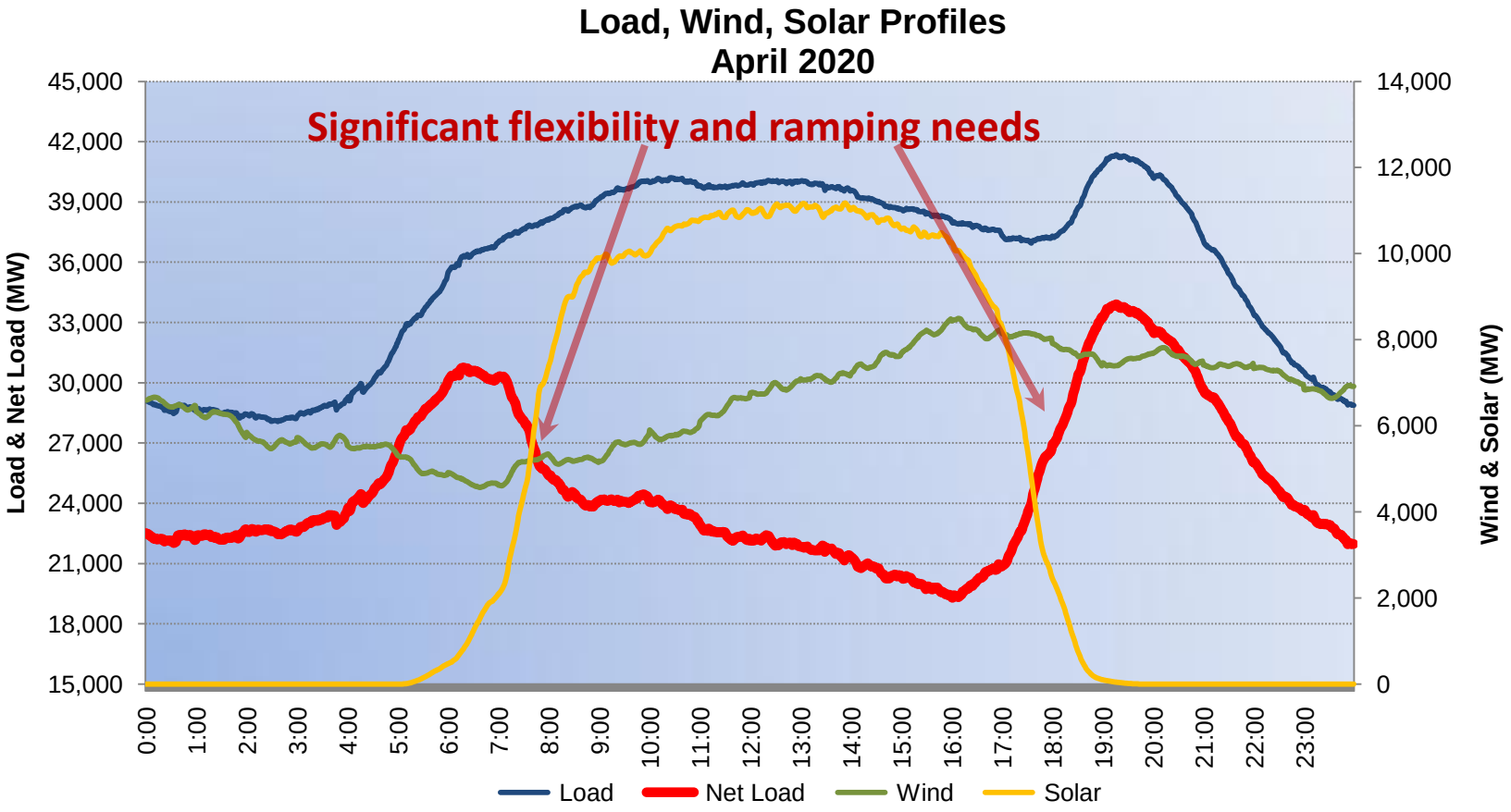
Real ramping need:

