Supplemental: Foundational Approach on Flexible Ramping Products

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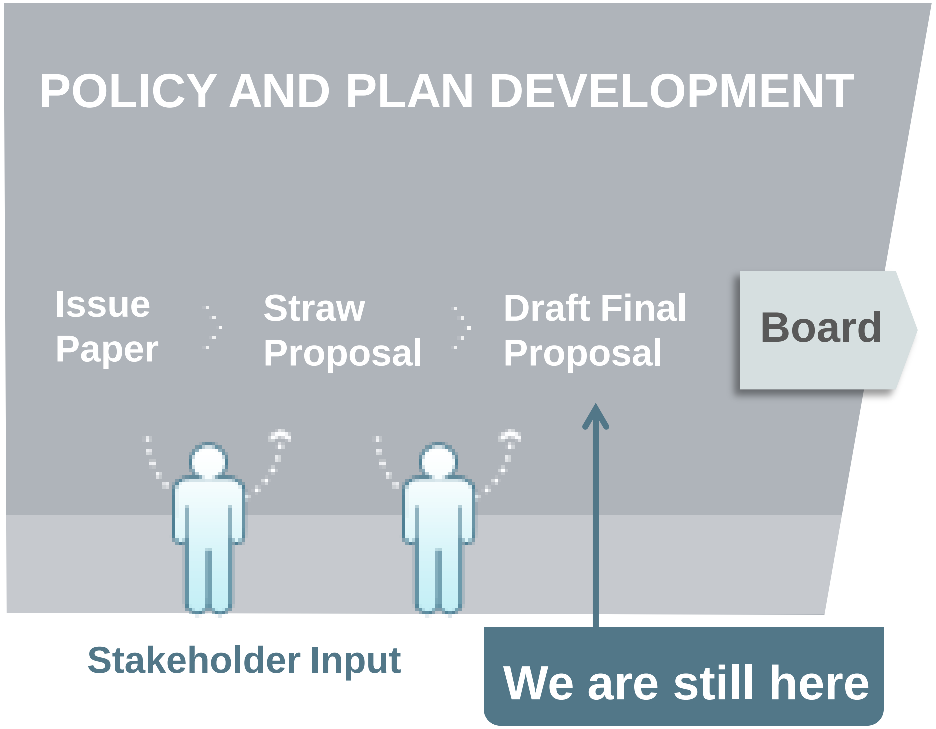
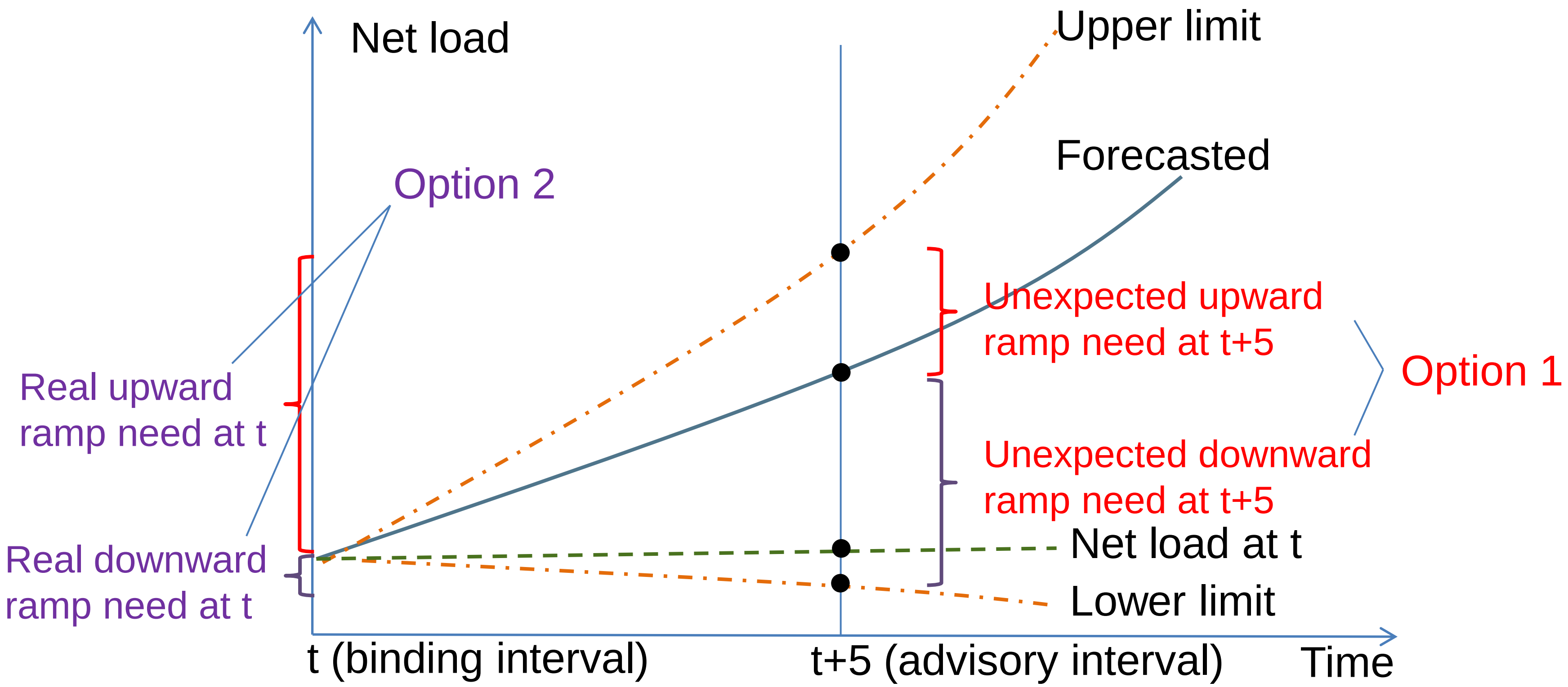
Agenda

Time	Topic	Presenter
11:00 – 11:10	Introduction	Chris Kirsten
11:10 – 12:00	Product Design and Examples	Lin Xu
12:00 – 1:00	Lunch Break	All
1:00 – 2:45	Product Design and Examples cont.	Lin Xu
2:45 – 3:00	Break	All
3:00 – 4:45	Cost Allocation	Don Tretheway
4:45 – 5:00	Next Steps	Chris Kirsten

