Gas Contingency Switching Example

MIC Special Session: Gas Contingency Costs

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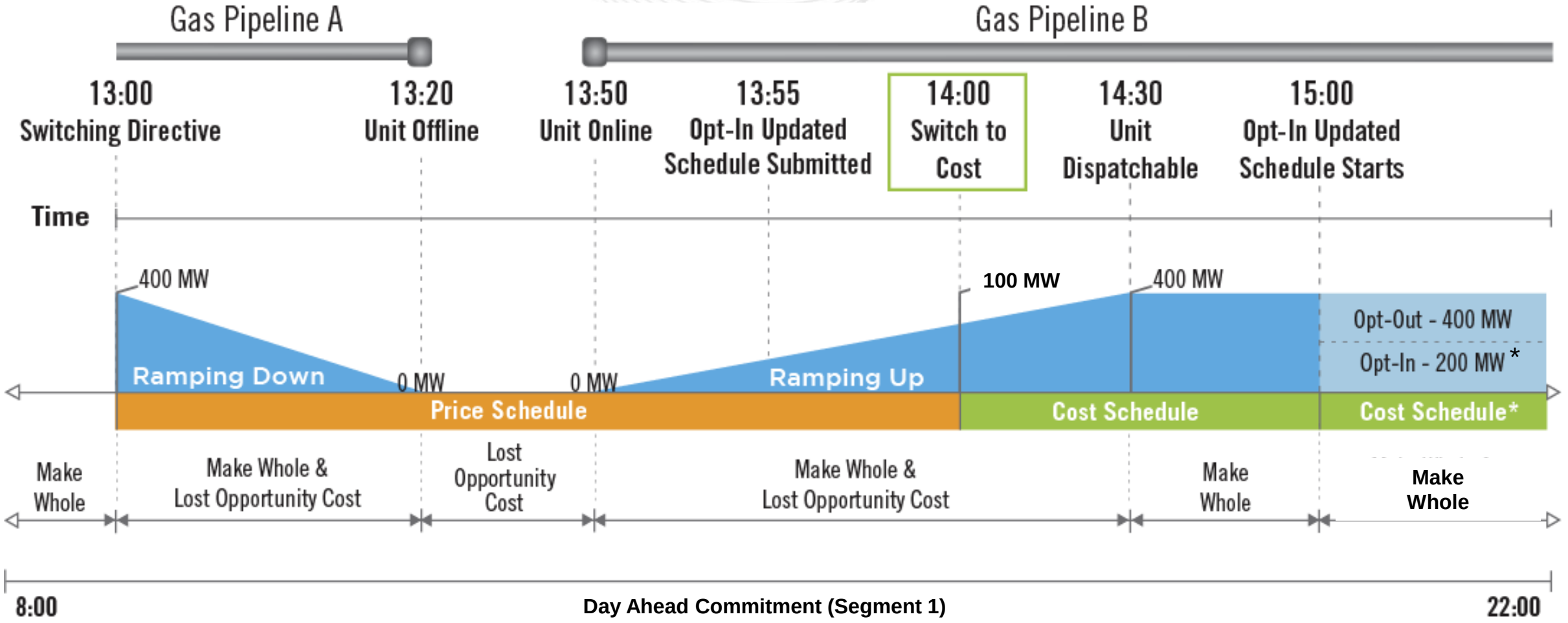
Switching Example Timeline

Natural gas fired unit is directed by PJM to switch pipelines

- T= 1300 - PJM Switching Directive
- T= 1320 - Unit shuts down to switch fuel supply
- T= 1350 - Unit restarts on new fuel supply
- T= 1355 - Opted In Unit submits updated Schedule to MG
- T= 1400 - Unit switches to cost schedule
- T= 1430 - Unit is dispatchable on new fuel supply
- T= 1500 - Opted in Unit updated cost schedule is active in MG