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

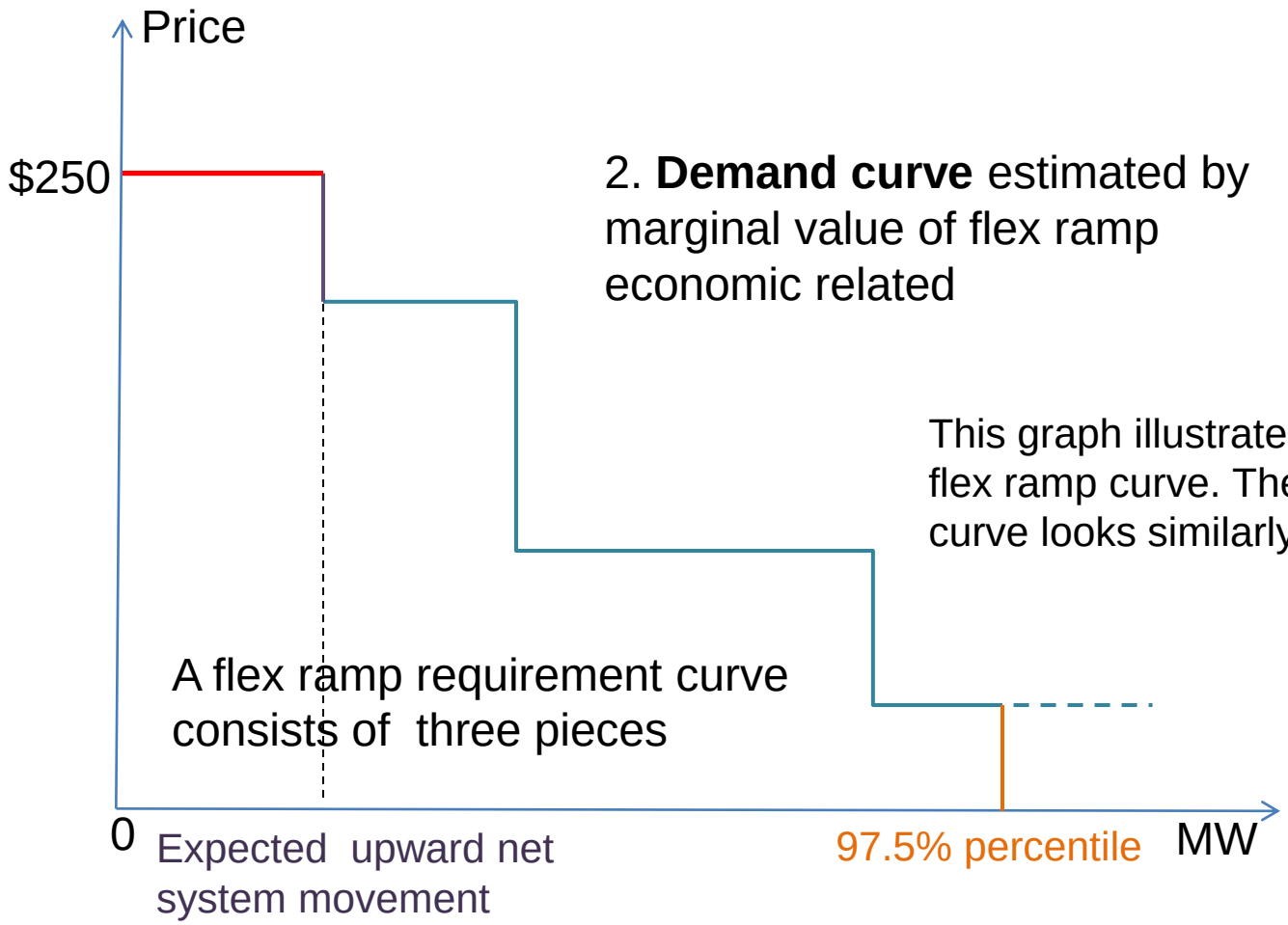
5-minute ramping need (95% confidence interval) January to March 2012



Ramping need is expected to increase with more renewable penetration



Flex ramp requirement and demand curve



1. Minimum requirement reliability related

3. **Maximum requirement** statistical limit

Flexible ramping capacity bidding rules

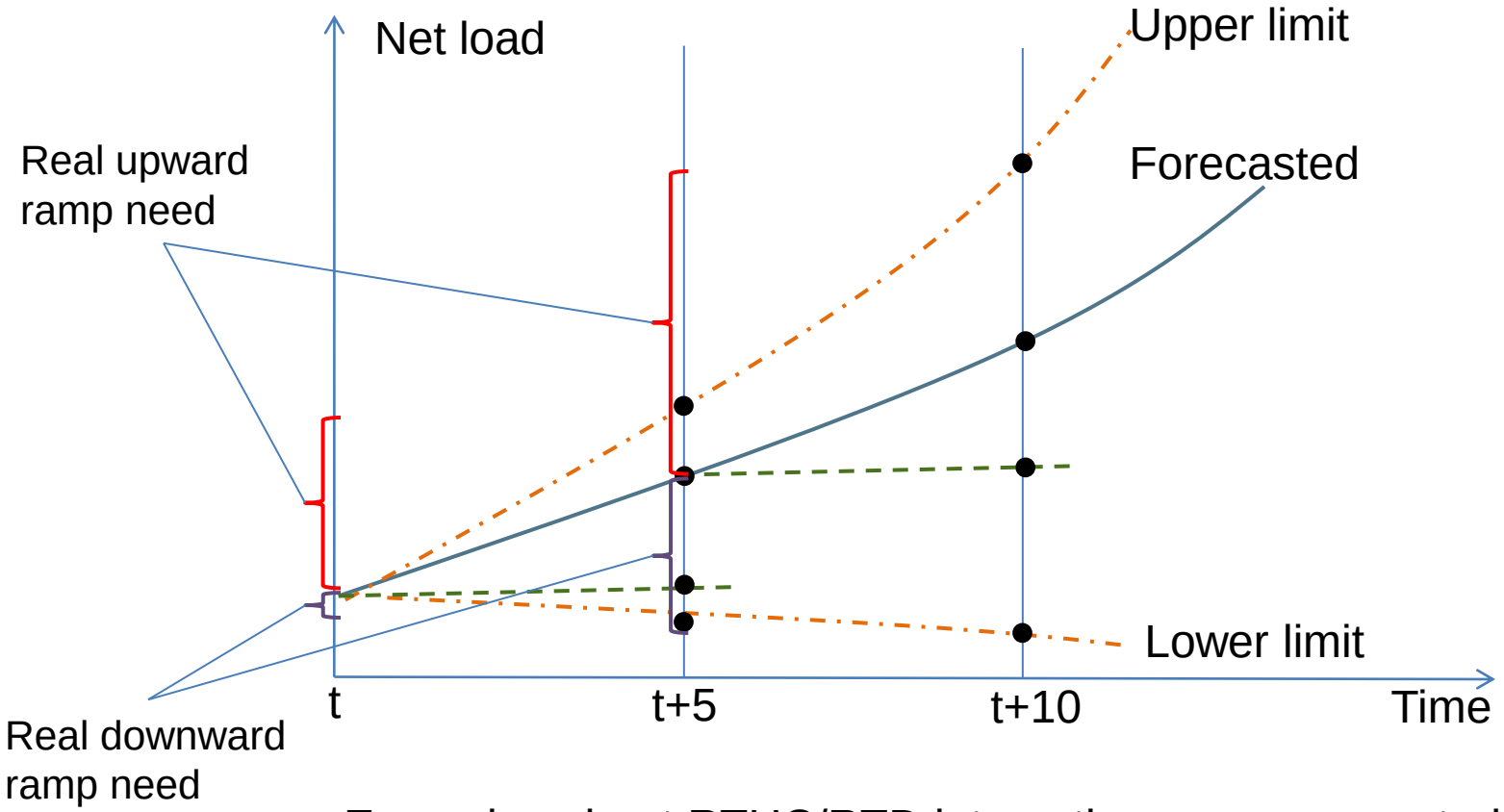
- A resource must have energy bid to participate in flex ramp market
  - Allow explicit flexible ramping bid
  - Assumed implicit $0 flexible ramping bid for resources with energy bid but not explicit flexible ramping bid
- System wide bid cap = $250/MWh, bid floor = $0/MWh
- No SC self provision (FRP must be “dispatchable”, like energy)
  - Concern 1: self provide downward flex ramp, w/high energy bid
  - Concern 2: self provide upward flex ramp to withhold supply, and strategically affect the energy price in a local congested area
- No market power mitigation for flex ramp
  - Given the bid cap, the implicit $0 flexible ramping offer from economic energy offers, the flexible ramping demand curve, and the regulation service participating as flex ramp, system level market power concern is low