ISO Policy Initiative Stakeholder Process



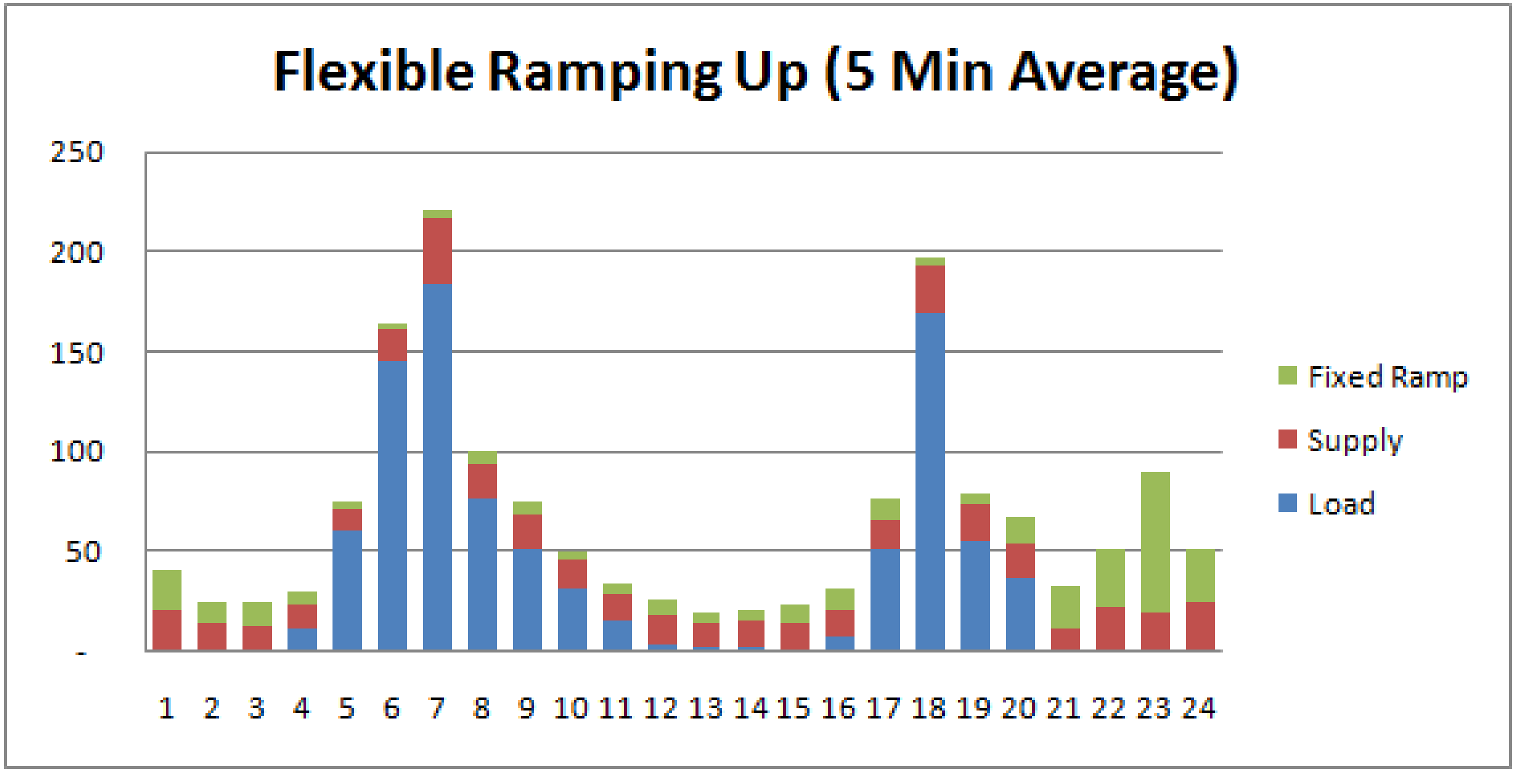
Unexpected ramp vs real ramp



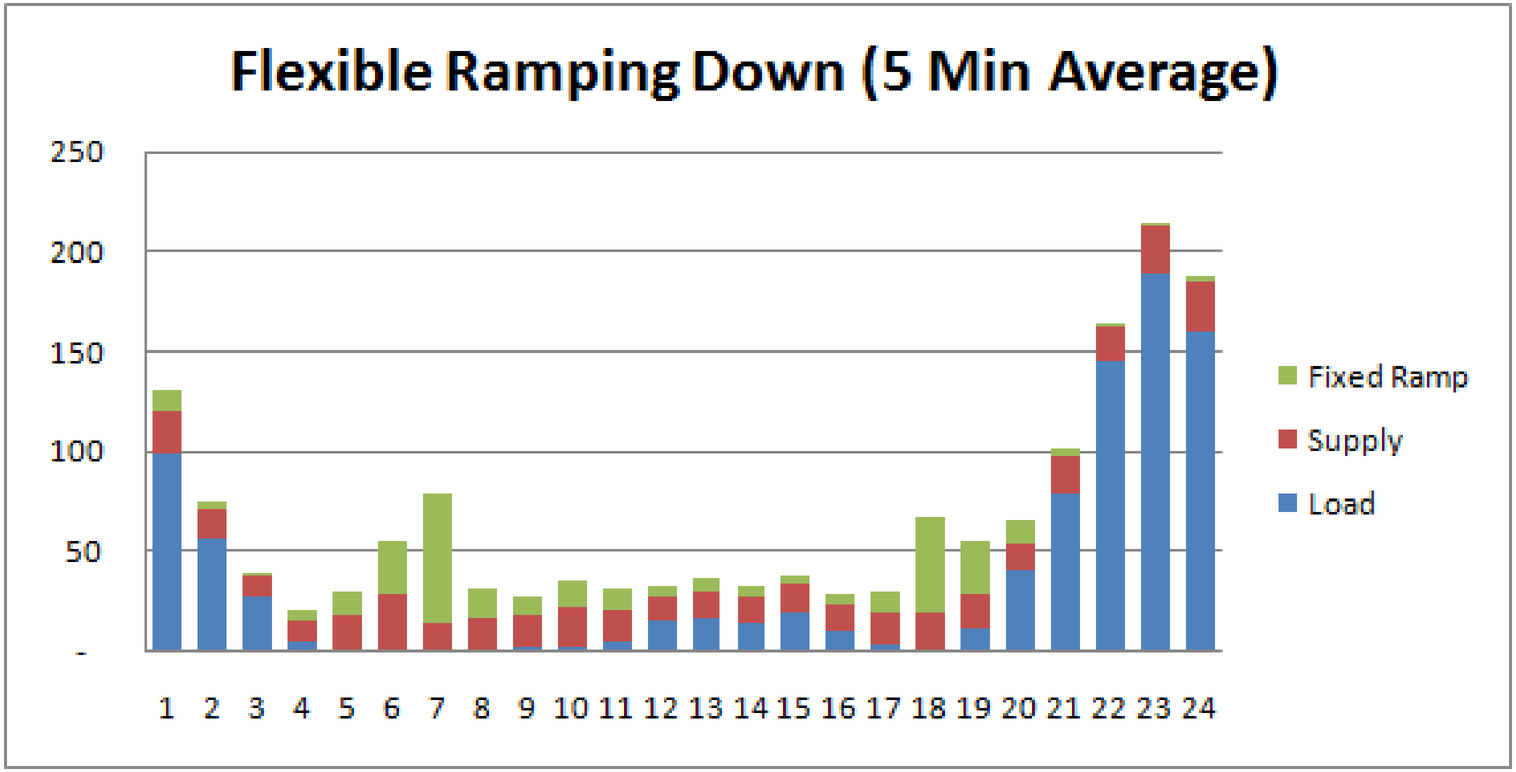
Option 1: unexpected ramping
the net load variability and uncertainties from what have been forecasted in t+5 (net load t+5 minus net load RTUC)

