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Quality of Wind BMU PNs
pp11_47

by Erol Chartan

Introduction

This presentation will discuss the idea of good industry practice for PN submissions. It will look at definitive / comparative benchmarks and how to present the results. It will include;

- Examples of Common PNs vs Metering
- Comparing all Wind BMUs
- Possible Industry Benchmarks
- Wind BMU PNs Vs National Grid Forecasting
- Proposed Industry Benchmark
- Presenting PN Performance

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Examples of Common PNs vs Metering

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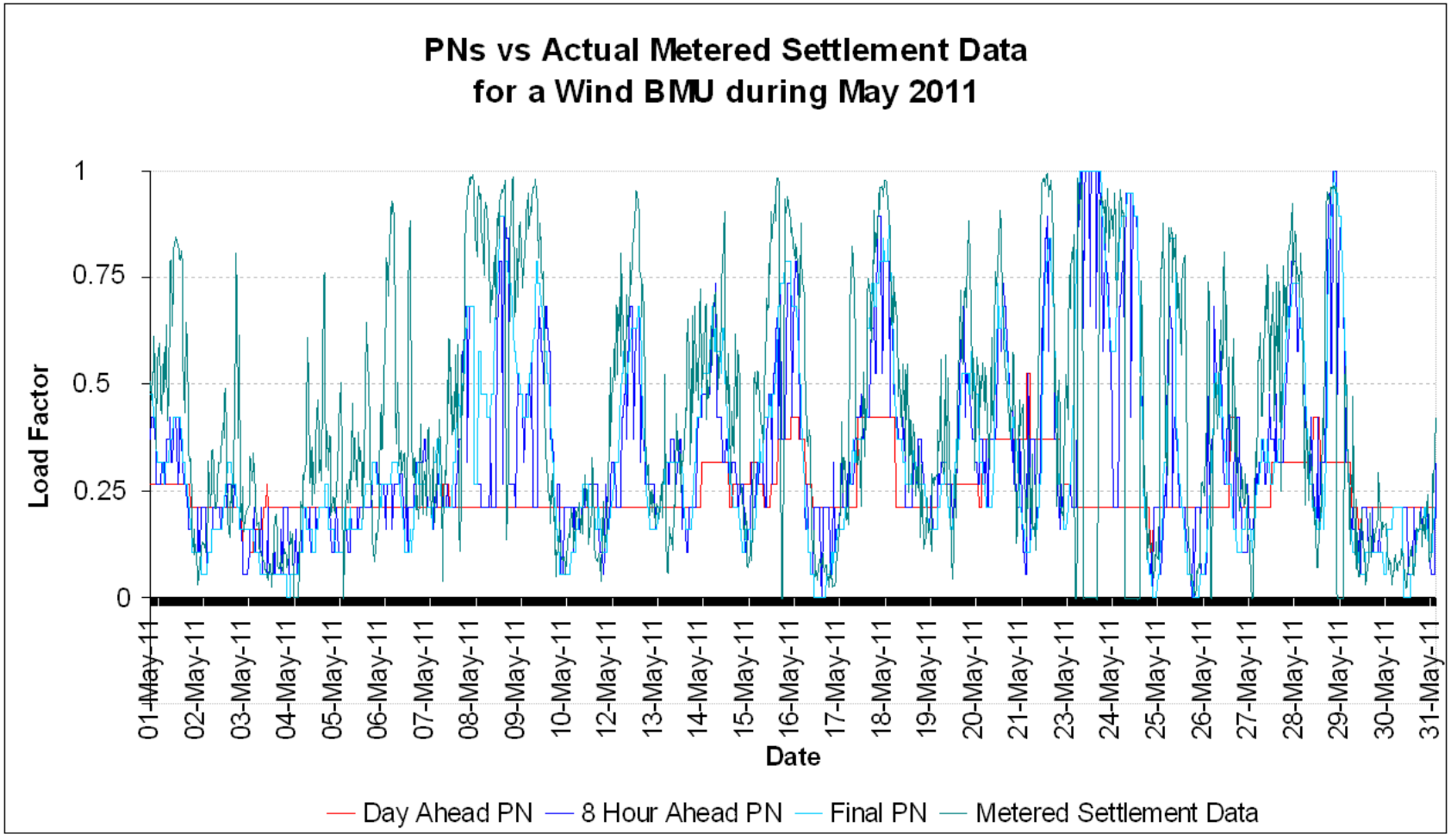
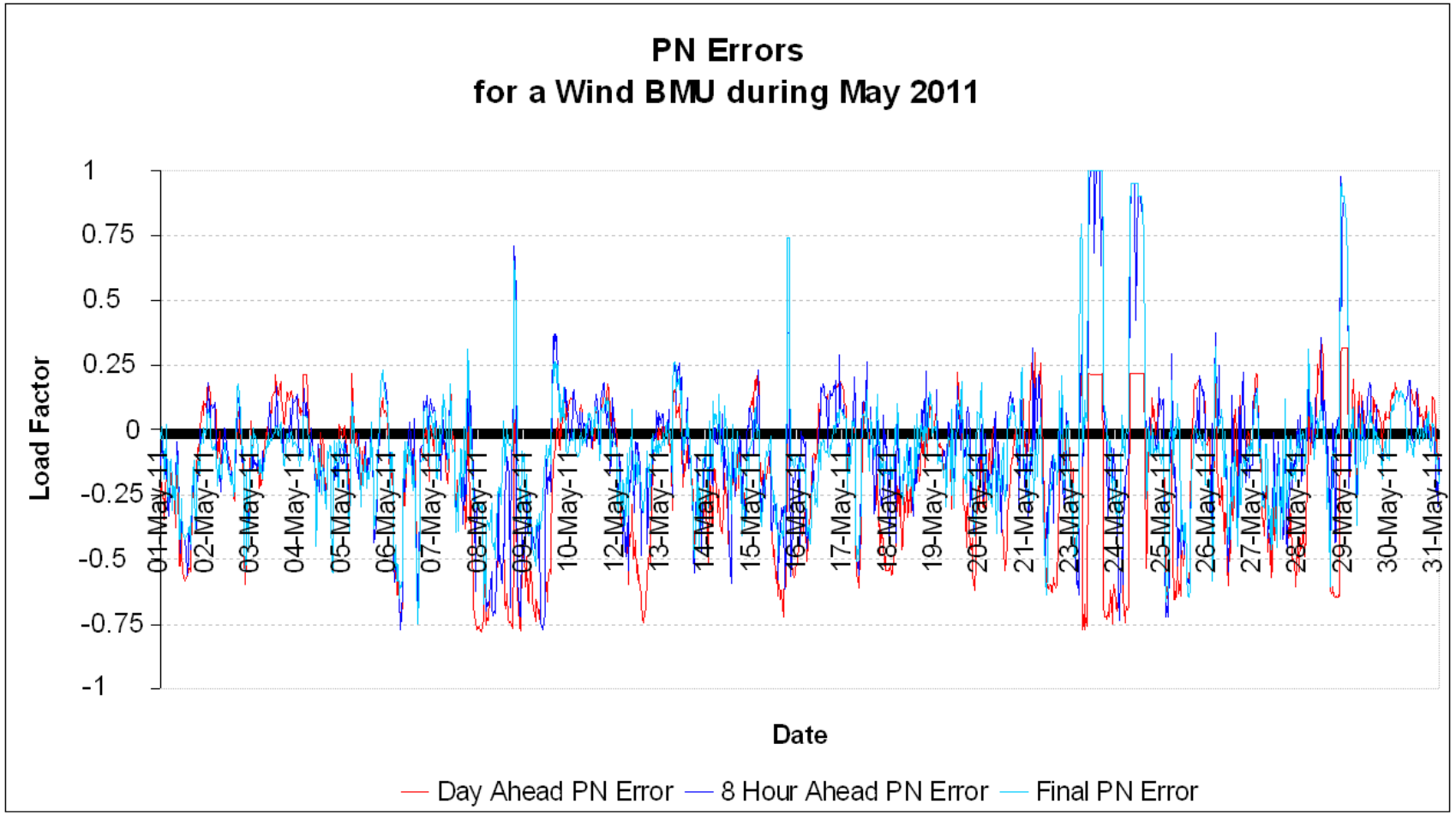
Examples of Common PNs vs Metering