Modeling flexible ramping

- Any resource that is 5-minute dispatchable by the ISO can provide flexible ramping
- Allow explicit flexible ramping bid
- Upward and downward ramping constraints
  - Ramping constraints in the same granularity as the market clearing interval: DA 60-minute, RTUC 15 minute, RTD 5-minute
- Co-optimized with ancillary services and energy
- Regulation services can participate as flex ramp
  - Bid in regulation capacity that is not awarded can be used to meet flex ramp up and down requirement in the co-optimization
  - Regulation service participating as flex ramp will be dispatched in RTD, not by AGC, and be compensated as flex ramp
  - In contrast, regulation service substituting for spinning reserve will be dispatched by AGC, and be compensated as regulation service
  - Regulation service participating as flex ramp will not receive regulation mileage payment

Model flex ramp in multi interval optimization

Ramping constraints will be enforced for every interval in the study horizon



Examples about RTUC/RTD interactions were presented in the 8/14 Market Surveillance Committee meeting.

Accommodate day-ahead flex ramp procurement

- Merging IFM and RUC in to iDAM
  - Co-optimize financial transactions and reliability needs
- Economic buy-back in RTD
  - Two settlement system for flex ramp
  - Day-ahead and RTD flex ramp award difference is settled at RTD flex ramp price
  - Benefits
    - Prevent strategically changing energy offer to take advantage of locked-in day-ahead flex ramp award
    - Eliminate double payment due to market clearing granularity difference between IFM and RTD
- Day-ahead non-contingent spinning reserve may be converted to flex ramp in real-time
  - Nice feature, but difficult to implement, and incremental benefit may be low given the feature of regulation service participating as flex ramp. The ISO recommends not doing this feature, and seeks stakeholders' comments.

Flexible ramping settlement

- Two settlement system for flex ramp
  - Day-ahead flexible ramping award settled at day-ahead price
  - Difference between RTD flex ramp award and day-ahead flex ramp award settled at RTD flex ramp marginal price
- Bid cost recovery
  - Flex ramp bid cost will be included in the total bid cost, and be evaluated against the total revenue including flex ramp revenue
- No pay charges
  - Flexible ramping products have lower payment priority than ancillary services, so no pay charge applies to flexible ramping first before it applies to ancillary services
  - Categories
    - undispatchable capacity
    - undelivered capacity
    - unavailable capacity
    - unsynchronized capacity

Flex ramp RTD examples

- Demonstrate properties and benefits of flex ramp under the following assumptions
  - Flex ramp bid cost is $0
  - Net system move is accurately predicted
- Four scenarios
  - Scenario 1: single interval RTD optimization without flex ramp
  - Scenario 2: single interval RTD optimization with flex ramp
  - Scenario 3: two-interval RTD optimization without flex ramp
  - Scenario 4: two-interval RTD optimization with flex ramp

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	

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 with settling the first interval
    - 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 with bid over time, 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 as a result of power balance violation due to insufficient ramp. In this case, we do not need bid cost recovery. However, if RTD had created more ramping capability in interval t at a lower much lower than $1000, we could have prevented the power balance violation.

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 with only settling the first interval
    - 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 consistent with bid over time.
    - If net system demand is slightly higher (e.g. 0.01 MW) 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.
  - Of course, these benefits of flex ramp have associated cost ($5/MW per 5 minutes).