Option 2: real ramping
Potential net load change from t to t+5 (net load t+5 – net load t)

Hourly Average 5 minute Ramping – Actual 1/1/12 to 3/31/12



Hourly Average 5 minute Ramping – Actual 1/1/12 to 3/31/12



Unexpected ramp vs real ramp example

Scenario	Morning load ramp	Middle day	Evening load drop
RTD net load at t	24,000	32,000	28,000
RTUC net load at t+5	24,400	32,000	27,400
Lower limit	24,080	31,800	27,500
Upper limit	24,500	32,300	27,900
RTUC unexpected ramp up	100	300	500
RTUC unexpected ramp down	320	200	0
RTD real ramp up	500	300	0
RTD real ramp down	0	200	500

Option 1: unexpected ramping

Upward: max{ [upper limit at t+5] – [RTUC net load at t+5], 0 }

Downward: max{ [RTUC net load at t+5] – [lower limit at t+5], 0 }

Option 2: real ramping

Upward: max{ [upper limit at t+5] – [RTD net load at t], 0 }

Downward: max{ [RTD net load at t] – [lower limit at t+5], 0 }

RTD dispatch example (morning ramp scenario)

Gen	EN Bid	FRU bid	FRD bid	En init	Ramp rate	Pmin	Pmax
G1	25	2	2	100	100	0	500
G2	30	5	5	400	10	0	500
G3	500	10	10	0	100	0	500

- Assume other resources in the system self schedule 23,500 MW of supply
- G1, G2, and G3 meet load beyond 23,500 MW
  - 500 MW load met by G1, G2, and G3 in interval t
  - 900 MW load met by G1, G2, and G3 in interval t+5
- G1, G2, and G3 provide flex ramp
- RTD at t-7 minutes performs two-interval optimization including
  - the energy binding interval t
  - the advisory interval t+5

RTD dispatch without flex ramp

	Interval t			Interval t+5		
gen	Energy	Flex-ramp up	Flex-ramp down	Energy	Flex-ramp up	Flex-ramp down
G1	150			500		
G2	350			400		
G3						

- G3 is the least economic resource, and should not be dispatched unless it is not possible to clear the market without it
- G1 is the most economic resource, and should be dispatched as much as possible in both intervals
- G2 has only 50 MW 5-minute ramping capability, and cannot meet the 400 MW load ramp from t to t+5 alone, so G1 has to take 350 MW ramp. This is why G1 is dispatched to 150 MW in interval t to keep 350 MW ramping capability.

RTD dispatch with real ramp need

	Interval t			Interval t+5		
gen	Energy	Flex-ramp up	Flex-ramp down	Energy	Flex-ramp up	Flex-ramp down
G1	50	450		450	50	
G2	450	50		450	50	
G3					400	

- G1 is dispatched down in interval t compared with the no flex ramp case
  - This is to free up more ramping capability to satisfy the 500 MW upward flex ramp need, which is higher than the 400 MW load ramp
- Does the real ramp case produce a less economic solution than the no flex ramp case?
  - Yes, if compare the objective function values of the two cases.
  - May not be, if consider the load distribution in interval t+5
    - For example, if the load in interval t is 950 MW, then without flex ramp, the system has to rely on the expensive G3. However, with flex ramp, no need to dispatch G3.

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RTD dispatch with unexpected ramp need

	Interval t			Interval t+5		
gen	Energy	Flex-ramp up	Flex-ramp down	Energy	Flex-ramp up	Flex-ramp down
G1	220	100	220	500		320
G2	350		100	400	100	
G3						

- Over generation in interval t
  - Load is going up, so gen should be dispatched low in interval t
  - However, the downward flex ramp requirement 320 MW in interval t means the gen should be dispatched high in interval t
- What caused the problem?
  - The unexpected ramp need is based on the forecasted net load in interval t+5, while the ramping capability to meet it is in interval t
  - The problem can be resolved if ramping capability in t+5 is used to meet the unexpected ramp need
    - G1 will have 500 MW downward ramping capability in interval t+5 compared with only 220 MW in interval t

Conclusion from the RTD dispatch examples

- Two ways to model flex ramp
  - unexpected ramp modeled in the advisory RTD interval
    - May produce false opportunity cost payment
      - For example, 100 MW resource has binding 20 MW upward flex ramp award in interval t+5 (with energy opportunity cost) based on 80 MW advisory energy dispatch, but later the binding energy dispatch for interval t+5 changes to 85 MW
  - real ramp modeled in the energy binding RTD interval
    - Will not produce false opportunity cost payment
- Model real ramp in the energy binding interval is the only known method that will not produce false opportunity cost payment

The flex ramp requirement

	Pros	Cons
Explicit approach	Straightforward.	Different requirements for DA, RTUC and RTD markets. Requirement needs to be tuned frequently to manage cost effectiveness.
Implicit approach	Same demand curves can be used for DA, RTUC and RTD markets. Can manage cost effectiveness.	Difficult to tune demand curve based system condition.

