Reserve Pricing in Two Settlement System for RTS

Market Structures Working Group

DRAFT: For Discussion Purposes Only

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AGENDA

This presentation demonstrates some of the fundamental principals of the two settlement system for operating reserves that has been proposed for RTS.

It will work through some very simplified examples including settlements.

Day-Ahead Position

	Min Gen (MW)	Incremental Energy (MW)	Maximum Capacity (MW)	Spinning Reserve (MW)	Incremental Energy Offer Price ($/MW)	DA Spinning Reserve Availability Offer ($/MW)	Energy Schedule (MW)	Reserve Schedule (MW)
Unit 1	50	150	200	10	25	1	200	0
Unit 2	50	150	200	10	35	2	195	5
Unit 3	50	150	200	10	45	3	145	10
Unit 4	50	150	200	10	55	4	50	10
							590	25

Load (MW)	590
Reserve Requirement (MW)	25

LBMP ($/MWh	$45
Reserve Clearing Price ($/MW)	$12

DAY AHEAD

The table above shows the day-ahead schedules for energy and reserves upon which all these examples are based.

The Day-Ahead LBMP is derived from the incremental offer price of Unit 3. The Day-Ahead operating reserve price is a combination of the $2 availability offer and $10 opportunity cost on Unit 2.

RT Base Case

	Min Gen (MW)	Incremental Energy (MW)	Maximum Capacity (MW)	Spinning Reserve (MW)	Incremental Energy Offer Price ($/MW)	RT Spinning Reserve Availability Offer ($/MW)	Energy Schedule (MW)	Reserve Schedule (MW)
Unit 1	50	150	200	10	25	0	200	0
Unit 2	50	150	200	10	35	0	200	0
Unit 3	50	150	200	10	45	0	90	5
Unit 4	50	150	200	10	55	0	50	10
Unit 5	50	150	200	10	65	0	50	10
							590	25

Load (MW)	590
Reserve Requirement (MW)	25

LBMP ($/MWh	$45
Reserve Clearing Price ($/MW)	$0

	Net Energy Schedule (MW)	Net Reserve Schedule (MW)	RT Energy Payment ($)	RT Reserve Payment ($)	Additional Cost ($)	Profit ($)
Unit 1	0	0	$ -	$ -	$ -	$ -
Unit 2	5	-5	$ 225	$ -	$ 175	$ 50
Unit 3	-55	-5	$ (2,475)	$ -	$ (2,475)	$ -
Unit 4	0	0	$ -	$ -	$ -	$ -
Unit 5	50	10	$ 2,250	$ -	$ -	$ 2,250
	0	0	$ -	$ -		
Load	0	0	$ -	$ -		

RT Base Case

Between day-ahead and real-time Unit 5 self commits, i.e. gets online in RT by reducing its minimum generation block bid to $0.

This causes a redistribution of RT energy and reserve scheduled creating net energy and reserve settlement positions for some of the generators in RT.

Note that as the RT load has not changed from day-ahead there is no RT settlement on load for either reserves or energy. All additional revenues required to pay generators not scheduled day-ahead is recovered from other generators who were scheduled day-ahead and were not in RT.

The RT LBMP is derived from the incremental offer price of Unit 3. The RT operating reserve price is $0 as no provider of reserves in RT has either an opportunity cost or a non-zero availability offer price.

