ERCOT FAST PROPOSAL – REGULATION SERVICE PAY-FOR-PERFORMANCE
APEX COMPRESSED AIR ENERGY STORAGE, LLC

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When providing Regulation Services to ERCOT, a unit's precision in following ERCOT instruction signals should be inherently linked to its value, since a more precise unit can more efficiently control deviations in energy imbalance and frequency. This precision is valued most during periods of large and/or frequent changes in signal instructions by ERCOT.

Aside from full or partial decertification, the current ERCOT market structure for Regulation Services neglects historical hourly precision as a criterion upon which Regulation providers are differentiated. The market's lack of hourly performance incentives can adversely affect grid or market operations. Apex believes that a real-time pay-for-performance mechanism will deliver two major benefits to ERCOT market participants…

1. Decrease procurement volumes for Regulation Services, since better performance should mean lower deployment levels; and
2. Partially rebate ancillary service costs to Load Serving Entities for payments to resources who fail to perform fully.

The proposed approach compares a unit's 1-minute control deviations from ERCOT instruction (summed across an hour) to cumulative instruction changes for a given hour in order to obtain a measure of a unit's precision in following the ERCOT Load Frequency Control (LFC) signal.

1-minute Deployment Deviation* $= \left| ATG\,MW_t - AEPFR\,MW_t - UDBP\,MW_t - ARI\,MW_t \right|$

Cumulative Instructed Changes $= \sum_{t=1}^{60} \left| UDBP\ MW\ t - UDBP\ MW\ t-1 \right|$

ATG = Average Telemetered Net Generation over 1-minute interval

AEPFR = Average estimated Primary Frequency Response (8.1.1.4.1)

UDBP = Updated Desired Base Point (6.5.7.6.1)

ARI MW_t = Average Regulation Instruction (8.1.1.4.1); sum of Reg Up and Reg Down Instruction

* Not to exceed the Regulation supply commitment for the Resource

The comparison between unit deviation from the ERCOT signal and the Cumulative Instructed Changes on a 1-minute interval, yields the unit's "error rate", or its imprecision in following ERCOT's Regulation signal. However, two adjustments should be added to the measurement of 1-minute Deployment Deviation – a small tolerance band to account for inherent lack of precision for large generation units and the plant metering, plus a correction for changes in UDBP signals that exceed the ramp commitment of a Resource (i.e., if a resource has sold 50 MW of Up-Regulation, then it's ramp commitment is 10 MW per minute).

Because generators are large electro-mechanical devices, utilizing equipment with some inherent imprecision, Apex believes that the performance based Regulation market should incorporate a

reasonable “tolerance band” to account for acceptable unit response deviation and signal noise during quiescent periods. Within the tolerance band, no penalties should be accrued.

$$\textbf{Hourly tolerance band} = Max\ (5\ MW,\ 5\% * \sum_{t=1}^{60} Cumulative\ Instructed\ Changes)$$

$$\textbf{Interval tolerance band} = 5\% * Instructed\ Change$$

The correction for UDBP signals that exceed ramp commitment would ensure that timing issues in the ERCOT SCED process would not create penalties for generation resources. This is in reference to “direction” changes while a generator is ramping one direction and then gets turned around. If the generator is short of the target when SCED runs for the next interval, it will calculate the LDL and HDL based on five times the ramp rate from the actual generation when SCED ran. This can cause the requested Target for the next interval to exceed the ramp rate of the unit. The generator most likely has already received control to achieve the previous UDBP but due to control latency has not quite achieved the target. The change from new UDBP from the previous UDBP can exceed the ramp capability/commitment of the generator and cause 1-minute Deployment Deviation.

$$\textbf{Hourly Error Rate (\%)} = \frac{\left[\sum_{t=1}^{60}(Dispatch\ deviation) - \sum_{t=0}^{360}(Tolerance\ band)\right]}{\sum_{t=0}^{60}(Cum.Instructed\ Changes)}$$

The Regulation payment received by an individual unit should be adjusted according to its Hourly Error Rate. This penalty is levied, on a $/MWh basis, as follows:

$$\textbf{Regulation Penalty Rate (\$/MWh)} = [2.0] * Max\ (0,\ Hourly\ Error\ Rate) * Regulation\ MCPC_{DAM}\ (\$/MW)$$