Construct the demand curve for the implicit approach: inputs

0 MW flex ramp	100 MW flex ramp	200 MW flex ramp	300 MW flex ramp
0-100 MW PBV, 0.3%	0-100 MW PBV, 0.2%	0-100 MW PBV, 0.1%	0-100 MW PBV, 0%
100-200 MW PBV, 0.2%	100-200 MW PBV, 0.1%	100-200 MW PBV, 0%	100-200 MW PBV, 0%
200-300 MW PBV, 0.1%	200-300 MW PBV, 0%	200-300 MW PBV, 0%	200-300 MW PBV, 0%

Power balance violation distribution

Power balance violation	Penalty
0-100 MW	$1000/MWh
100-200 MW	$3000/MWh
200-300 MW	$5000/MWh

Power balance violation penalties

Construct the demand curve for the implicit approach: system penalty cost for power balance violation

Cost0 = system penalty cost associated with 0 MW flex ramp =	Cost100 = system penalty cost associated with 100 MW flex ramp =
Average(0-100 MW PBV)*0.3%*1000+ average(100-200 MW PBV)*0.2%*3000+ average(200-300 MW PBV)*0.1%*5000	Average(0-100 MW PBV)*0.2%*1000+ average(100-200 MW PBV)*0.1%*3000+ average(200-300 MW PBV)*0%*5000
= 50*0.3%*1000+ 150*0.2%*3000+ 250*0.1%*5000	= 50*0.2%*1000+ 150*0.1%*3000+ 250*0%*5000
= $2300/h	= $550/h

Construct the demand curve for the implicit approach: system penalty cost for power balance violation

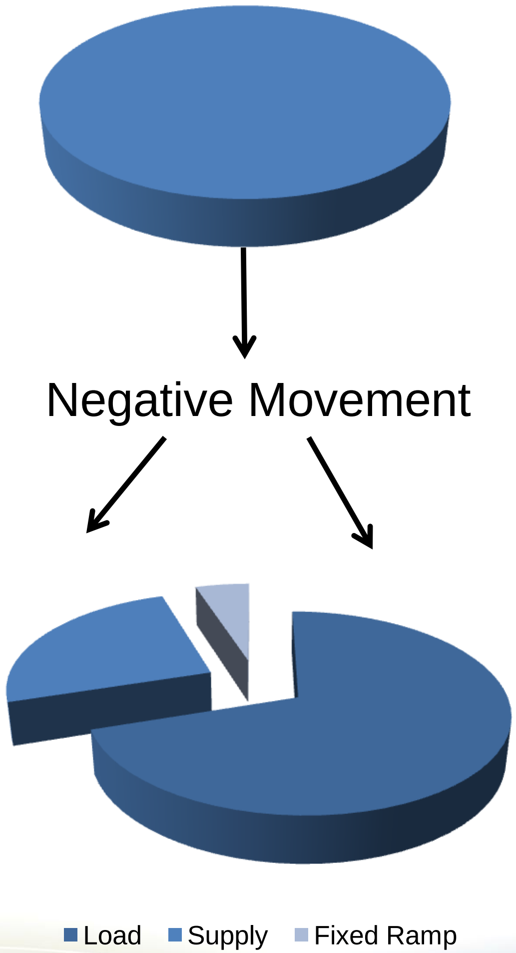
Cost200 = system penalty cost associated with 200 MW flex ramp =	Cost300 = system penalty cost associated with 300 MW flex ramp =
Average(0-100 MW PBV)*0.1%*1000+ average(100-200 MW PBV)*0%*3000+ average(200-300 MW PBV)*0%*5000	Average(0-100 MW PBV)*0%*1000+ average(100-200 MW PBV)*0%*3000+ average(200-300 MW PBV)*0%*5000
= 50*0.1%*1000+ 150*0%*3000+ 250*0%*5000	= 50*0%*1000+ 150*0.1%*3000+ 250*0%*5000
= $50/h	= $0/h

Construct the demand curve for the implicit approach: the marginal value of flex ramp

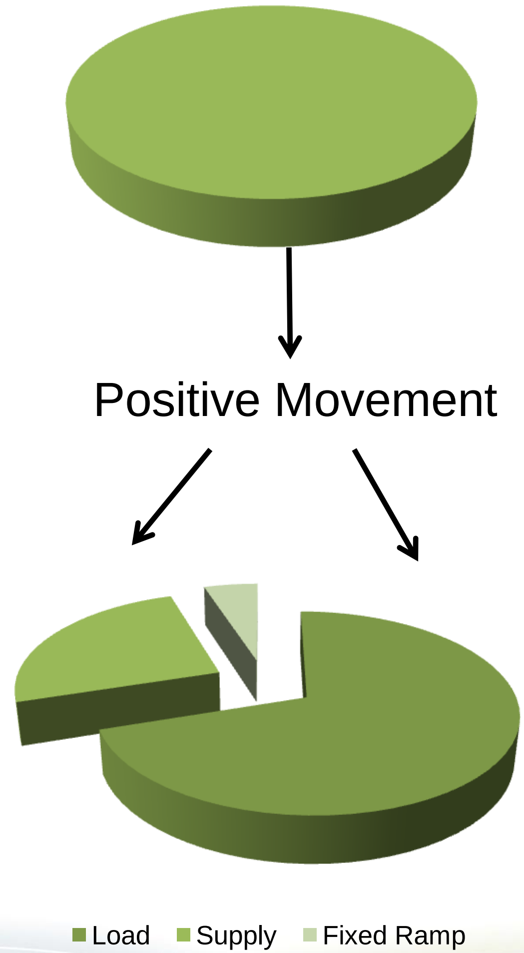
- The marginal values of flex ramp are
  - 0 MW to 100 MW, \$17.5/MWh
    - (cost0 – cost100)/100 = (2300 – 550)/100 = \$17.5/MWh
  - 100 MW to 200 MW, \$5/MWh
    - (cost100 – cost200)/100 = (550 – 50)/100 = \$5/MWh
  - 200 MW to 300 MW, \$0.5/MWh
    - (cost200 – cost300)/100 = (50 – 0)/100 = \$0.5/MWh
- The demand curve is defined by the marginal values