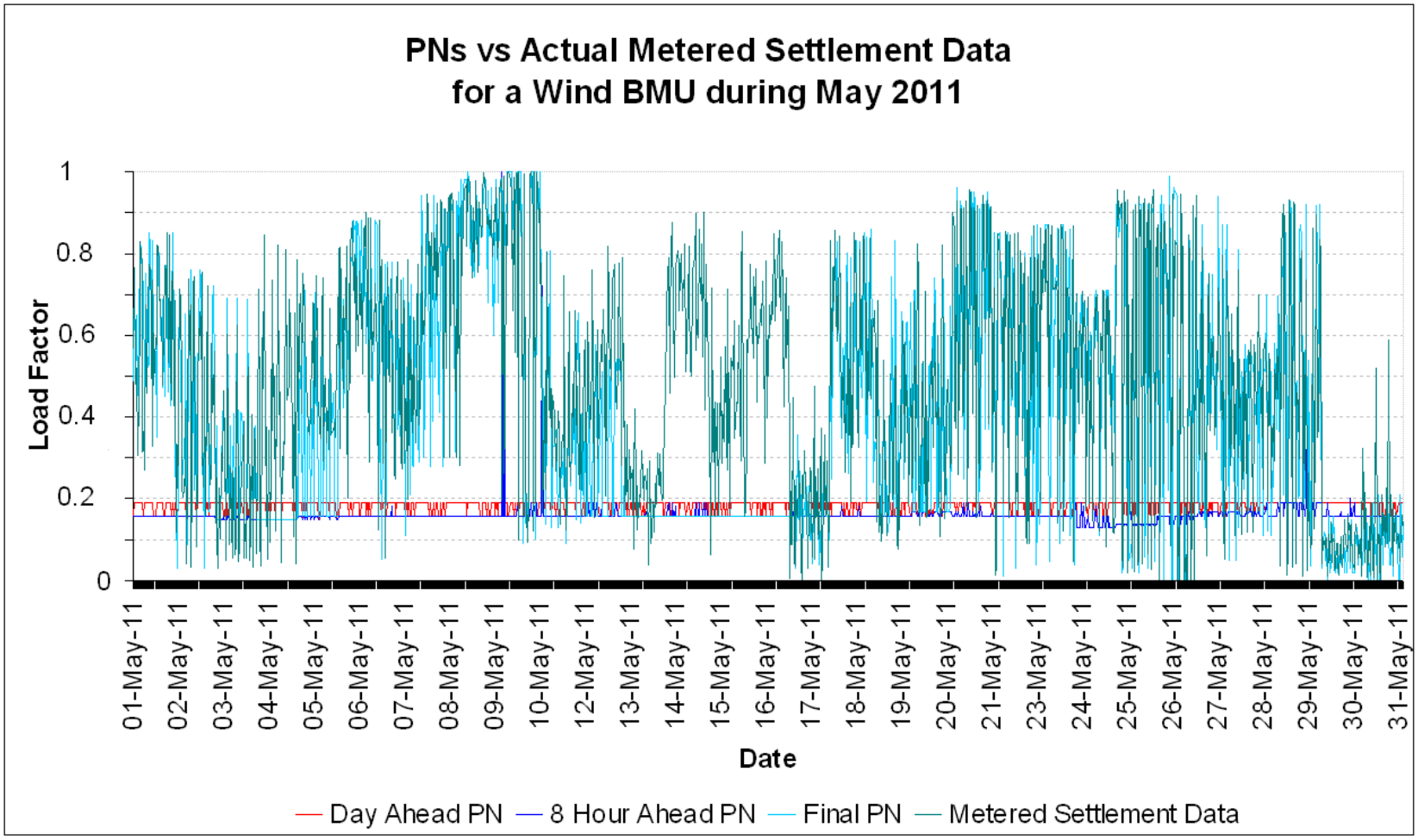
Examples of Common PNs vs Metering



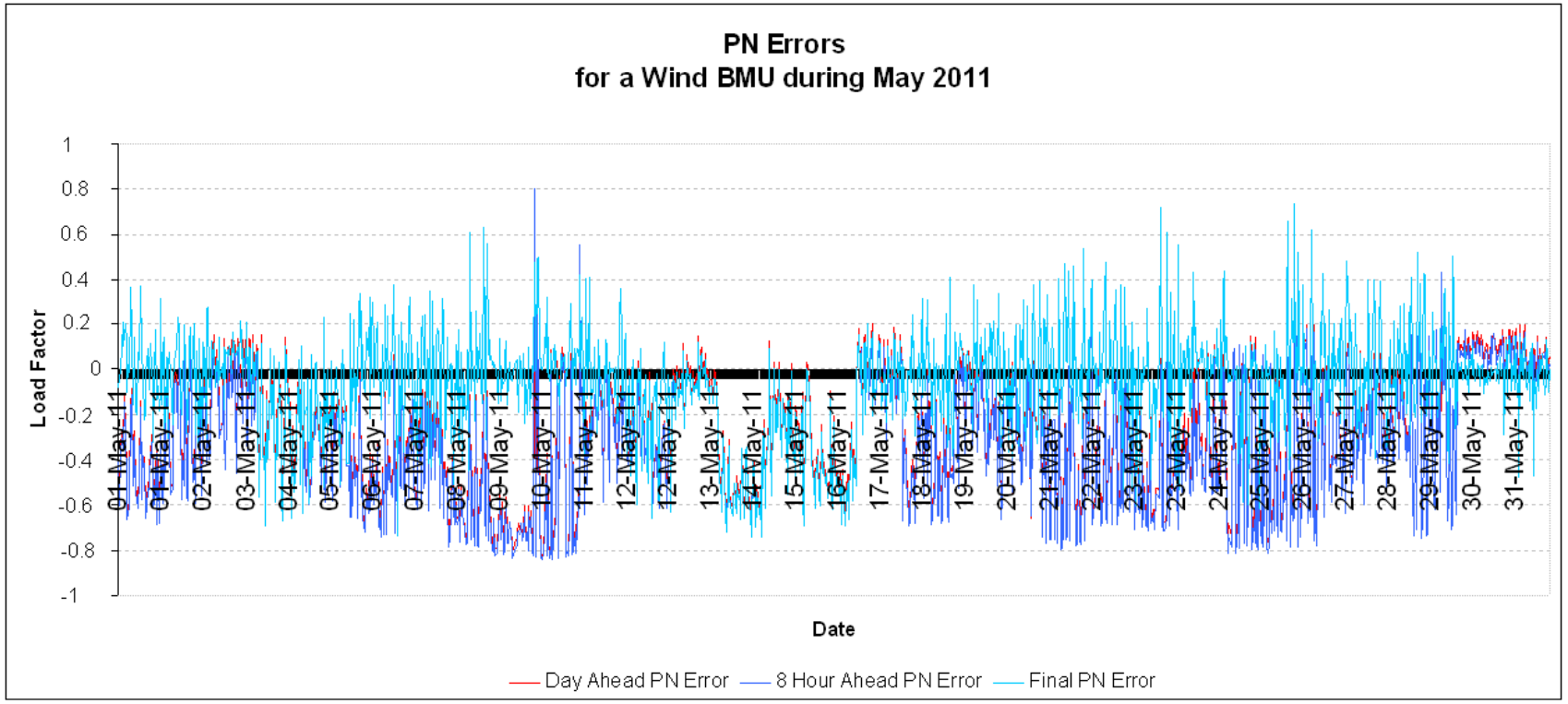
Examples of Common PNs vs Metering

- This is a common example of a wind BMU whose PN data increases in resolution and accuracy as the horizons decrease
  - This approach to PN submissions is ideal
  - There is little difference between the errors of each PN
  - This particular wind BMU ranked 19/30 for FPN accuracy using percentage error (shown later on)
- Simpler approaches such as keeping day and 8 hour ahead PNs constant around a “best guess” for average load factor can potentially be quite accurate depending on how the errors are measured.