The product of the penalty rate and a generating unit’s total Regulation award (MW) yields the total penalty amount charged to the unit for a specific hour.

$$\textbf{Hourly Regulation Penalty (\$)} = Regulation\ Penalty\ Rate\ (\$/MWh) * Regulation\ Award\ for\ Resource\ (MW)$$

Example calculation

Table 1, below, provides a chronological example of a unit’s output, in relation to the ERCOT instruction (UDBP + Reg MW), over an hour with 1-minute intervals. Chart 1, below, provides a graphical representation of Table 1; the area between the red and blue lines depicts 1-minute Deployment Deviations for the Resource, or the difference between Resource MW output (ATG) and the ERCOT instruction (UDBP).

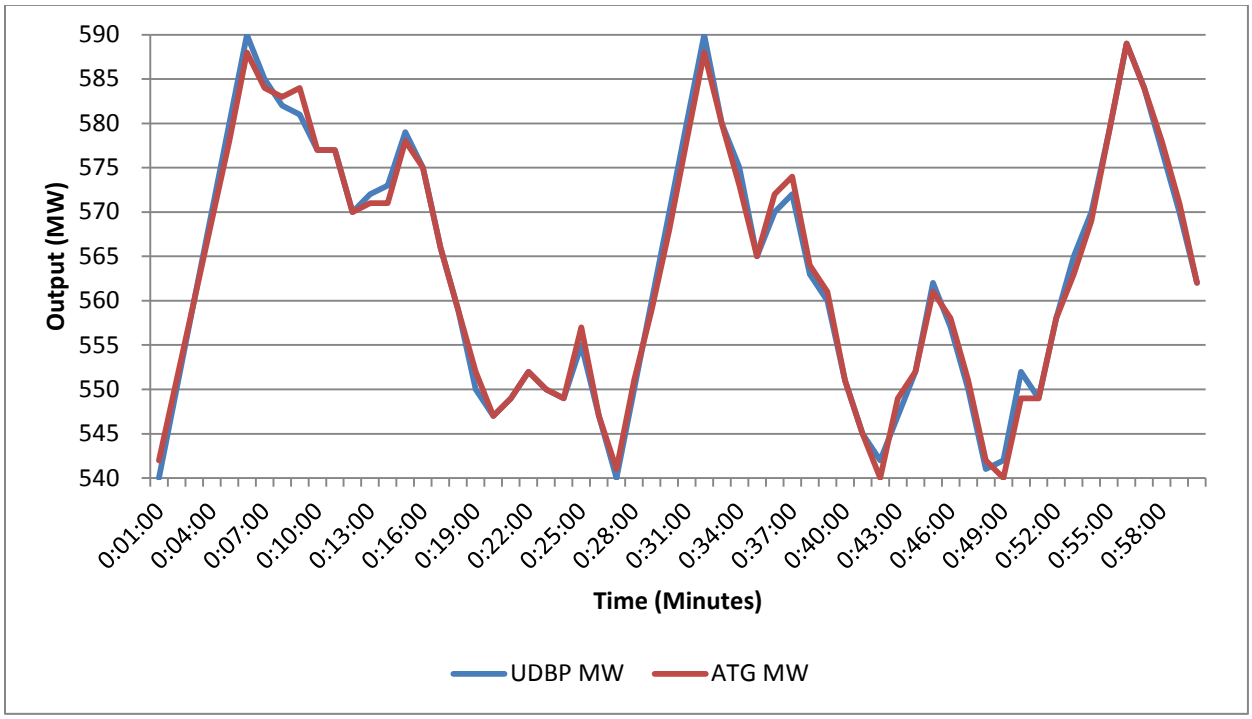
Table 1: 1-minute unit responses to ERCOT Regulation instruction for a one-hour duration