Allocate flexible ramping product costs consistent with guiding principles

Flexible Ramping Up



Flexible Ramping Down



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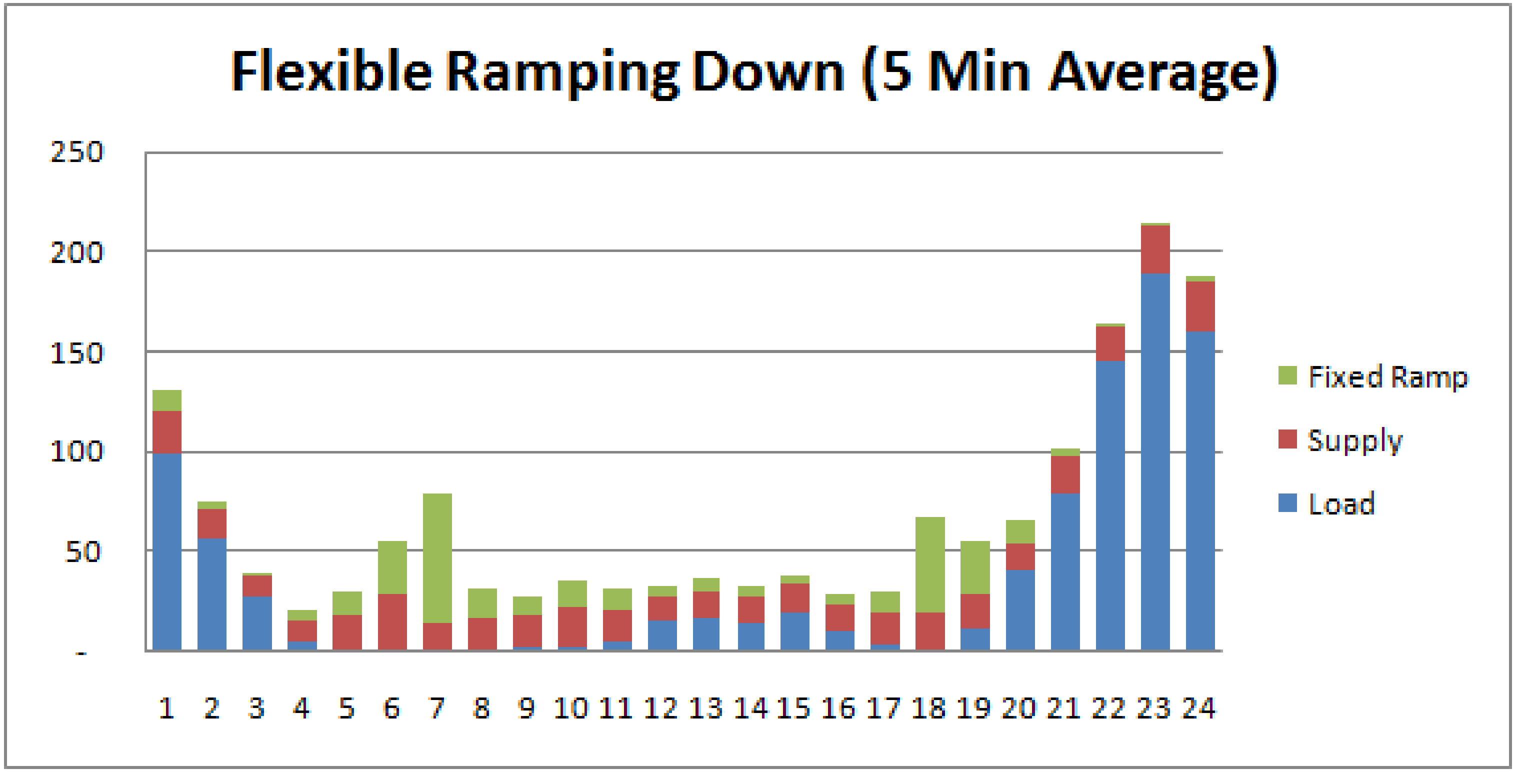
Movement is the 10 minute change