VERs can provide flexible ramping product down

- Revenue can offset cost allocation of flexible ramping up
- BUT, must submit economic bid
- Participating Intermittent Resource Program does NOT allow economic bids
- PIRP allows monthly netting of uninstructed imbalance energy if the resource submits a real-time self-schedule equal to the 3rd party provided forecast

PIRP Decremental Bidding

- On an hourly basis, PIRP resource submits:
  - Real-time self-schedule equal to 3rd party forecast
  - Maximum MW curtailment
  - Ramp rate
  - Energy bid price willing to be decremented
  - Flexible ramping down bid price
- The ISO will use the 15 minute expected output* for RTUC FRP headroom and to assess availability for decremental dispatch
- If resource is dispatched, the 10 minute settlement interval is not included in monthly netting of UIE

* Same as used for FRP cost allocation

Spreadsheet example posted

Not dispatched beyond maximum curtailment

Max Curtailment (MW)	60.0
Ramp Rate (MW/Min)	6
Bid Price	$ (100)
Maximum FRD Capacity (MW)	30.0

	Hour 1												
PIRP RT Self-Schedule (MW)	120.0												120.0 MWh
	RTUC 1			RTUC 2			RTUC 3			RTUC 4			
RTUC Expected Output (MW)	50.0			80.0			120.0			150.0			100.0 MWh

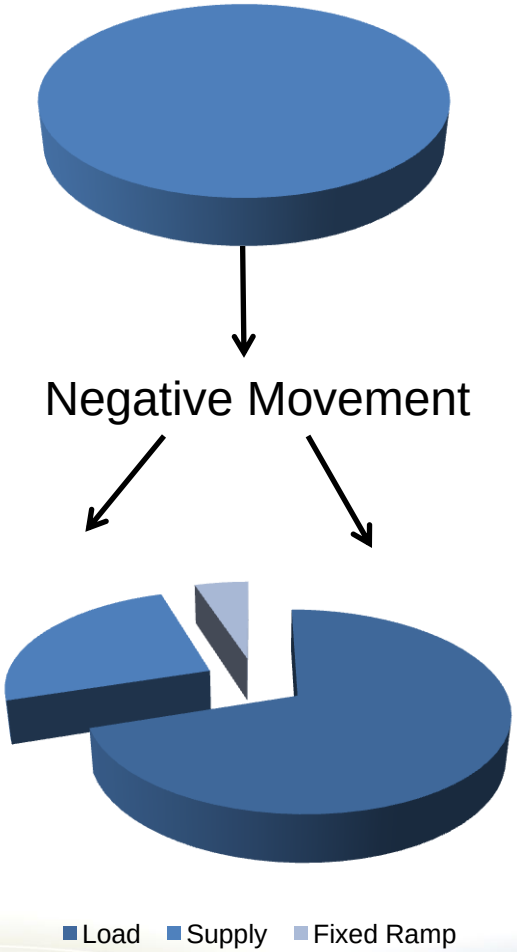
	RTD 1	RTD 2	RTD 3	RTD 4	RTD 5	RTD 6	RTD 7	RTD 8	RTD 9	RTD 10	RTD 11	RTD 12	
RTD Expected Output (MW)	50.0	50.0	50.0	80.0	80.0	80.0	120.0	120.0	120.0	150.0	150.0	150.0	
Bid Price	$ (100)	$ (100)	$ (100)	$ (100)	$ (100)	$ (100)	$ (100)	$ (100)	$ (100)	$ (100)	$ (100)	$ (100)	
LMP	$ (150)	$ (50)	$ (50)	$ (50)	$ (150)	$ (90)	$ (150)	$ (90)	$ (150)	$ (150)	$ (50)	$ (75)	
Dispatch (MW)	120.0	120.0	120.0	120.0	60.0	120.0	90.0	120.0	90.0	120.0	120.0	120.0	110.0 MWh

Settlement	Int 1	Int 2	Int 3	Int 4	Int 5	Int 6	
Meter (MWh)	7.0	15.0	20.0	15.0	21.0	36.3	114.3 MWh
IIE (MWh)	20.0	20.0	15.0	17.5	17.5	20.0	110.0 MWh
UIE (MWh)	-13.0	-5.0	5.0	-2.5	3.5	16.3	4.3 MWh
PIRP Monthly Netting Settlement	Yes	Yes	No	No	No	Yes	

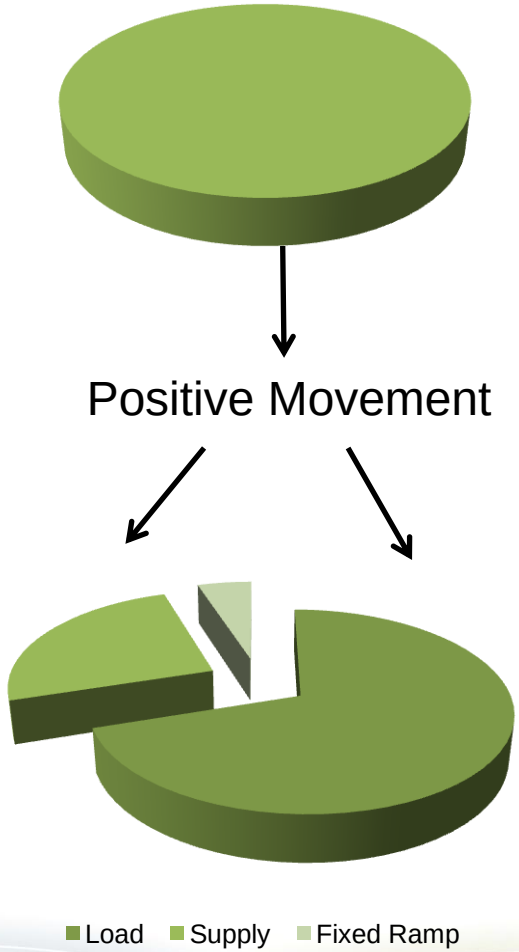
Resource is dispatched
UIE not eligible for monthly netting