Time	Signal MW	Unit output MW	Dispatch deviation |Unit - UDBP| MW	Cumulative Instructed Changes $\|UDBP_t - UDBP_{t-1}\|$ MW	Interval Tolerance Band (5% * Instructed Changes) MW
0:01:00	540	542	2	0	0.00
0:02:00	550	551	1	10	0.50
0:03:00	560	560	0	10	0.50
0:04:00	570	569	1	10	0.50
0:05:00	580	578	2	10	0.50
0:06:00	590	588	2	10	0.50
0:07:00	585	584	1	5	0.25
0:08:00	582	583	1	3	0.15
0:09:00	581	584	3	1	0.05
0:10:00	577	577	0	4	0.20
0:11:00	577	577	0	0	0.00
0:12:00	570	570	0	7	0.35
0:13:00	572	571	1	2	0.10
0:14:00	573	571	2	1	0.05
0:15:00	579	578	1	6	0.30
0:16:00	575	575	0	4	0.20
0:17:00	566	566	0	9	0.45
0:18:00	559	559	0	7	0.35
0:19:00	550	552	2	9	0.45
0:20:00	547	547	0	3	0.15
0:21:00	549	549	0	2	0.10
0:22:00	552	552	0	3	0.15
0:23:00	550	550	0	2	0.10
0:24:00	549	549	0	1	0.05
0:25:00	555	557	2	6	0.30
0:26:00	547	547	0	8	0.40
0:27:00	540	541	1	7	0.35
0:28:00	550	551	1	10	0.50
0:29:00	560	559	1	10	0.50
0:30:00	570	568	2	10	0.50
0:31:00	580	578	2	10	0.50
0:32:00	590	588	2	10	0.50
0:33:00	580	580	0	10	0.50
0:34:00	575	573	2	5	0.25
0:35:00	565	565	0	10	0.50
0:36:00	570	572	2	5	0.25
0:37:00	572	574	2	2	0.10
0:38:00	563	564	1	9	0.45
0:39:00	560	561	1	3	0.15
0:40:00	551	551	0	9	0.45
0:41:00	545	545	0	6	0.30
0:42:00	542	540	2	3	0.15
0:43:00	547	549	2	5	0.25
0:44:00	552	552	0	5	0.25
0:45:00	562	561	1	10	0.50
0:46:00	557	558	1	5	0.25
0:47:00	550	551	1	7	0.35
0:48:00	541	542	1	9	0.45
0:49:00	542	540	2	1	0.05
0:50:00	552	549	3	10	0.50
0:51:00	549	549	0	3	0.15
0:52:00	558	558	0	9	0.45
0:53:00	565	563	2	7	0.35
0:54:00	570	569	1	5	0.25
0:55:00	579	579	0	9	0.45
0:56:00	589	589	0	10	0.50
0:57:00	584	584	0	5	0.25
0:58:00	577	578	1	7	0.35
0:59:00	570	571	1	7	0.35
1:00:00	562	562	0	8	0.40
			56	***374***	***18.70***

Hourly Tolerance Band = max(5,18.7)

Hourly Error Rate (%) = 10% = (56 MW – 18.70 MW) / 374 MW

Chart 1: 1-minute resource response to ERCOT Regulation signal: 1-minute Deployment Deviation



The unit represented in table 1 and chart 1 demonstrates a 25% error rate for the hour period. Assuming the DAM cleared Regulation at a price of $15/MWh, the following equation would summarize the unit's penalty for the period:

$$\textbf{Regulation Penalty Rate (\$/MWh)} = [2.0] * 10\% * \$15/MWh = \textbf{\$3.00/MWh}$$

zAssuming that the unit had been awarded 50 MW of Regulation, it would be penalized an amount equal to:

$$\textbf{Hourly Regulation Penalty (\$)} = 50\ MW * \$3.00/MWh = \textbf{\$150}$$

Other issues to consider:

Implementation of the pay-for-performance concept will require integration with ERCOT Protocols. Some areas where integration would be necessary…

1. Are fixes needed for UDBP process to account for transitions between PFR and non-PFR periods?

2. Consolidation of measurement across a QSE with multiple Resources

3. Modifications for Controllable Load Resources and Fast Responding Resources

4. Can QSE self monitor the calculation data?

5. Should hourly Regulation Penalty Rate ($/MWh) and Hourly Regulation Penalty ($) by Resource/QSE be published?

Can this pay-for-performance metric by applied to other AS products, such as PFR, FRR, RRS, or NSRS?