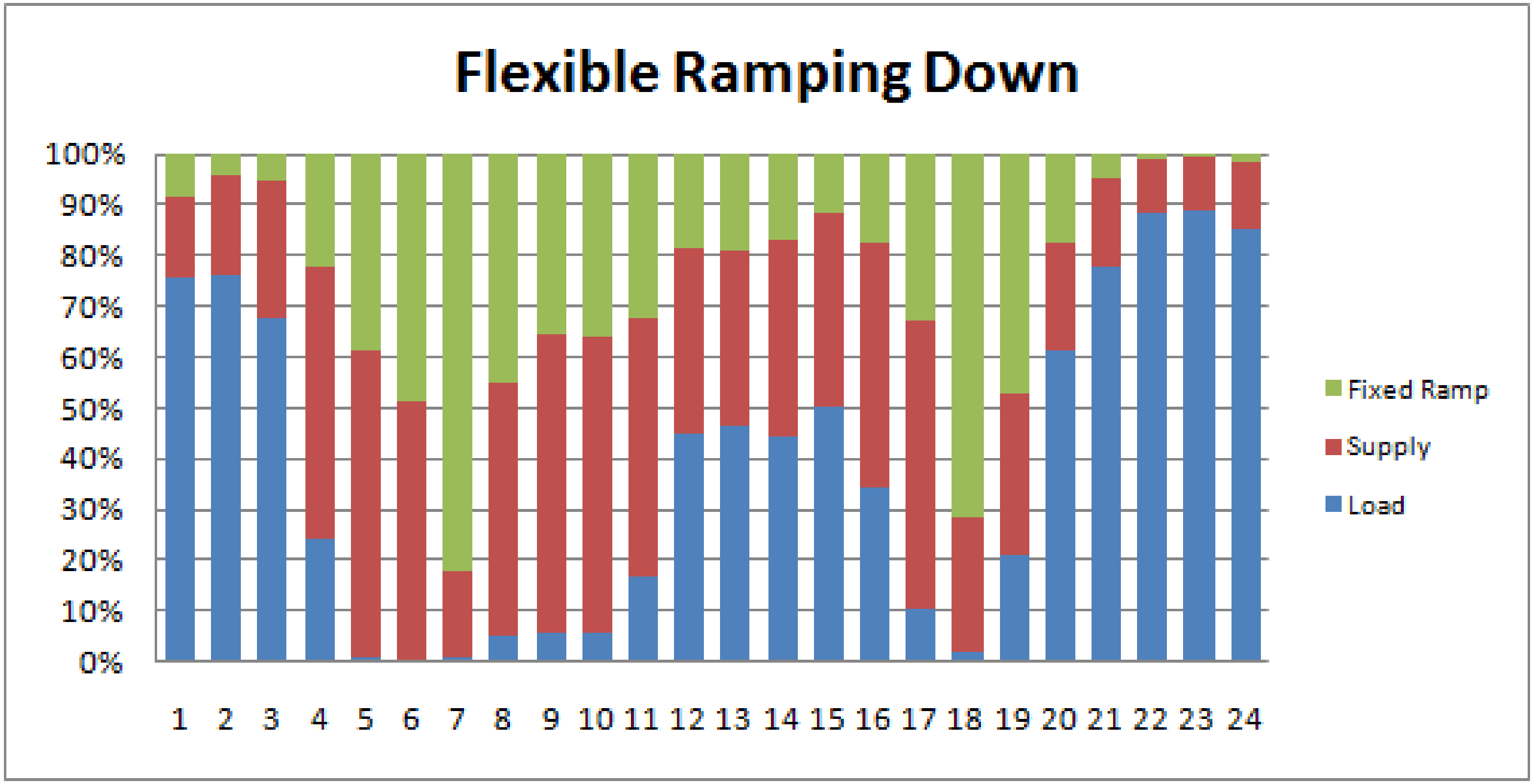
Initial Pie Slice

			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

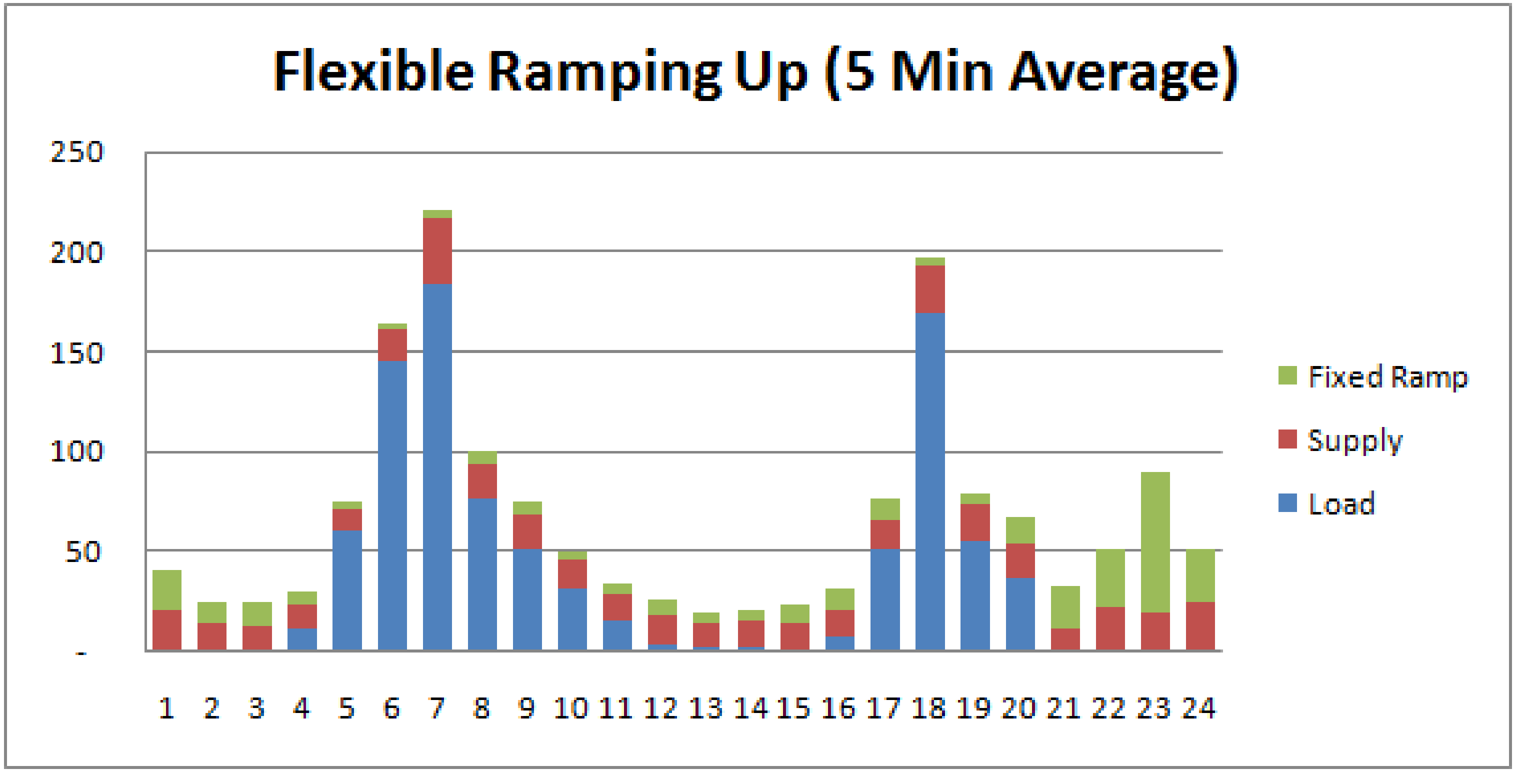
Hourly Average 5 minute Ramping – Actual 1/1/12 to 3/31/12