Gas Contingency Switching Example



Assumptions

- 400 MW Unit with 200 MW Eco Min
- Unit was picked up DA for 400 MW from 0800 to 2200
- DA LMP for 0800 to 2200 is $25/MWh
- RT LMP for 0800 to 1500 is $25/MWh
- Unit is backed down to 200 MW at 1500(Opt-In Unit Case)
- RT LMP from 1500 on is $54/MWh (Opt-In Unit Case)
- Gas balancing charges on Pipeline A are $10,000
- Penalty charges on Pipeline B are $8,000

DA & RT Pre-switching	
MW	Price
200	$18/MWh
400	$20/MWh
No-Load	$2,000/hr
Start Cost	$ 5,000

RT Post-switching	
MW	Cost
200	$54/MWh
400	$60/MWh
No-Load	$6,000/hr
Start Cost	$15,000

Settlements

- All affected units on the affected pipeline(s) will be offer capped.
- During schedule switching periods, Settlements will use the schedule in affect for the majority of the hour.
- Opt-in units may update cost schedule in accordance with their Fuel Cost Policies to reflect the current commodity cost.
- Opt-In & Opt-Out units will provide separately to PJM updated cost schedules based on actual commodity cost and any additional pipeline charges for an after the fact resettlement.

Settlement Make Whole Eligibility

- Settlements will use the schedule in affect for the majority of the hour to calculate make whole and LOC

Time Period	Output	Eligible for	Schedule
Before 1300	dispatchable	Make Whole	Price
1300 – 1320	ramping off	Make Whole + LOC	Price
1320 – 1350	off line	LOC	Price
1350 – 1400	ramping up	Make Whole + LOC	Price
1400 – 1430	ramping up	Make Whole + LOC	Cost
1430 – 1500	dispatchable	Make Whole	Cost
After 1500	dispatchable	Make Whole	Updated Cost*

*Opt-In only

Settlement Numerical Examples

- Three different settlement cases were run:
  - Base case where DA and RT are identical.
  - Switching case for Opt-Out unit. No schedule update after switching.
  - Switching case for Opt-In unit that is backed down when updated schedule is active.

Base Case

Day Ahead

- DA Credits - $140,000
- DA OP Res - $ 0

Real Time

- RT Bal Credits - $ 0
- RT Costs - $ 0
- BOR - $ 0
- Reduced LOC - $ 0
- Offline LOC - $ 0

Credits – Costs

- Credits - $140,000
- PJM Pipe Credits - $ 0
- Costs - $139,600
- Pipeline Charges - $ 0
- Sum - $ 600

Opt-Out Unit Switching Case

Day Ahead

- DA Credits - $140,000
- DA OP Res - $ 0

Real Time

- RT Bal Credits - $ -10,677
- RT Costs - $295,329
- BOR - $161,006
- Reduced LOC - $ 1,256
- Offline LOC - $ 1,200

Credits – Costs

- Credits - $292,785
- PJM Pipe Credits - $ 18,000
- Costs - $295,329
- Pipeline Charges - $ 18,000
- Sum - $ -2,544

Opt-In Unit Switching Case

Day Ahead

- DA Credits - $140,000
- DA OP Res - $ 0

Real Time

- RT Bal Credits - $ -86,277
- RT Costs - $211,329
- BOR - $152,606
- Reduced LOC - $ 1,256
- Offline LOC - $ 1,200