Examples of Common PNs vs Metering



Examples of Common PNs vs Metering



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Examples of Common PNs vs Metering

- This is also a common example. The day and 8 hour ahead PNs are approximately constant around a “best guess” for average load factor
- This is a simpler approach to PN submissions
- The errors show that they have underestimated their average load factor for May 2011
- A constant Day and 8 hour ahead PN at a slightly higher load factor could potentially compete with the accuracy of the varying FPN depending on how it’s measured

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Comparing all Wind BMUs

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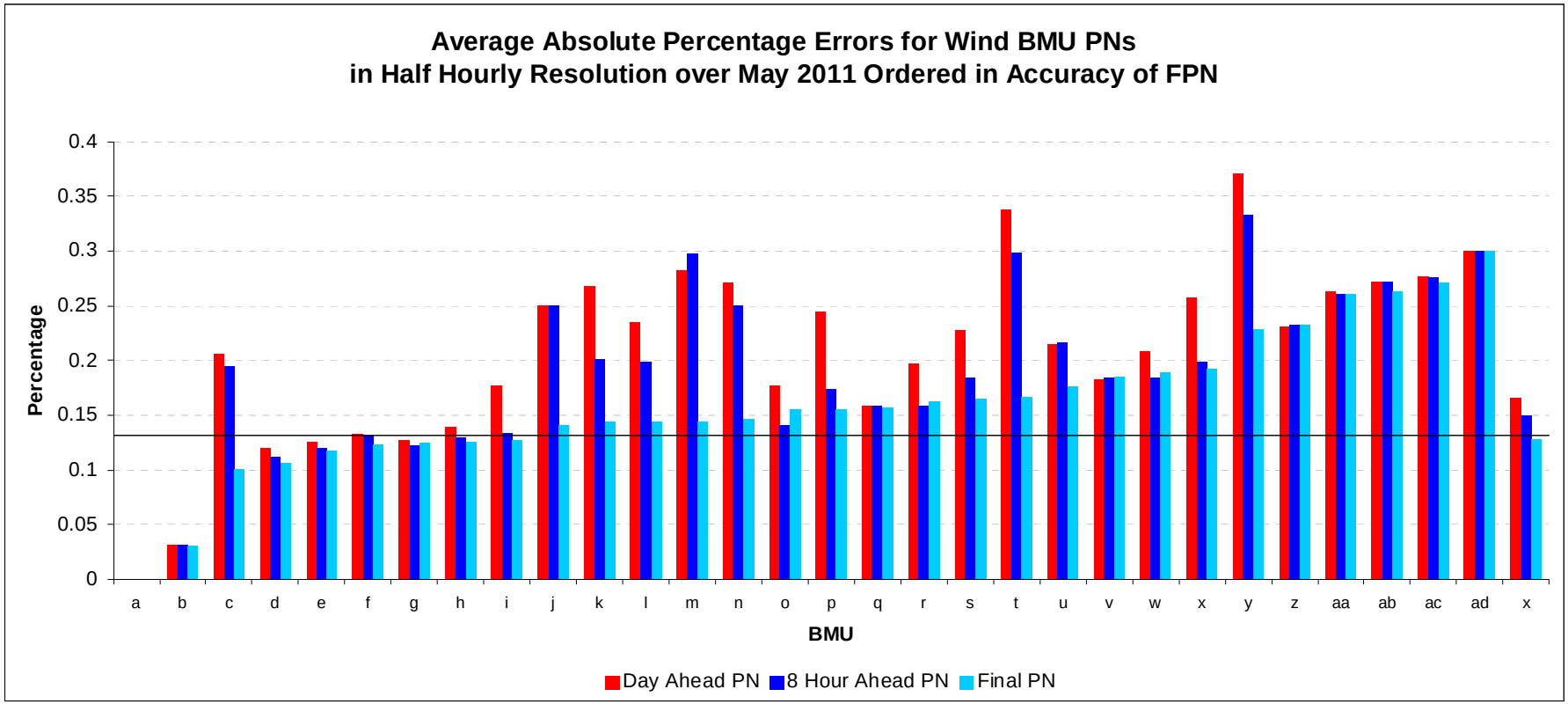
Comparing all Wind BMUs

- It would be interesting to see how the accuracy of PN submissions from wind BMUs compare with each other
- Some factors that can effect the accuracy of PN submissions need to be considered when deciding an industry benchmark using analysis over one month
  - Wind predictability in that area at that time
  - How big the company is – how much money and workforce can they afford to spend on forecasting?
  - How important is each horizon of PN is to us?