Allocate flexible ramping product costs consistent with guiding principles

Flexible Ramping Up



Flexible Ramping Down



Movement is the 10 minute change

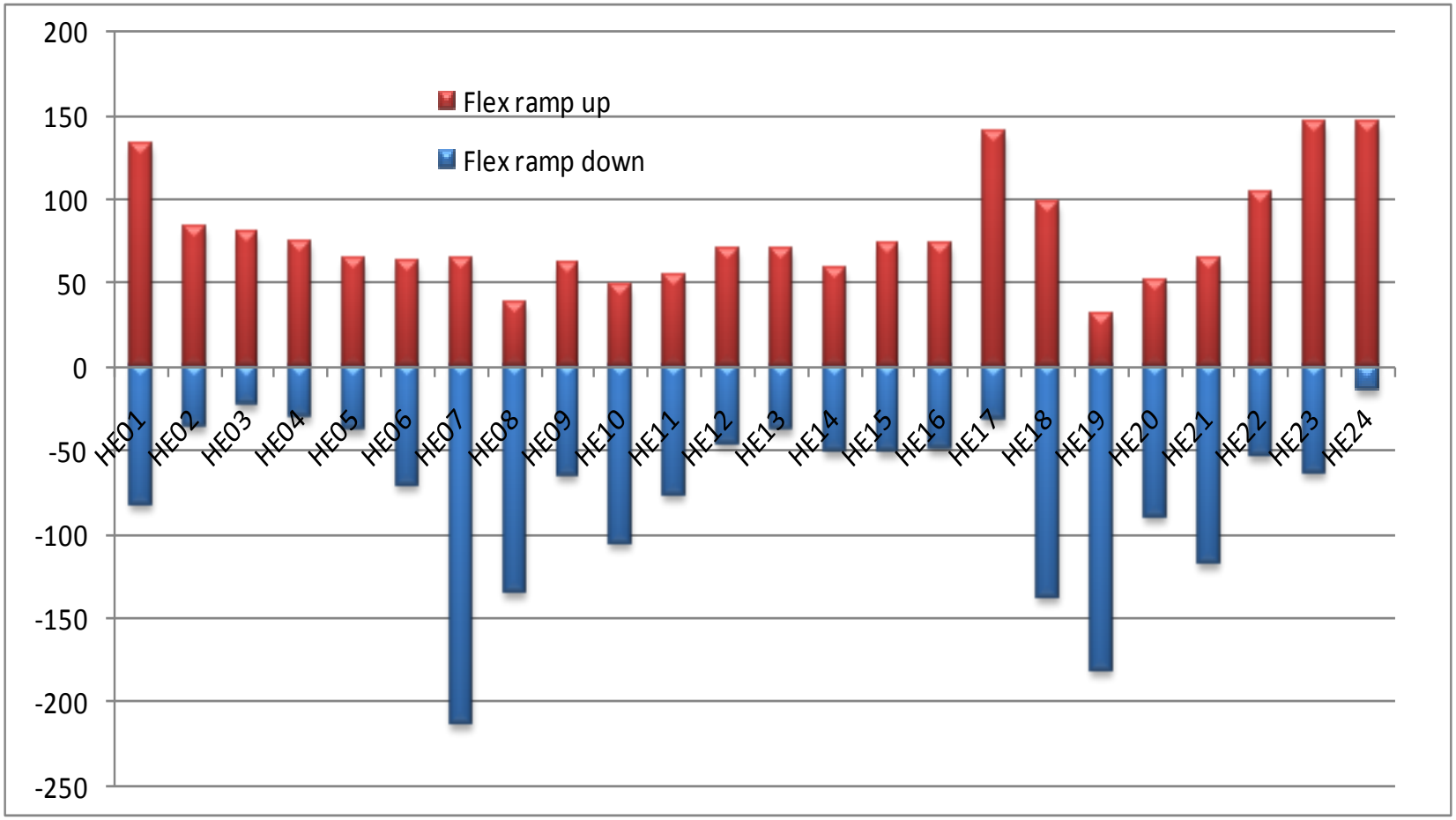
Common movement metric used to divide total costs in to three categories

No netting across 10 minute intervals.