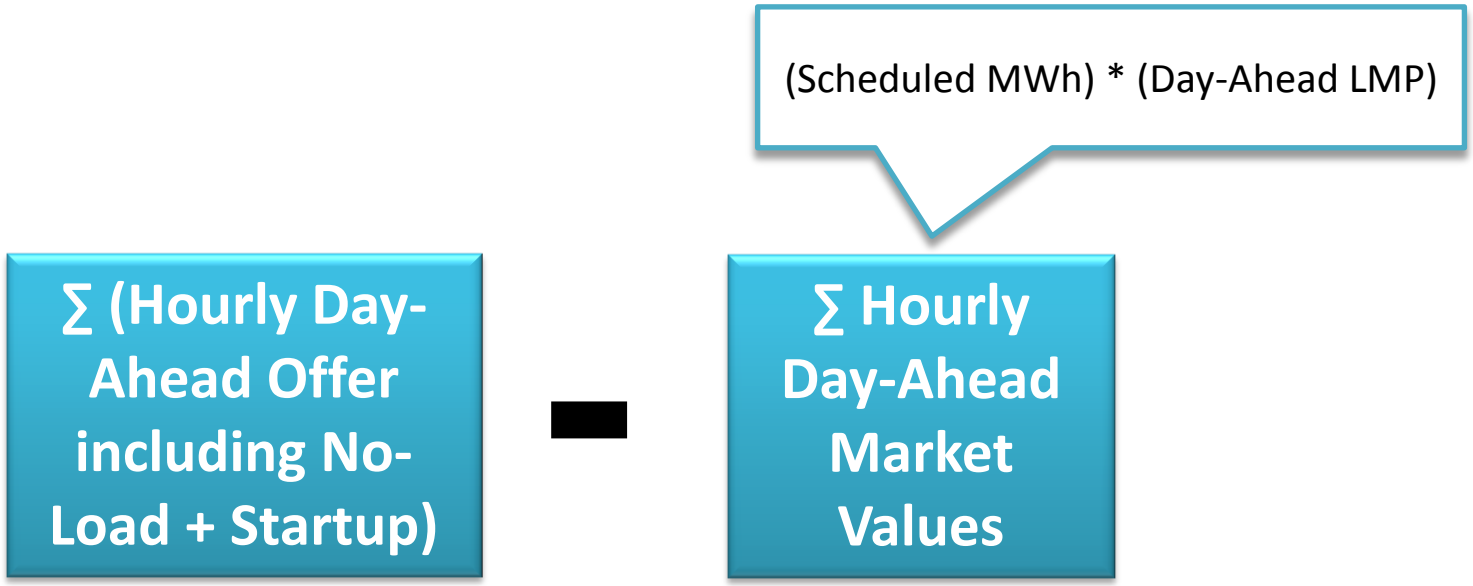
Credits – Costs

- Credits - $208,785
- PJM Pipe Credits - $ 18,000
- Costs - $211,329
- Pipeline Charges - $ 18,000
- Sum - $ -2,544

Appendix

- Market Settlement 301 Slides

Day-Ahead Operating Reserve Pool-Scheduled Generator Credit (BLI 2370)



- Day-ahead Operating Reserve credit equals any portion of resource's total day-head offer amount in excess of its total day-ahead market value
- Day-Ahead Offer based on committed offer and cleared Day-Ahead MWh
- Applies Startup and no-load bids if start up and no-load switch is set for resource offer data and if start-up bid is applicable for MWh and status of resource

BOR Generator Credit (BLI 2375)

- Balancing Operating Reserve Credit for each segment
- If result is negative, credit is $0

Real-Time MW is Greater of …

- Real-Time MW
- *Lessor of …*
  - DA Scheduled MW
  - *Greater of …*
    - RT Dispatch Desired MW
    - Committed Offer Desired MW

(Real-Time MW – Day-Ahead MW) * (Real-time LMP / 12)

∑ (5-Minute Real-Time Energy Offer including No-Load) + Startup − **∑ (5-Minute Balancing Value)** − **∑ 5-Minute Synchronized & Non Synchronized Reserves, Reactive & DASR Excess Revenues** − **Daily Day-Ahead Value** − **Daily Day-Ahead Operating Reserve Credit**

- All inputs with exception of Startup Cost are sum of 5-minute interval results applicable to segment
- Startup Cost is applied to applicable segment

- Only applies to segment corresponding to Day-Ahead Commitment (Segment 1 in Settlements)