RT Higher Load

	Min Gen (MW)	Incremental Energy (MW)	Maximum Capacity (MW)	Spinning Reserve (MW)	Incremental Energy Offer Price ($/MW)	RT Spinning Reserve Availability Offer ($/MW)	Energy Schedule (MW)	Reserve Schedule (MW)
Unit 1	50	150	200	10	25	0	200	0
Unit 2	50	150	200	10	35	0	200	0
Unit 3	50	150	200	10	45	0	195	5
Unit 4	50	150	200	10	55	0	190	10
Unit 5	50	150	200	10	65	0	165	10
							950	25

Load (MW)	950
Reserve Requirement (MW)	25

LBMP ($/MWh	$65
Reserve Clearing Price ($/MW)	$20

	Net Energy Schedule (MW)	Net Reserve Schedule (MW)	RT Energy Payment ($)	RT Reserve Payment ($)	Additional Cost ($)	Profit ($)
Unit 1	0	0	$ -	$ -	$ -	$ -
Unit 2	5	-5	$ 325	$ (100)	$ 175	$ 50
Unit 3	50	-5	$ 3,250	$ (100)	$ 2,250	$ 900
Unit 4	140	0	$ 9,100	$ -	$ 7,700	$ 1,400
Unit 5	165	10	$ 10,725	$ 200	$ 7,475	$ 3,450
	360	0	$ 23,400	$ -	$ 17,600	$ 5,800
Load	360	0	$ 23,400	$ -		

RT High Load

Unit 5 self commits in Real-Time but Real-Time load comes in much higher than was expected Day-Ahead.

This causes a redistribution of RT energy and reserve scheduled creating net energy and reserve settlement positions for some of the generators in RT.

The net Real Time load must cover its shortfall in the energy market. However the load bought sufficient operating reserves day-ahead, so any increases in a generators reserve schedule is offset by another generators reduction.

The RT LBMP is derived from the incremental offer price of Unit 5. The RT operating reserve price is derived from the opportunity cost of Unit 3 relative to the RT LBMP

RT Shortage Condition

	Min Gen (MW)	Incremental Energy (MW)	Maximum Capacity (MW)	Spinning Reserve (MW)	Incremental Energy Offer Price ($/MW)	RT Spinning Reserve Availability Offer ($/MW)	Energy Schedule (MW)	Reserve Schedule (MW)
Unit 1	50	150	200	10	25	0	200	0
Unit 2	50	150	200	10	35	0	200	0
Unit 3	50	150	200	10	45	0	200	0
Unit 4	50	150	200	10	55	0	195	5
Unit 5	50	150	200	10	65	0	190	10
Shortage	0	0	0	25	N/A	100		10
							985	25

Load (MW)	985
Reserve Requirement (MW)	25

LBMP ($/MWh	$155
Reserve Clearing Price ($/MW)	$100

	Net Energy Schedule (MW)	Net Reserve Schedule (MW)	RT Energy Payment ($)	RT Reserve Payment ($)	Additional Cost ($)	Profit ($)
Unit 1	0	0	$ -	$ -	$ -	$ -
Unit 2	5	-5	$ 775	$ (500)	$ 175	$ 100
Unit 3	55	-10	$ 8,525	$ (1,000)	$ 2,475	$ 5,050
Unit 4	145	-5	$ 22,475	$ (500)	$ 7,975	$ 14,000
Unit 5	190	10	$ 29,450	$ 1,000	$ 9,100	$ 21,350
Shortage	0	10				
Total	395	0	$ 61,225	$ (1,000)	$ 19,725	$ 40,500
Load	395	0	$ 61,225	$ -		

Shortage Conditions

Unit 5 self commits in Real-Time but Real-Time load comes in much higher than was expected Day-Ahead causing a reserve shortage. The reserve demand curve starts at a shortage cost of $100 for the first 15 MW of shortage.

The RT LBMP is derived from the incremental offer price of Unit 4 at $55 which is where the next MW of energy would be dispatched plus the shortage cost of operating reserves as the system is now an additional MW short of reserves . The RT operating reserve price is derived from the demand curve ($100).