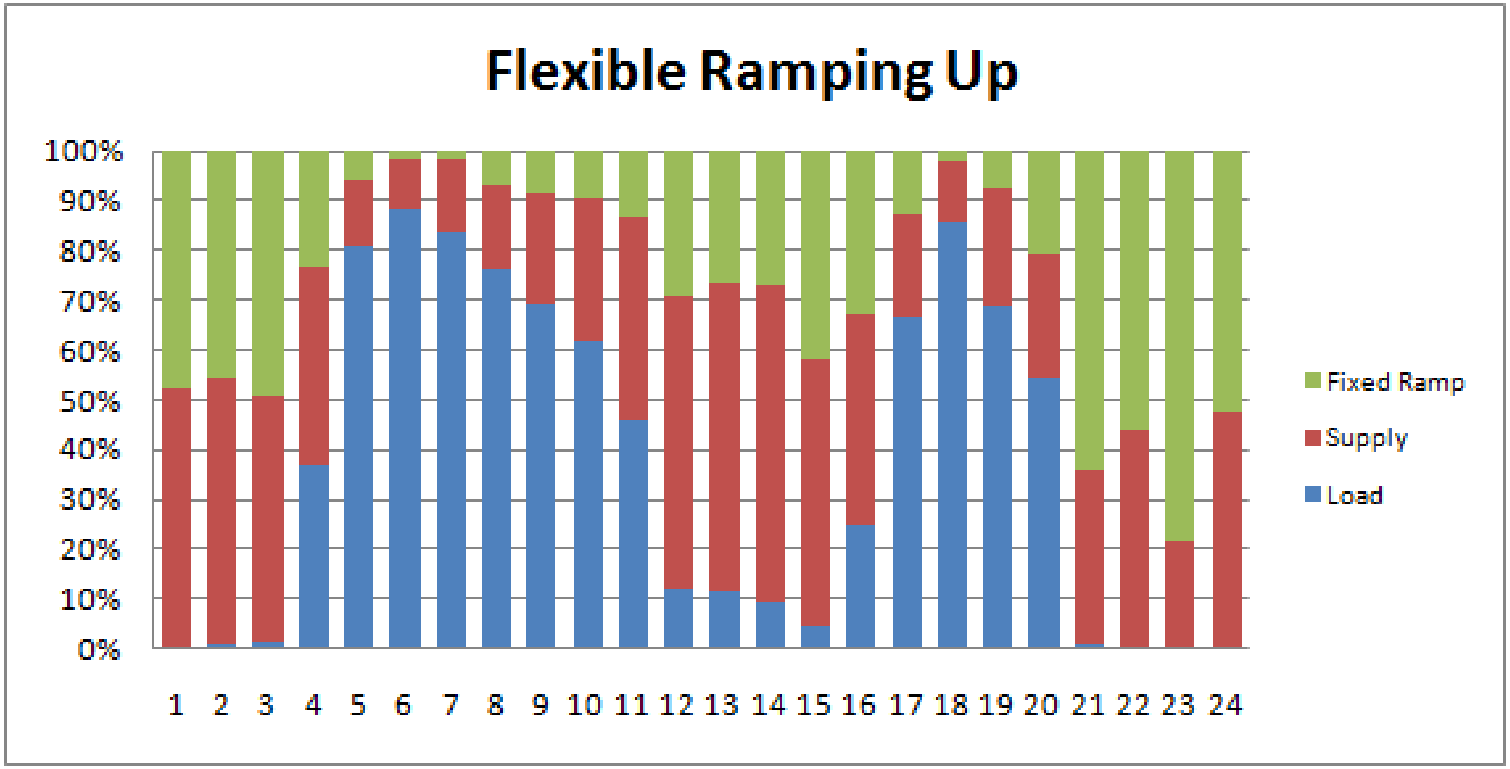
Hourly Split of the Pies – Actual 1/1/12 to 3/31/12



Hourly Average 5 minute Ramping – Actual 1/1/12 to 3/31/12

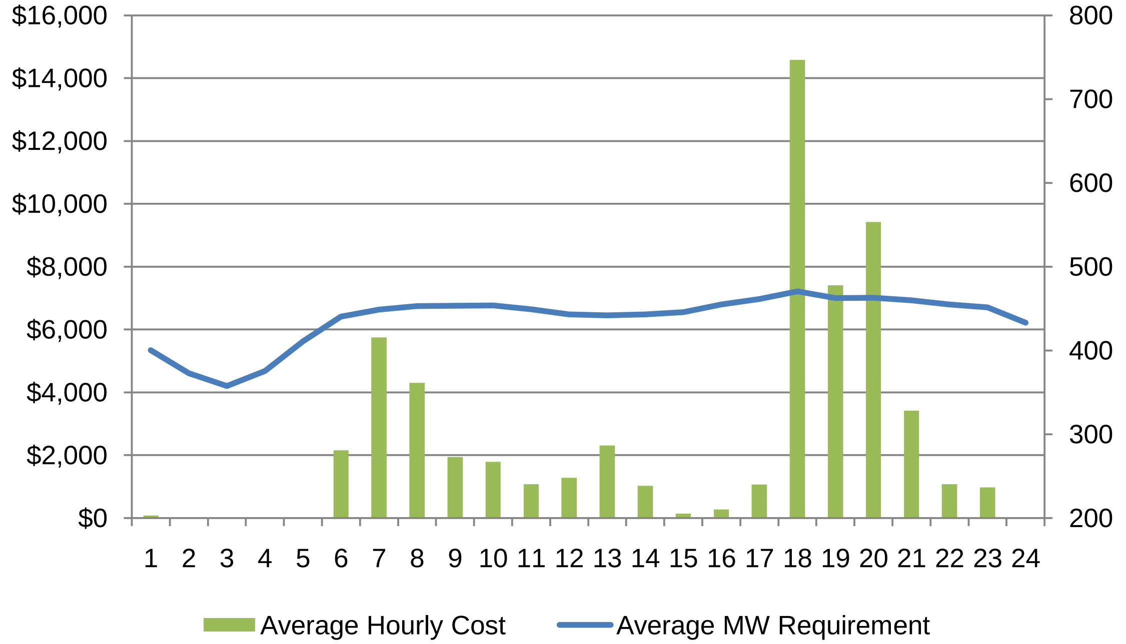


Hourly Split of the Pies – Actual 1/1/12 to 3/31/12



Flexible Ramping Constraint Costs by Hour (January to March)

