**Example Calculation of Benefit and Cost (Make-Whole payment) to Market**

**Setup:**

Gen Offer of 60,001 MW @ 30 $/MWh

Gen Offer of 100 MW @ 3,000 $/MWh

DR Bid To Buy of “blocky” 50 MW @ 1000 $/MWh (not to exceed price)

**Scenario of benefit to Market:**

1. Short Term Load Forecast is accurate
2. Multi-Interval Real-Time Market makes **correct commitment decision** (instructs DR to curtail consumption). The commitment instruction to DR (instruction to curtail) goes out at 8:55 and the instruction is to curtail “blocky” 50 MW from 9:00 to 9:15

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 9:00 | 9:05 | 9:10 | 9:15 | 9:20 | 9:25 | 9:30 | 9:35 | 9:40 |
| Load Forecast | 60,000 MW | 60,040 MW | 60,040 MW | 60,040 MW | 60,000 MW | 60,000 MW | 60,000 MW | 60,000 MW | 60,000 MW |
| Demand used in Pricing Run | 60,000 MW | 60,040 MW | 60,040 MW | 60,040 MW | 60,000 MW | 60,000 MW | 60,000 MW | 60,000 MW | 60,000 MW |
| Metered Demand with Curtailment | 60,000 MW | 59,950 MW | 59,950 MW | 59,950 MW | 60,000 MW | 60,000 MW | 60,000 MW | 60,000 MW | 60,000 MW |

*8:50 8:55 9:00 9:05 9:10 9:15 9:20 9:25 9:30 9:35 9:40 9:35*

Intervals where **ONLY** Commitment Instructions are **binding** and the LMPs and MW awards (energy, AS) are **indicative**

Interval where the LMPs, MW awards (energy, AS) and Commitment Instructions are **ALL** **binding** commitment instructions

Sequence of Multi-Interval RT Markets

Analysis window of rolling 30 minutes

RT Market Execution: Depicts the start and end times of the clearing process and the length of symbol is indicative of maximum time allowed to clear market

**30$** 1000$ 1000$ 1000$ 30$ 30$

**1000$** 1000$ 1000$ 30$ 30$ 30$

**1000$** 1000$ 30$ 30$ 30$ 30$

**1000$** 30$ 30$ 30$ 30$ 30$

1. In our current system (single interval SCED) with no DR participation, the LMP will be 3,000 $/MWh for the each SCED run at 9:00, 9:05 and 9:10 (future 15 minute interval)
	1. For future 15 minute interval (5, 10,15 minutes out) the Loads pay = 60,040 \*3,000 \*1/4= 45,030,000 $
2. For the Multi-Interval Real-Time Market (MIRTM) that runs at 8:55 covering the time 8:55 to 9:25 with DR participation, the indicative LMP will be 1000$/MWHr  starting at 9:00 to 9:15 (future 15 minute interval)
	1. As the load forecast is used by MIRTM @ time 8:55, the indicative LMPs will be correct and become the binding LMPs for the MIRTM that runs at 9:00, 9:05 and 9:10 (i.e. binding LMP from 9:00 to 9:15 will be 1000$/MWh)
		1. Here the DR is marginal as it sets the price=1000$/MWh (this will come out of the pricing run needed to price out “blocky” MW where the 50 MW is added back to demand and the “blocky” MW is treated as variable)
		2. For the settlement interval 9:00 to 9:15 the loads pay for actual energy consumed as per meter reading= (60,040-50)\*1000\*1/4=14,997,500 $
		3. There is no Make-Whole and no Uplift
3. Benefit to the Market is 45,030,000 $ - 14,997,500 $ =30,032,500 $

**Scenario of cost (Make-Whole payment) to Market:**

1. Short Term Load Forecast is overstating demand
2. Multi-Interval Real-Time Market **makes commitment decision which is not correct** **due to errors in the input Load Forecast** (instructs DR to curtail consumption). The commitment instruction to DR (instruction to curtail) goes out at 8:55 and the instruction is to curtail “blocky” 50 MW from 9:00 to 9:15

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 9:00 | 9:05 | 9:10 | 9:15 | 9:20 | 9:25 | 9:30 | 9:35 | 9:40 |
| Load Forecast | 60,000 MW | 60,040 MW | 60,040 MW | 60,040 MW | 60,000 MW | 60,000 MW | 60,000 MW | 60,000 MW | 60,000 MW |
| Actual Realized Demand | 60,000 MW | 60,000 MW | 60,000 MW | 60,000 MW | 60,000 MW | 60,000 MW | 60,000 MW | 60,000 MW | 60,000 MW |

1. The final binding LMP for 9:00, 9:05, 9:10 is actually 30 $/MWh
2. This means that there is no need to deploy DR
3. Gen offer is still marginal as it sets the price = 30$/MWh
4. For future 15 minute interval (10,15,20 minutes out) the loads pay for energy = (60,000-50)\*30\*1/4=449,625 $
5. Make-Whole payment to DR For future 15 minute interval (9:00 – 9:15)= 50\*1000\*1/4=12,500$ 🡨 Cost

*8:50 8:55 9:00 9:05 9:10 9:15 9:20 9:25 9:30 9:35 9:40 9:35*

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