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

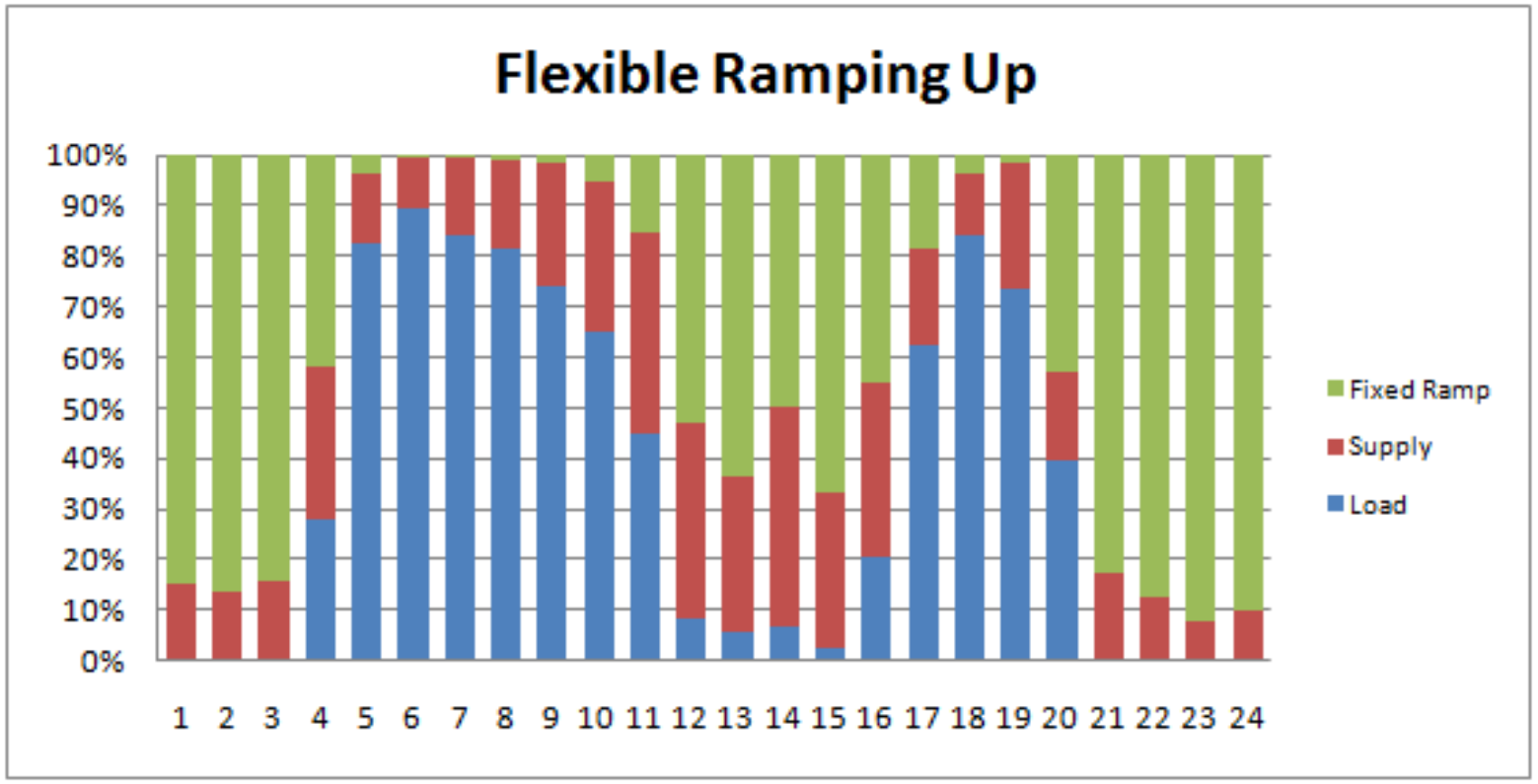
* Posted example showing by UIE in not appropriate for Load

5-minute ramping need (95% confidence interval) January to March 2012



Split between categories

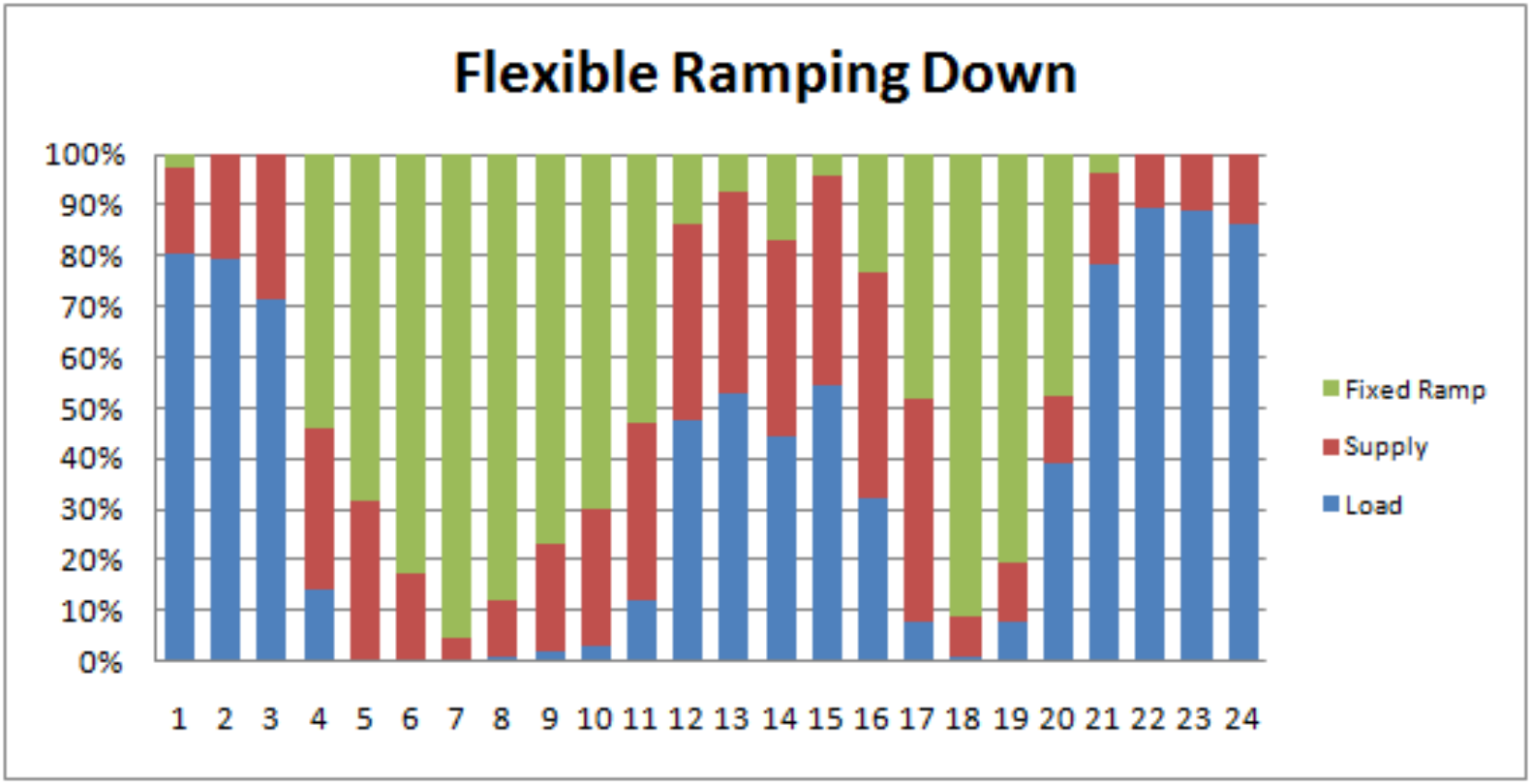
Fixed ramp include internal day-ahead self schedule energy