LOC Credit for Pool Scheduled Generators (BLI 2375)

- LOC Credits are calculated for each eligible 5-minute interval
- If result is negative, credit is $0

LOC Deviation MW

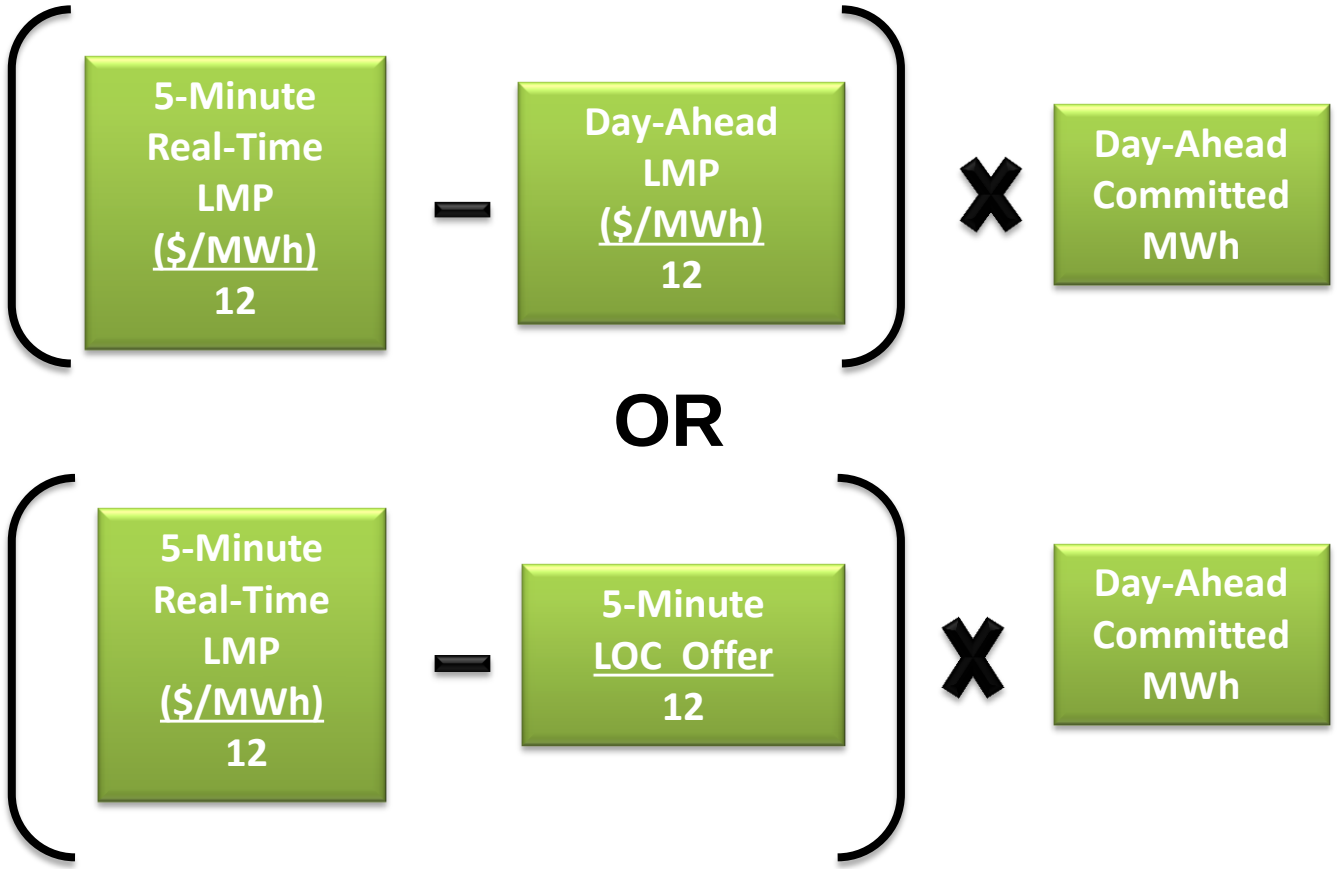
(**5-Minute Real-Time LMP Desired (MW)** − **5-Minute Revenue Data for Settlements (MW)**) × (**5-Minute Real-Time LMP ($/MWh)** / **12** − **5-Minute Lost Opportunity Cost Offer** / **12**)