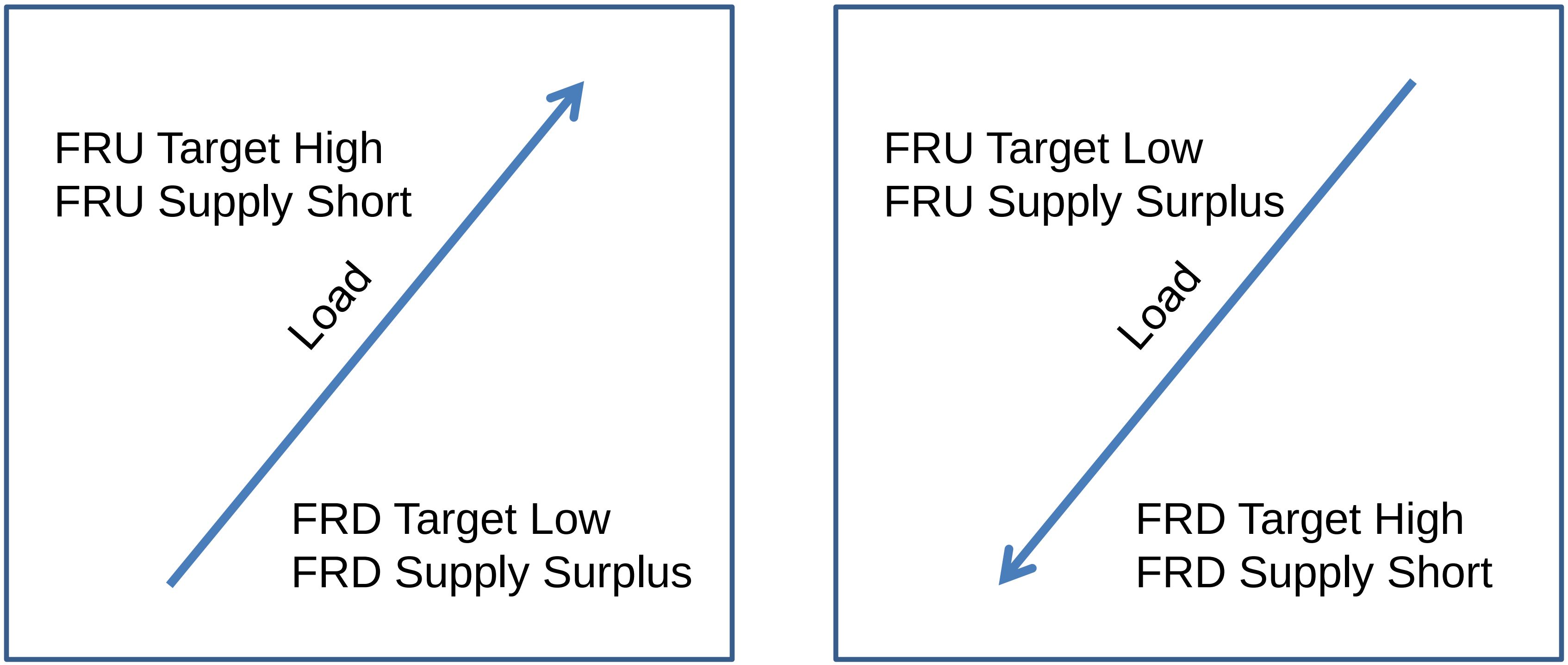
	Average MW Requirement	Total Cost	Average Hourly Cost
HE 01	400	$ 7,136	$ 78
HE 02	373	$ 2,549	$ 28
HE 03	357	$ -	$ -
HE 04	375	$ 10	$ 0
HE 05	411	$ -	$ -
HE 06	440	$ 196,147	$ 2,155
HE 07	449	$ 522,761	$ 5,745
HE 08	453	$ 391,416	$ 4,301
HE 09	453	$ 176,463	$ 1,939
HE 10	454	$ 163,007	$ 1,791
HE 11	449	$ 98,292	$ 1,080
HE 12	443	$ 116,843	$ 1,284
HE 13	442	$ 210,416	$ 2,312
HE 14	443	$ 93,867	$ 1,032
HE 15	446	$ 12,885	$ 142
HE 16	455	$ 24,749	$ 275
HE 17	462	$ 97,445	$ 1,071
HE 18	471	$ 1,327,341	$ 14,586
HE 19	463	$ 674,018	$ 7,407
HE 20	463	$ 857,866	$ 9,427
HE 21	460	$ 311,296	$ 3,421
HE 22	455	$ 97,828	$ 1,075
HE 23	451	$ 88,118	$ 979
HE 24	433	$ 94	$ 1
Total		$ 5,470,546	



Load Category	$3.8M (70%)
Supply Category	$1.0M (19%)
Fixed Ramp	$0.6M (12%)

Propose hourly granularity for cost allocation

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

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Allocation of each pie slice

		Baseline	Actual	Deviation	Allocation
1	Load	Day-Ahead Schedule	Metered Demand	UIE1 + UIE2	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 Movement	Gross by SC

No netting across settlement intervals.

Other Design Elements

- Maintain monthly resettlement, but by hour
- 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	• 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. • Transition period
Synchronized	• Monthly re-settlement of hourly costs
Rational	• Maximize the use of existing settlement functionality

Next Steps

Item	Date
Post Supplemental Paper and Data	July 11, 2012
Stakeholder Meeting	July 17, 2012
Stakeholder Comments Due	July 24, 2012
Post Revised Draft Final Proposal	August 9, 2012
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

Please submit comments to FRP@caiso.com

Upcoming ISO Training Offerings

Date	Training
July 26	Welcome to the ISO (teleconference/webex)
August 1, 2	SC Certification Training (on-site)
August 23	Welcome to the ISO (teleconference/webex)

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