Actual data Jan 1, 2012 to March 31, 2012

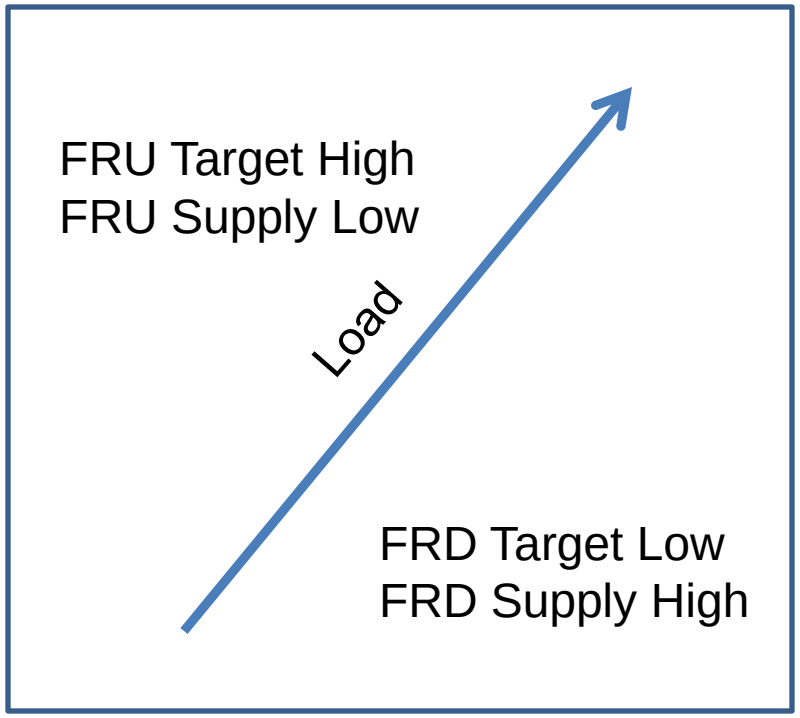
Split between categories

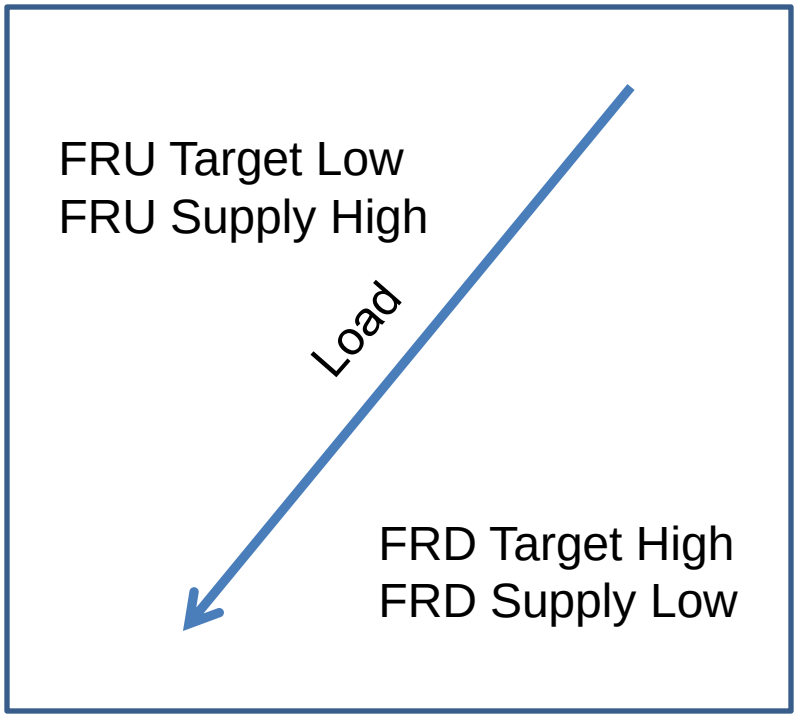
Fixed ramp include internal day-ahead self schedule energy



Actual data Jan 1, 2012 to March 31, 2012

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

Allocation of each pie slice

No netting across settlement intervals.

		Baseline	Actual	Deviation	Allocation
1	Load	Day-Ahead Schedule	Metered Demand	UIE	Gross Deviation
2	Variable Energy Resource	15 Minute Expected Energy*	10 Minute Meter	Baseline - Actual	Delta Deviation Outside Threshold
	Internal Generation	Instruction	10 Minute Meter	UIE1 + UIE2	Delta UIE Outside Threshold
	Dynamic Transfers	Instruction	10 Minute Meter	UIE1 + UIE2	Delta UIE Outside Threshold
3	Fixed Ramp Interties & Self-Schedules	Ramp Modeled	Assumed Delivered	Net Portfolio Movement	Gross by SC

* Optional

Implementation of Supply category delta UIE metric in settlement system requires feasibility assessment.