- Determined using schedule on which unit is dispatched and 5-minute LMP
- Adjusted for effective 5-minute Regulation and Synchronized Reserve Assignments
- Capped at 5-minute economic max or Maximum Facility Output (MFO)
- Capped at 5-minute wind forecast for wind generators

- Does not include no-load and startup cost
- Offer is additional cost unit would have incurred if operating at LMP Desired MW ($/Deviation MW amount)

LOC Credit for Flexible Resource Committed Day-Ahead Not Operating in Real-Time

Each 5-minute interval LOC Credit is higher of …



LOC Offer

- 5-minute offer includes no-load and startup cost
- Startup cost excluded if resource operates in Real-Time in a 5-minute interval that coincides with Day-Ahead commitment
- Offer is additional cost unit would have incurred if operating at DA MW ($/DA MW amount)
- If result is negative, credit is $0

BOR Credit Interval Calculations

OLD

Hour End	OR Desired Gen (MWh)	RT Gen (MWh)	RT Gen Used (MWh)	RT LMP ($/MWh)	RT Energy Offer ($)	RT No Load ($)	RT Startup Cost ($)	Ancillary Service Offsetting Revenues	DASR Offsetting Revenues	Balancing Value ($)
01	50	46	46	96	$ 4,600	$ 50	$ 1,000	$ 100	$ 500	$ 4,416

$ 634 **Balancing Operating Reserve Credit**

Offer: 100 MW @$100/MWh

RT Energy Offer
+ RT No Load
+ RT Startup Cost
– Ancillary Service Offsetting Revenues
– DASR Offsetting Revenues
– Balancing Value

NEW

5-Minute Interval Begin Time	OR Desired Gen (MW)	RT Profiled Gen (MW)	RT Gen Used (MW)	RT LMP ($/MWh)	RT Energy Offer ($)	RT No Load Cost ($)	RT Startup Cost ($)	Ancillary Service Offsetting Revenues ($)	DASR Offsetting Revenues ($)	Balancing Value ($)
:00	0	0	0	$75	0	0	-	0		0
:05	0	0	0	$80	0	0	-	0		0
:10	0	0	0	$85	0	0	-	0		0
:15	0	0	0	$85	0	0	-	0		0
:20	0	0	0	$90	0	0	-	0		0
:25	0	0	0	$95	0	0	-	0		0
:30	100	50	50	$100	$ 417	$ 4.17	$1,000	$ 8.33	$ 41.67	$ 417
:35	100	98	98	$100	$ 817	$ 4.17	-	$ 8.33	$ 41.67	$ 817
:40	100	100	100	$125	$ 833	$ 4.17	-	$ 8.33	$ 41.67	$ 1,042
:45	100	108	108	$125	$ 900	$ 4.17	-	$ 8.33	$ 41.67	$ 1,125
:50	100	100	100	$100	$ 833	$ 4.17	-	$ 8.33	$ 41.67	$ 833
:55	100	100	100	$90	$ 833	$ 4.17	-	$ 8.33	$ 41.67	$ 750
					$ 4,633	**$ 25**	**$ 1,000**	**$ 50**	**$ 250**	**$ 4,983**

Sum (RT Energy Offer)
+ Sum (RT No Load)
+ RT Startup Cost
– Sum (Ancillary Service Offsetting Revenues)
– Sum (DASR Offsetting Revenue)s
– Sum (Balancing Value)

$ 375 **Balancing Operating Reserve Credit**