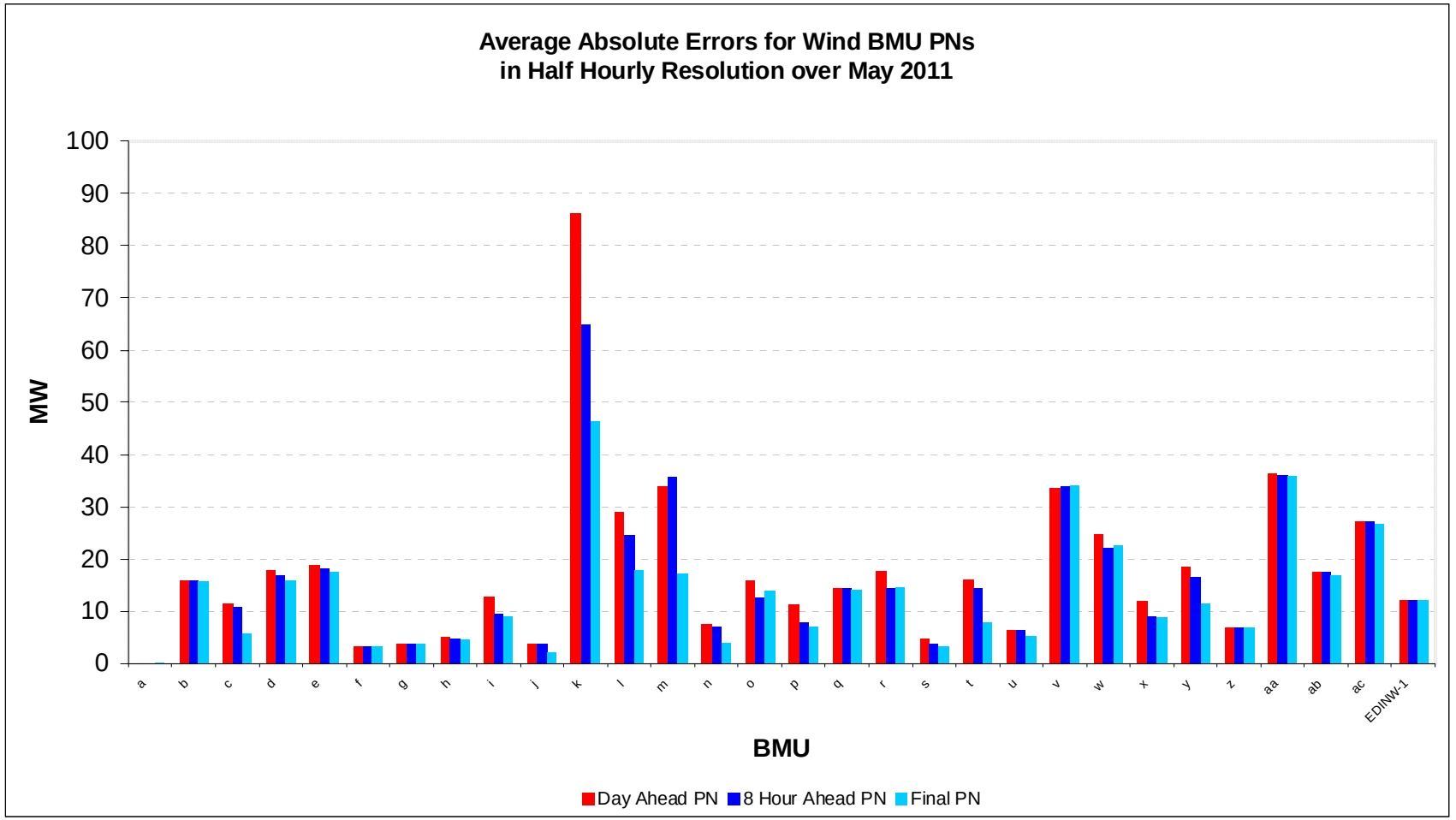
Comparing all Wind BMUs



Comparing all Wind BMUs

- The majority of the wind BMUs have a similar percentage error; around 15%. This is very close to Windy Millar's performance which was our wind power forecasting tool in May 2011. Total MW error varies with capacity.
- The "x" category at the end is the average error for each horizon weighted with capacity. The black line shows this average FPN error. The averages show:
  - That in general the accuracy increases as horizon decreases
  - The majority of wind BMUs' FPNs are higher than average because in general it's the large capacity wind farms that produce accurate FPNs
  - When all 3 bars for a BMU are the same height it is clear that they have not altered their day ahead PN as the horizon decreased.
- Wind farms with a capacity larger than the number of working turbines gives them an unfairly lower percentage error