As requested, the ISO posted a spreadsheet that calculates different deviation approaches

	Hour 1						Hour 2						Hour 3						Total
Hourly Schedule (MWh)	90						120						90						300.0
	Int 1	Int 2	Int 3	Int 4	Int 5	Int 6	Int 1	Int 2	Int 3	Int 4	Int 5	Int 6	Int 1	Int 2	Int 3	Int 4	Int 5	Int 6	
Baseline (MWh)	15.0	15.0	15.0	15.0	15.0	15.0	20.0	20.0	20.0	20.0	20.0	20.0	15.0	15.0	15.0	15.0	15.0	15.0	300.0
Meter (MWh)	15.0	10.0	5.0	10.0	15.0	20.0	25.0	20.0	20.0	15.0	25.0	20.0	20.0	20.0	10.0	10.0	10.0	10.0	280.0
UIE (MWh)	0.0	-5.0	-10.0	-5.0	0.0	5.0	5.0	0.0	0.0	-5.0	5.0	0.0	5.0	5.0	-5.0	-5.0	-5.0	-5.0	-20.0
Delta UIE (MWh)	0.0	5.0	5.0	-5.0	-5.0	-5.0	0.0	5.0	0.0	5.0	-10.0	5.0	0.0	0.0	10.0	0.0	0.0	0.0	10.0
FRU (Delta)	0.0	5.0	5.0	0.0	0.0	0.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0	0.0	10.0	0.0	0.0	0.0	35.0
FRD (Delta)	0.0	0.0	0.0	5.0	5.0	5.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0
FRU (Gross)	0.0	5.0	10.0	5.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	5.0	5.0	5.0	5.0	45.0
FRD (Gross)	0.0	5.0	5.0	0.0	0.0	0.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0	0.0	10.0	0.0	0.0	0.0	35.0

	Hour 1						Hour 2						Hour 3						Total
Hourly Expected (MWh)	90						120						90						300.0
	RTPD 1		RTPD 2		RTPD 3		RTPD 4		RTPD 1		RTPD 2		RTPD 3		RTPD 4		RTPD 1		RTPD 2		RTPD 3		RTPD 4		
15 Min Expected (MWh)	20		20		25		25		30		30		30		30		25		25		20		20		300.0
	Int 1	Int 2	Int 3	Int 4	Int 5	Int 6	Int 1	Int 2	Int 3	Int 4	Int 5	Int 6	Int 1	Int 2	Int 3	Int 4	Int 5	Int 6	
Baseline (MWh)	13.3	13.3	13.3	16.7	16.7	16.7	20.0	20.0	20.0	20.0	20.0	20.0	16.7	16.7	16.7	13.3	13.3	13.3	300.0
Meter (MWh)	15.0	10.0	5.0	10.0	15.0	20.0	25.0	20.0	20.0	15.0	25.0	20.0	20.0	20.0	10.0	10.0	10.0	10.0	280.0
UIE (MWh)	1.7	-3.3	-8.3	-6.7	-1.7	3.3	5.0	0.0	0.0	-5.0	5.0	0.0	3.3	3.3	-6.7	-3.3	-3.3	-3.3	-20.0
Delta UIE (MWh)	0.0	5.0	5.0	-1.7	-5.0	-5.0	0.0	5.0	0.0	5.0	-10.0	5.0	0.0	0.0	10.0	-3.3	0.0	0.0	10.0
FRU (Delta)	0.0	5.0	5.0	0.0	0.0	0.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0	0.0	10.0	0.0	0.0	0.0	35.0
FRD (Delta)	0.0	0.0	0.0	1.7	5.0	5.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	25.0
FRU (Gross)	0.0	3.3	8.3	6.7	1.7	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	6.7	3.3	3.3	3.3	41.7
FRD (Gross)	0.0	5.0	5.0	0.0	0.0	0.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0	0.0	10.0	0.0	0.0	0.0	35.0

- VER use of 15 minute expected output is OPTIONAL
- Gross UIE uses existing (ISO & MP) settlement functionality

Other Design Elements

- Modified Supply category threshold to the minimum of 3% of instruction or 0.83 MWh (5MW/6)
  - The threshold is not used for the initial allocation to 3 categories
- Maintain monthly resettlement with hourly granularity
- Maintain functionality for SC's to assign a resource's allocation to another SC
- Design for regional procurement and allocation
  - The same cost allocation methodology but initial pie is regional versus system.

Align cost allocation with principles

Guiding Principle	Cost Allocation Design Element
Causation	• Costs allocated to entities based upon system need for real-time dispatch.
Comparable Treatment	• Similar resources are treated the same.
Efficient Policy Achievement	• Allow netting across resources within a cost category. • Using actual data to analyze the proposed allocation.
Incentivize Behavior	• Incentive for resources to improve dispatch performance and provide service.
Manageable	• Option to use real-time forecast updated every 15 minutes to measure VERs uninstructed energy. • Functionality to allow a resource's allocation to be transferred between SC's.
Synchronized	• Monthly re-settlement of hourly costs
Rational	• Maximize the use of existing settlement functionality

Next Steps

Item	Date
Stakeholder Meeting	August 16, 2012
Stakeholder Comments Due	August 23, 2012
Post 2nd Revised Draft Final Proposal	September 11, 2012
Stakeholder Meeting	September 18, 2012
Stakeholder Comments Due	September 25, 2012
Board of Governors Meeting	November 1-2, 2012

Submit written comments to FRP@caiso.com

Questions

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The ISO offers comprehensive training programs

Date	Training
August 23	Welcome to the ISO (web conference)
September 5	Regulatory Must-Take pre-market sim training (web conference)
September 18	FERC Order 745 pre-market sim training (web conference)
September 20	Welcome to the ISO (web conference)
October 2	Introduction to the ISO Market (on-site)
October 3, 4	ISO Market Transactions (on-site)
October 5	Replacement Requirement pre-market sim training (web conference)

Training calendar - http://www.caiso.com/participate/Pages/Training/default.aspx
Contact us - markettraining@caiso.com