Intermittent Resource Review

Use of Median Output to Determine Qualified Capacity Values

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Background

- Intermittent generators (wind, solar, hydro, etc.) have different operational characteristics and as such their Claimed Capability Audits are performed differently than traditional generators
  - Use of many hours over a season versus a single test over a few hours
  - Audit method captures variability in output due to weather fluctuations
- These *same* audit principles are applied to the Forward Capacity Market (FCM) for determination of appropriate Qualified Capacity Values

Summer and Winter Reliability Hours

- Summer Reliability Hours
  - Pursuant to Section III.13.1.2.2.2.1 of the tariff, the ISO shall determine the median of the intermittent Power Resources and Intermittent Settlement Only Resource's net output in the Summer Intermittent Reliability Hours
  - Summer Reliability Hours shall be hours ending 1400 and 1800
  - The summer Qualified Capacity shall be the average of the of the median numbers determined in Section III.13.1.2.2.2.1
- Winter Reliability Hours
  - Pursuant to Section III.13.1.2.2.2.2 of the tariff, the ISO shall determine the median of the intermittent Power Resources and Intermittent Settlement Only Resource's net output in the Winter Intermittent Reliability Hours
  - Winter Reliability Hours shall be hours ending 1800 and 1900
  - The winter Qualified Capacity shall be the average of the of the median numbers determined in Section III.13.1.2.2.2.2
- ISO New England's assessment of the net output of intermittent resources adheres strictly to the tariff provision in Section III.13.1.2.2.2.1 & Section III.13.1.2.2.2.2

What are the Median and Mean Values?

- Median
  - The number separating the higher half of a data sample, a population, or a probability distribution, from the lower half
  - At most, half the data have values strictly less than the median and, at most, half have values strictly greater than the median
  - A single large observation (outlier) may not throw off the measurement or calculation
  - Median reliability hours are based on the assumption that a resource will be able to perform at or above its qualified capacity 50% of the time within the specified reliability hours
- Mean
  - Computed by adding all of the observations and dividing by the number of observations
  - A single large observation can throw off the measurement
  - However, when the sample size is large and does not include outliers (a normal distribution), the mean usually provides a comparable measure of central tendency.
- Median is a more robust measure of central tendency compared to Mean

How Qualified Capacity is Determined

- Non-intermittent generators have an average of their latest five years of Seasonal Claimed Capability (SCC) values, which is a *single* test, to determine their Qualified Capacity Value
- Intermittent generators have an average of their latest five years of SCC values, which were determined as the median of the generators output over the *summer reliability hours*, to determine their Qualified Capacity Value
- If a resource has not been commercial for the full period, Qualified Capacity will be calculated based on available data

Qualified MW of Existing Resources
Intermittent Resources

- Example:

Summer Period	Median Hourly Output (MW)
2013	46.00
2014	24.00
2015	10.00
2016	15.00
2017	30.00
Summer Qualified MW	**25.00**

Winter Period	Median Hourly Output (MW)
2013-2014	25.00
2014-2015	20.00
2015-2016	12.00
2016-2017	8.00
n/a	n/a
Winter Qualified MW	**16.25**

Comparison of Median and Mean Over the Reliability Hours

				Photovoltaic Resources								
		Median Calculation						Mean Calculation				
Asset ID	2012	2013	2014	2015	Average		Asset ID	2012	2013	2014	2015	Average
PV1	0.528	0.493	0.475	0.543	**0.510**		PV1	0.524	0.494	0.482	0.518	**0.504**
PV2	0.351	0.335	0.300	0.372	**0.339**		PV2	0.370	0.360	0.330	0.376	**0.359**
PV3	0.316	0.292	0.337	0.279	**0.306**		PV3	0.312	0.296	0.333	0.298	**0.310**
PV4	0.291	0.267	0.382	0.416	**0.339**		PV4	0.325	0.298	0.386	0.396	**0.351**
PV5	0.684	0.592	0.680	0.741	**0.674**		PV5	0.718	0.665	0.695	0.738	**0.704**
				Total	**2.167**						Total	**2.229**

- Note: PV resources have winter SCC of zero MW since the reliability hours in the winter are in the early evening

Comparison of Median and Mean Over the Reliability Hours, cont'd

Hydro Resources

Median Summer

Asset ID	2012	2013	2014	2015	Average
H1	0.000	2.149	0.000	1.507	**0.914**
H2	5.405	12.365	6.010	4.710	**7.123**
H3	7.276	13.822	10.585	6.621	**9.576**
H4	1.540	5.182	2.266	3.672	**3.165**
H5	7.361	10.567	9.428	6.172	**8.382**
				Total	**29.159**

Mean Summer

Asset ID	2012	2013	2014	2015	Average
H1	1.116	2.665	1.578	2.536	**1.974**
H2	7.388	12.212	6.098	6.118	**7.954**
H3	9.754	13.322	10.227	8.719	**10.506**
H4	2.105	5.158	2.677	4.247	**3.547**
H5	8.789	11.491	9.524	8.218	**9.505**
				Total	**33.486**

Median Winter

Asset ID	2013	2014	2015	Average
H1	4.708	3.397	2.918	**3.674**
H2	12.650	11.435	8.655	**10.913**
H3	12.660	11.107	11.224	**11.663**
H4	5.443	4.258	3.600	**4.434**
H5	11.954	9.769	9.724	**10.482**
			Total	**41.167**

Mean Winter

Asset ID	2013	2014	2015	Average
H1	4.681	3.577	3.025	**3.761**
H2	12.945	10.906	9.254	**11.035**
H3	13.001	10.876	11.465	**11.781**
H4	5.576	4.858	4.201	**4.878**
H5	12.661	10.616	10.780	**11.352**
			Total	**42.807**

Comparison of Median and Mean Over the Reliability Hours, cont'd

Wind Resources

Median Summer					
Asset ID	**2012**	**2013**	**2014**	**2015**	**Average**
W1	0.000	0.366	0.337	0.159	**0.215**
W2	0.000	0.401	0.000	0.297	**0.174**
				Total	**0.390**

Mean Summer					
Asset ID	**2012**	**2013**	**2014**	**2015**	**Average**
W1	0.204	0.369	0.391	0.318	**0.321**
W2	0.114	0.397	0.119	0.332	**0.241**
				Total	**0.561**

Median Winter				
Asset ID	**2013**	**2014**	**2015**	**Average**
W1	0.569	0.457	0.477	**0.501**
W2	0.306	0.252	0.237	**0.265**
			Total	**0.766**

Mean Winter				
Asset ID	**2013**	**2014**	**2015**	**Average**
W1	0.681	0.480	0.508	**0.557**
W2	0.328	0.281	0.227	**0.279**
			Total	**0.835**

Comparison of Median and Mean Over the Reliability Hours, cont'd

- Only a small set of data was analyzed but the general observation was that the Mean SCC MW output calculation is relatively larger than the Median SCC MW output calculation for PV, Wind and Hydro
- However, the median is a more robust measure compared to mean when there is a non-normal distribution of data
- We need more performance data to better understand the applications of other approaches to determining SCC and/or FCM Qualified Capacity

Questions