Measurement and Verification for Variable DR Economic Resources

DRS
6/4/2013
• Variable Resources: Load cannot be forecasted accurately
  – If cannot be forecasted, cannot measure load reduction
  – RRMSE >20%

• RRMSE: objective metric to determine accuracy of forecast
  – Average of forecast error squared (%)
Focus on these customers
Current Variable Load alternative CBLs

- **Max Base Load (MBL)**
  - Developed to accommodate random load which can not be forecast.
    - Dynamic FSL type approach to determine quantifiable load reductions

- **3 Before + 2 After (3+2) - testing approach**
  - Developed to capture intra-day variation where daily usage is fairly consistent but hourly usage is variable

- **7 Day Types (3 day average)**
  - Developed to capture reasonably consistent inter-day variation
    - Monday is fairly consistent but different than Tuesday
Evaluation of CBLs for Variable Resources

• Inter-day variation
  – Group like days, compare same hour each day
  – 3 day type: Weekdays, Sat., Sun. + Holidays
  – 7 day type: Sun., Mon., Tues.,…

• Intra-day variation
  – Look at one day only, group several hours on each day

• Both
  – SAA – Symmetric additive adjustment
  – ARIMA
• 20 CBLs
  – Standard CBL: High 4/5 – 2/3 like days
    • 3 day type: Mean, Mean + SAA (Standard CBL)
    • 25% usage threshold
  – Past 5/5 – 3/3 like days
    • 3 day type: Mean, Median, Mean + SAA, Median + SAA
    • 5 day type: Mean, Median, Mean + SAA, Median + SAA
    • 7 day type: Mean, Median, Mean + SAA, Median + SAA
    • All hours mixed – Mean, Median
  – 3+2
  – ARIMA
  – MBL: Mean, Median

• 115 Registrations
  – RRMSE 20-40% using existing methods
<table>
<thead>
<tr>
<th>RRMSE range</th>
<th>Min. RRMSE across existing CBL</th>
<th>Mean - 3 day SAA</th>
<th>Mean 7 day SAA</th>
<th>3 + 2</th>
<th>ARIMA</th>
<th>Min. RRMSE across variable options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of Registrations</td>
<td>&lt;20%</td>
<td>0%</td>
<td>11%</td>
<td>9%</td>
<td>13%</td>
<td>13%</td>
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<tr>
<td>20%-30%</td>
<td>63%</td>
<td>44%</td>
<td>38%</td>
<td>23%</td>
<td>3%</td>
<td>48%</td>
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<tr>
<td>&gt;30%</td>
<td>37%</td>
<td>44%</td>
<td>53%</td>
<td>64%</td>
<td>2%</td>
<td>28%</td>
</tr>
<tr>
<td>Percent of MW</td>
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<td>2%</td>
<td>2%</td>
<td>32%</td>
<td>6%</td>
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<tr>
<td>20%-30%</td>
<td>26%</td>
<td>22%</td>
<td>18%</td>
<td>12%</td>
<td>1%</td>
<td>17%</td>
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<tr>
<td>&gt;30%</td>
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<tr>
<td>Average Bias</td>
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<td>-0.3%</td>
<td>-1.6%</td>
<td>-0.9%</td>
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<tr>
<td>&gt;30%</td>
<td>3.0%</td>
<td>3.2%</td>
<td>15.9%</td>
<td>2.0%</td>
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</tr>
</tbody>
</table>
Distribution of RRMSE

Percent of Registrations

RRMSE

<10% 15% 20% 25% 30% 35% 40% 45% >50%

Original
New CBL
Proposed new Alternative CBLs to make available & include in Manual

- 3 + 2
- 3 Day type (5 of 5, no usage threshold)
- 7 Day type (no usage threshold)
- ARIMA? Work in progress.
• 3 Before + 2 After CBL
  – Average hourly load for 3 hours before event (skip 1 hour before start) plus 2 after (skip 1 hour after)
• Only available upon PJM approval based on:
  – Must be available for dispatch or offer in DA market for at least 4 contiguous hours
  – Another method is not more accurate (including potential for regression model)
  – RRMSE >20% and <=30%
  – Daily usage fairly consistent (intra-day hourly volatility)
  – No significant pre or post change in operations that will impact CBL calculation
    • Thermal load (pre-cooling or snapback)
    • Change in typical operations (including on-site generation schedule)
  – Test results do not have significant positive bias

Worked well for some of the larger loads
Mean 3 Day with SAA

- 5 of 5 (non-holiday weekdays) and 3 of 3 (holidays/Sundays or Saturdays)
- Eliminate usage threshold
- 45 day CBL lookback window

Move 13 of 115 registrations from variable to non-variable load (<20%)
• 3 of 3
• CHANGE - Eliminate usage threshold
• 60 day CBL lookback window
• Expect events < 6 hours (longer the event the more difficult it is to predict)

• Inconclusive, but promising results
  – Custom fit for each location and potentially for each settlement
  – Requires 2 months of interval data for each settlement
  – Significant effort/cost to implement in PJM system
• Autoregressive integrated moving average
• Potentially use hours 2, 3, 24, 26, 27
  – For example Hour 2 is hour 2 hour before event
  – Each hour will have different weight based on ability to predict load in the future
  – Weighted moving average