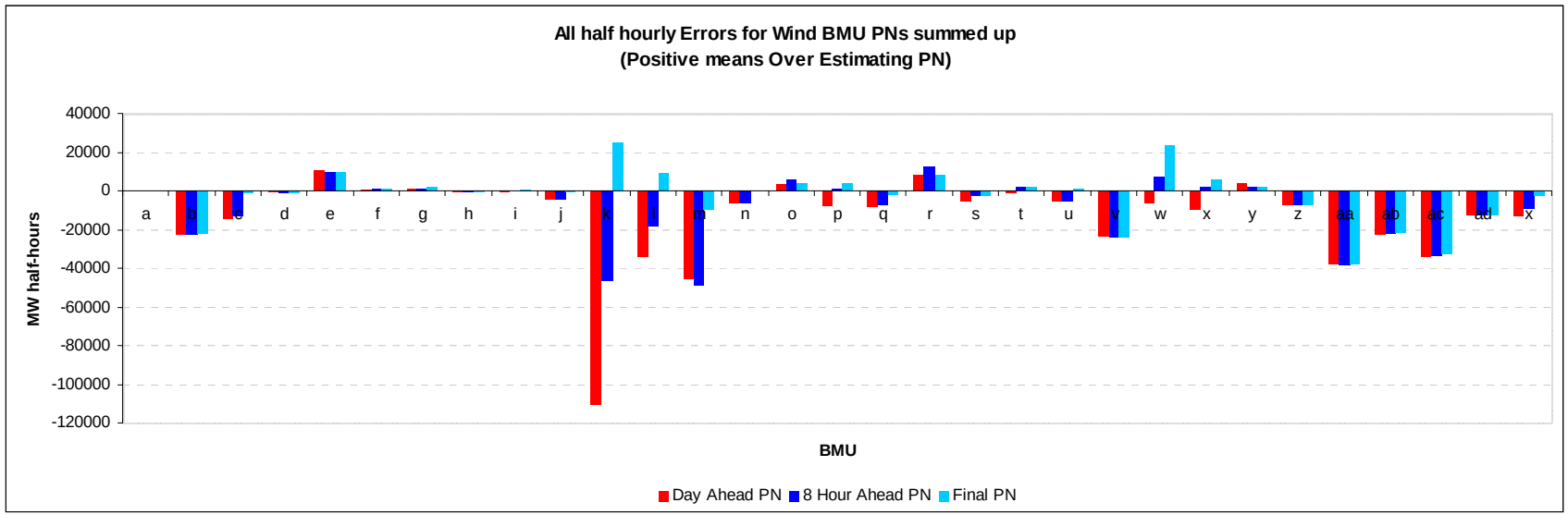
Comparing all Wind BMUs



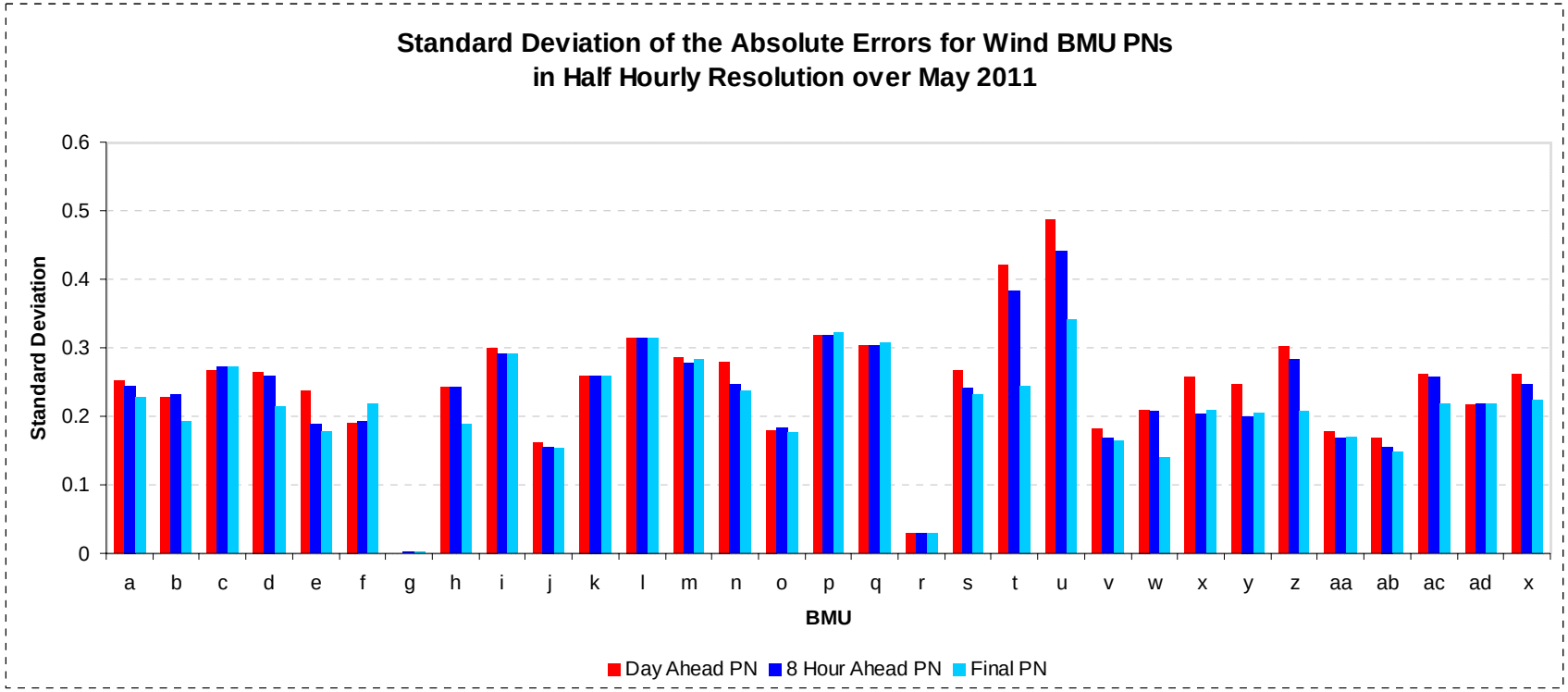
Comparing all Wind BMUs

- Still ordered in FPN percentage error accuracy
- Percentage error was similar throughout and the larger wind farms are producing more error
- Previously conventional plant that produced an absolute error in their FPN of more than 100 MW would justify a significant event report. With the number of smaller BMUs increasing mostly due to wind power, percentage error is likely to become a more suitable industry benchmark

Comparing all Wind BMUs



Comparing all Wind BMUs



Comparing all Wind BMUs

- Generally the wind farms aren't over or under forecasting
- Small bars don't necessarily mean more accurate as errors can cancel each other out, depends on the SD of error. E.g. a low SD of error with a largely positive / negative sum of error would show a constant over / under forecast respectively
- Wind farms are motivated to over forecast their PNs
  - When a wind BMU over forecasts its PN, then they can decrease their MEL to match their generation but when a wind BMU under forecasts its PN, they cannot increase their SEL to match generation
  - Offers are not possible with wind power but bids are. The bids are determined from their PN value – higher the PN, more National Grid pays them for a bid.

