

Regulation Hydro Lost Opportunity Cost Calculation Examples

Regulation Lost Opportunity Cost (RegLOC) is calculated for units that can be dispatched (pool scheduled) for regulation. The purpose is to quantify the foregone revenue or increased costs incurred by a unit when it regulates.

The example problems below only relate to market clearing hydro RegLOC calculation. Settlements will use real-time schedules and LMPs to calculate the average LMP and RegLOC used in billing.

More information about Regulation Market and hydro RegLOC can be obtained from section 3 (Overview of the PJM Regulation Market) of manual 11 – Scheduling Operations.

<http://www.pjm.com/documents/~/media/documents/manuals/m11.ashx>

Formula for Calculating RegLOC for Hydro Units

LMP = Forecasted hourly LMP at the hydro unit bus

ED = the average LMP at the hydro unit bus for the appropriate on-peak or off-peak period excluding those hours during which all available units at the hydro plant were operating.

Day-Ahead LMPs are used to calculate ED. Off-Peak hours are HE1 through HE7, and HE24. On-Peak hours are HE8 through HE23.

Actual LMP are used in the after-the fact settlement calculation of ED (average LMP).

If ScheduledMW > 0 then, LOMW (Lost Opportunity MW) = RegCapability

- a. For Pump Storage or Run Of River; $LOC = \max[LMP - ED, 0]$
- b. For Hydro Spill, $LOC = \max[LMP, 0]$

RegLOC (hydro) = $LOC * LOMW / RegCapability$

Example 1:

Units @ Hydro Plant			1	2	3		
DA_Period	HE	Include in AVE_LMP Calculation	DA_LMP	MW	MW	MW	
Off peak	1	Y	24.68	0	0	0	Off-Peak Ave_LMP = 21.28
	2	Y	23.14	0	0	0	
	3	Y	21.46	0	0	0	
	4	Y	18.78	0	0	0	
	5	Y	17.74	0	0	0	
	6	Y	17.37	0	0	0	
	7	Y	16.73	0	0	0	
On peak	8	Y	35.29	0	0	90	On-Peak Ave_LMP = 42.61
	9	N	56.77	80	120	100	
	10	N	71.01	80	120	100	
	11	N	89.92	80	120	100	
	12	N	89.45	80	120	100	
	13	N	94.58	80	120	100	
	14	N	86.06	80	120	100	
	15	N	80.89	80	120	100	
	16	N	82.48	80	120	100	
	17	N	90.22	80	120	100	
	18	N	96.5	80	120	100	
	19	N	92.98	80	120	100	
	20	N	85.08	80	120	100	
	21	N	73.18	80	120	100	
	22	Y	56.76	70	100	0	
	23	Y	35.79	0	0	90	
Off peak	24	Y	30.36	0	0	90	

Let's assume hydro unit 2 in plant A has the following parameters:

EcoMax = 120, Regulation Offer MW = 25

Scenario 1:

Unit 2 was pool scheduled for Regulation for HE11 for 25 MW. The forecasted LMP at the unit bus = \$52.10

- i. ScheduledMW > 0
- ii. LOMW = RegCapability = 25 MW
- iii. The unit is a run of river hydro but not spilling
- iv. $LOC = \max[LMP - ED, 0] = \max[(52.10 - 42.61), 0] = 9.49$
- v. $RegLOC = LOC * LOMW / RegCapability = 9.49 * 25 / 25 = \$9.49 / MWhr$

Scenario 2:

Unit 2 was pool scheduled for Regulation for HE12 for 25 MW. The forecasted LMP at the unit bus = \$35.78

- i. ScheduledMW > 0
- ii. LOMW = RegCapability = 25
- iii. The unit is a run of river hydro but not spilling
- iv. $LOC = \max[LMP - ED, 0] = \max[(35.78 - 42.61), 0] = 0$
- v. $RegLOC = LOC * LOMW / RegCapability = 0 * 25 / 25 = \$0 / MWhr$ (**No RegLOC**)

Example 2:

DA_Period	Units @ Hydro Plant			1	2	
	HE	Include in Ave_LMP Calculation	DA LMP	MW	MW	
Off-Peak	1	N	10	-200	-200	Off-Peak Ave_LMP = (33+35+45) / 3 = 37.67
	2	N	15	-200	-200	
	3	N	20	-200	-200	
	4	N	13	-200	-200	
	5	N	21	-200	-200	
	6	Y	33	0	0	
	7	Y	35	0	0	
On-Peak	8	Y	44	0	0	On-Peak Ave_LMP = (44+52+56+48+50+60+75+71) / 8 = 57
	9	N	68	200	200	
	10	N	75	200	200	
	11	N	95	200	200	
	12	N	100	200	200	
	13	Y	52	0	0	
	14	Y	56	0	0	
	15	Y	48	0	0	
	16	Y	50	0	0	
	17	Y	60	0	0	
	18	Y	75	200	0	
	19	N	110	200	200	
	20	N	121	200	200	
	21	N	99	200	200	
	22	N	89	200	200	
	23	Y	71	0	0	
Off-Peak	24	Y	45	0	0	

Let's assume hydro unit 1 in plant B has the following parameters:

EcoMax = 200, Regulation Offer MW = 50

Scenario 3:

Unit 1 was pool scheduled for Regulation for HE19 for 50 MW. The forecasted LMP at the unit bus = \$65

- i. ScheduledMW > 0
- ii. LOMW = RegCapability = 50
- iii. The unit is a pump storage hydro
- iv. $LOC = \max[LMP - ED, 0] = \max[(65 - 57), 0] = 8$
- v. $RegLOC = LOC * LOMW/RegCapability = 8 * 50/50 = \$8/MW\text{Hr}$

Scenario 4:

Unit 1 was pool scheduled for Regulation for HE20 for 50 MW. The forecasted LMP at the unit bus = \$35

- i. ScheduledMW > 0
- ii. LOMW = RegCapability = 50
- iii. The unit is a pump storage hydro
- iv. $LOC = \max[LMP - ED, 0] = \max[(35 - 57), 0] = 0$
- v. $RegLOC = LOC * LOMW/RegCapability = 0 * 50/50 = \$0/MW\text{Hr}$ (**No RegLOC**)

Note:

The example problems only relate to the market clearing hydro RegLOC calculation. Settlements will use real-time schedules and LMPs to calculate the average LMP and LOC used in billing.

In after the fact settlement calculation, RegLOC will only be paid to a regulation pool scheduled unit which does not recover its costs of regulating through the Regulation Market Clearing Price (RMCP).

Please send your questions on these examples to PJM Markets Hotline at markets_hotline@pjm.com or call 610-666-8998.