Original

Energy Schedule (MW)	Reserve Schedule (MW)
200	0
200	0
200	0
195	5
190	10
	10
985	25

Incremental MW of Energy

Energy Schedule (MW)	Reserve Schedule (MW)
200	0
200	0
200	0
196	4
190	10
	11
986	25

Difference

Energy Schedule (MW)	Reserve Schedule (MW)
0	0
0	0
0	0
1	-1
0	0
0	1
1	0

Reserve Pickup

	Min Gen (MW)	Incremental Energy (MW)	Maximum Capacity (MW)	Spinning Reserve (MW)	Incremental Energy Offer Price ($/MW)	RT Spinning Reserve Availability Offer ($/MW)	Energy Schedule (MW)	Reserve Schedule (MW)
Unit 1	50	150	200	10	25	0	200	0
Unit 2	50	150	200	10	35	0	195	5
Unit 3	50	150	200	10	45	0	145	10
Unit 4	0	0	0	0	55	0	0	0
Unit 5	50	150	200	10	65	0	50	10
							590	25

Load (MW)	590
Reserve Requirement (MW)	25

LBMP ($/MWh	$45
Reserve Clearing Price ($/MW)	$10

	Net Energy Schedule (MW)	Net Reserve Schedule (MW)	RT Energy Payment ($)	RT Reserve Payment ($)	Additional Cost ($)	Profit ($)
Unit 1	0	0	$ -	$ -	$ -	$ -
Unit 2	0	0	$ -	$ -	$ -	$ -
Unit 3	0	0	$ -	$ -	$ -	$ -
Unit 4	-50	-10	$ (2,250)	$ (100)	$ (2,750)	$ 400
Unit 5	50	10	$ 2,250	$ 100	$ -	$ 2,350
	0	0	$ -	$ -	$ (2,750)	$ 2,750
Load	0	0	$ -	$ -		

Reserve Pickup

Unit 5 self commits in Real-Time but Unit 4 trips causing a reserve pickup. In many respects a reserve pickup is no different from a regular dispatch as the model continues to try and secure the operating reserve requirements while also meeting load.

There are a variety of reserve pickup modes that RTD-CAM can operate in.

In this case the tripped unit is financially responsible for providing all the revenues necessary to pay Unit 5's real time schedule.

Before Reserve Pickup

	Min Gen (MW)	Incremental Energy (MW)	Maximum Capacity (MW)	Spinning Reserve (MW)	Incremental Energy Offer Price ($/MW)	RT Spinning Reserve Availability Offer ($/MW)	Energy Schedule (MW)	Reserve Schedule (MW)
Unit 1	50	150	200	10	25	0	200	0
Unit 2	50	150	200	10	35	0	200	0
Unit 3	50	150	200	10	45	0	90	5
Unit 4	50	150	200	10	55	0	50	10
Unit 5	50	150	200	10	65	0	50	10
							590	25

Load (MW)	590
Reserve Requirement (MW)	25

LBMP ($/MWh	$45
Reserve Clearing Price ($/MW)	$0

Reserve Pickup

	Min Gen (MW)	Incremental Energy (MW)	Maximum Capacity (MW)	Spinning Reserve (MW)	Incremental Energy Offer Price ($/MW)	RT Spinning Reserve Availability Offer ($/MW)	Energy Schedule (MW)	Reserve Schedule (MW)
Unit 1	50	150	200	10	25	0	200	0
Unit 2	50	150	200	10	35	0	195	5
Unit 3	50	150	200	10	45	0	145	10
Unit 4	0	0	0	0	55	0	0	0
Unit 5	50	150	200	10	65	0	50	10
							590	25

Load (MW)	590
Reserve Requirement (MW)	25

LBMP ($/MWh	$45
Reserve Clearing Price ($/MW)	$10

Reserve Pickup

Before the reserve pickup Unit 2 is scheduled to produce 200 MW of energy and 0 MW of reserves and during/after the reserve pickup it is scheduled to produce 195 MW of energy and 5 MW of reserves. If strict tolerances were applied to overgeneration and the unit did not reduce its output to 195 MW it would not be paid for its operating reserve, as it did not provide any, and would only be settled in RT relative to the 195 MW basepoint.

The units must follow their reserve and energy basepoints to ensure full payment under the two settlement system.