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Possible Industry Benchmarks

by Erol Chartan

Possible Industry Benchmarks

- Throughout this chapter there are 4 possibilities for Industry Benchmarks that will be explained and discussed
  - **Absolute** – A specific percentage
  - **Relative** – A percentage relative to the best performing wind farm
  - **Average Relative** – A percentage relative to the average performance of the best few wind farms

Possible Industry Benchmarks

- Noting the variability of wind speed predictability observe two example two-tier methods,
  - **1) An absolute Industry Benchmark:**
    - Percentage Error > 15% ➔ Notified and warned
    - Percentage Error > 20% ➔ Further action taken
  - **2) A relative Industry benchmark:**
    - Percentage Error > percentage error of the best performing wind BMU + 3% ➔ Notified and warned
    - Percentage Error > percentage error of the best performing wind BMU + 6% ➔ Further action taken

Possible Industry Benchmarks

- The performance of wind BMU PNs for May 2011 for the 2 Industry Benchmarks proposed earlier is as below:
  - **1) Absolute Industry Benchmark:**
    - 14/30 had performed acceptably
    - 10/30 would have been notified and warned
    - 6/30 would have had further action taken
  - **2) Relative benchmark:**
    - The best performing Wind BMU needed no notification. The second best would have been notified and warned and all the rest would have had further action taken.

Possible Industry Benchmarks

Relative Benchmark Advantages

- Adapts to different levels of predictability due to weather, forecast horizon etc
- There is constant motivation for the Wind Farms to improve

Relative Benchmark Disadvantages

- If there was at least one wind farm with nearly no wind all month they are almost guaranteed to have great percentage error
- The best performing wind farms have a high capacity of wind turbines out of service leaving them with an unjustifiably low percentage error.

Possible Industry Benchmarks

Average Relative Benchmark Possibility

- A possibility is to have the Industry Benchmark as the average error of the 5 most accurate wind BMUs out of the 10 wind BMUs with highest load factor for each time period. This would:
  - Remove disadvantage of windy sites struggling to keep errors as low as calm sites.
  - Promote competition
  - But be time consuming

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Wind BMU PNs Vs National Grid Forecasting

by Erol Chartan

Wind BMU PNs Vs National Grid Forecasting

- Our own forecasting tool is essential as well as having PNs. Below is the comparison of day ahead percentage error from our wind power forecasts with similar wind BMU wind power forecasts.
  - WindyMillar's average percentage error was 16.4 %
  - Windy Millar's weighted average percentage error was 18%
  - WPFS's average percentage error was 20.6.%
  - WPFS's weighted average percentage error was 18.3%
  - Wind BMUs' average percentage error was 21%
  - Wind BMUs' weighted average percentage error was 16.6%

Wind BMU PNs Vs National Grid Forecasting

- Overall, WPFS does forecast better than WM and this period was unusual.
- The difference in forecasting error month on month varies a lot. Basing an Industry Benchmark that is not variable on less than one year is perhaps unfair.
- It is worth noting that
  - The bad data has been removed so WPFS and WM here aren't 100% comparable but close.
  - The wind farms forecasted for are not just BMUs and that the data for May 2011 covers 1st - 23rd May
- The weighted average percentage error being lower than the average percentage error shows that WPFS finds large wind farms easier to forecast. Money and workforce is also a factor as the difference for the BMU PNs from average to weighted average is even bigger.
- For an Industry Benchmark it is only worth looking at the non-weighted average error because the Industry Benchmark will be the same percentage for all capacities.

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Proposed Industry Benchmark

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Proposed Industry Benchmark

- Using the absolute method;
  - Final PN
    - Percentage Error > 8% ➔ Notified and warned
    - Percentage Error > 12% ➔ Further action taken
  - 8 hour ahead PN
    - Percentage Error > 10% ➔ Notified and warned
    - Percentage Error > 14% ➔ Further action taken
  - Day ahead PN
    - Percentage Error > 12% ➔ Notified and warned
    - Percentage Error > 16% ➔ Further action taken

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Presenting PN Performance

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Presenting PN Performance

- Present 3 tables, one for each PN horizon
- Sort the Wind BMUs in order of percentage error
- Highlight those who fall in different bands of percentage error based on what we set as an Industry Benchmark
  - Green = Acceptable PN
  - Orange = Notified and warned
  - Red = Further action taken

Presenting PN Performance

		DAY AHEAD			
BMU_ID	Sum of Error in MW half-hours	Average of absolute errors / Capacity	Max	Min	Standard Deviation
a	9.49	6.56951E-05	1	-1.772	0.252013
b	-22784.152	0.031575237	3.48	-46.88	0.228387
d	-616.352	0.120276434	85.946	-103.524	0.265334
e	10402.642	0.125492428	125	-100.474	0.236549
g	1349.878	0.127262948	22.896	-18.696	0.000363
f	958.588	0.132205749	18.1	-19.352	0.191007
h	-761.786	0.139918519	24.086	-23.356	0.242293
q	-8557.822	0.158941562	46.384	-67.586	0.302947
o	2998.294	0.177588157	90.558	-86.49	0.18046
i	-721.472	0.177834267	69.376	-56.102	0.299708
v	-23531.7	0.183669136	95.32	-106.88	0.181434
r	8568.158	0.19673302	90.548	-81.894	0.029915
c	-14683.652	0.205606519	8.576	-43.338	0.267559
w	-6533.306	0.207826826	110.5	-83	0.209746
u	-5524.678	0.21536698	5.31	-23.192	0.487111
s	-4998.86	0.228182924	7.054	-14.83	0.266988
z	-7343.954	0.231636066	6.224	-22.21	0.302557
l	-34196.67	0.234530166	19.58	-103.62	0.314389
p	-7763.4	0.24537313	17.12	-34.95	0.317656
j	-4843.442	0.250660842	2.064	-12.392	0.160318
x	-9561.13	0.257727764	41.8	-35.36	0.25763
aa	-37758.06	0.263358287	122.652	-122.32	0.177709
k	-111032.764	0.267800407	53.14	-262.17	0.258861
n	-6690.842	0.271116599	23.816	-26.462	0.278936
ab	-22648.542	0.272750063	25.452	-64.514	0.168537
ac	-34005.09	0.276598553	43.012	-99.134	0.261709
m	-45876.068	0.283159745	19.832	-84.116	0.284522
ad	-12625.628	0.300152505	9.082	-31.132	0.217219
t	-1547.64	0.337456877	42.82	-44.4	0.419916
y	3976.36	0.371152688	60.04	-57.68	0.246969

Presenting PN Performance

		8 Hour Ahead			
BMU_ID	Sum of Error in MW half-hours	Average of absolute errors / Capacity	Max	Min	Standard Deviation
a	117.49	0.000233952	3	-0.772	0.243579113
b	-22663.12	0.03150591	7.76	-46.88	0.231305613
d	-1419.852	0.112558548	72.718	-99.024	0.258780495
e	9599.142	0.120744633	118	-93.474	0.188436072
g	1374	0.122949821	23.93	-18.696	0.001020352
h	-835.26	0.12905667	20.886	-22.858	0.24236979
f	1512.588	0.132047353	18.1	-16.156	0.193187133
i	77.528	0.133848641	71.376	-61.638	0.291360077
o	6206.294	0.140470176	90.592	-86.49	0.182455732
q	-7276.822	0.159273402	43.612	-68.086	0.304576344
r	12158.158	0.159504406	89.464	-81.894	0.029985942
p	1049.6	0.173800257	43.12	-30.88	0.319352126
w	7329.64	0.184222446	110.5	-75.5	0.20669806
v	-24057.2	0.184237962	95.32	-106.88	0.169255505
s	-2623.86	0.184438044	19.02	-14.606	0.241532126
c	-13202.206	0.19440493	23.968	-42.338	0.272255618
x	1891.87	0.198743426	44.11	-33.57	0.204600002
l	-18434.67	0.198815416	111.83	-103.15	0.314389316
k	-46627.67	0.201443244	304.56	-239.44	0.259982974
u	-5212.728	0.216306989	26.156	-23.192	0.440927915
z	-7380.954	0.232420833	6.224	-22.21	0.284221686
n	-6619.842	0.250540851	24.378	-26.462	0.246655236
j	-4851.458	0.250945072	2.064	-12.392	0.156047869
aa	-38366.56	0.261444444	122.652	-122.32	0.169082922
ab	-22360.542	0.271900055	24.952	-64.514	0.155904007
ac	-33627.09	0.275803723	43.012	-99.134	0.256494443
m	-49270.518	0.29769916	80.364	-84.116	0.277596339
t	2073.36	0.299077621	47.86	-45.22	0.383607836
ad	-12625.628	0.300152505	9.082	-31.132	0.217673271
y	1644.36	0.333417204	64.02	-63.9	0.19965685

Presenting PN Performance

		FINAL			
BMU_ID	Sum of Error in MW half-hours	Average of absolute errors / Capacity	Max	Min	Standard Deviation
a	235.44	0.00046043	3	-0.772	0.227205302
b	-22528.22	0.031336795	6.44	-46.88	0.191863048
c	-1323.75	0.101032522	34.926	-35.016	0.272295135
d	-1510.102	0.106075815	68.256	-99.524	0.2150667
e	9508.892	0.117382849	123	-84.67	0.17824768
f	1197.588	0.123917907	18.1	-15.542	0.217660517
g	1962.688	0.124715681	24.896	-16.164	0.001423999
h	-341.03	0.125563608	23.786	-21.842	0.189078669
i	594.528	0.126492346	71.376	-61.638	0.291351881
j	-756.588	0.140484229	13.322	-11.728	0.153244749
k	24872.302	0.143718005	312.09	-186.12	0.26017397
l	8993.93	0.143881124	120.41	-67.926	0.314389316
m	-10070.322	0.143902207	73.612	-74.1	0.282493572
n	-18.06	0.146170123	25.126	-22.374	0.236697073
o	4037.294	0.15584425	84.58	-68.028	0.175179281
p	3996.6	0.15597417	44.12	-25.17	0.323146544
q	-2060.322	0.157086783	63.33	-67.586	0.307138325
r	8198.158	0.162700612	85.318	-67.046	0.030150643
s	-2314.86	0.16428725	19.122	-14.2	0.230886055
t	1971.36	0.167264225	48	-45.64	0.243602825
u	1397.61	0.176280332	30.31	-26.484	0.341158567
v	-24192.2	0.185885344	95.32	-106.88	0.165662796
w	23292.652	0.188800067	110.5	-59.84	0.141631922
x	5644.87	0.192404015	46.16	-31.76	0.208961226
y	2076.36	0.228756452	65	-60.76	0.205221563
z	-7382.938	0.232445923	6.224	-22.21	0.207721461
aa	-38111.56	0.260986306	122.652	-122.32	0.16975771
ab	-21406.042	0.263812017	26.442	-64.514	0.14809038
ac	-32875.09	0.271779638	84.356	-99.134	0.219262452
ad	-12625.628	0.300152505	9.082	-31.132	0.218414416