RPM as a Seasonal Construct: Motivation, Proposal, and Results of an Illustrative Simulation

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Seasonal Capacity Resources Senior Task Force
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RPM as a Seasonal Construct (proposal #1 of 2)

1. Background and Motivation
2. Proposed Approach to RPM as a Seasonal Construct
3. Results of Illustrative Simulation
4. Summary: Potential Benefits

Appendix A: Additional details of the illustrative simulation
Appendix B: Planned and maintenance outage data
PJM Loads are Seasonal

- PJM RTO, and nearly all zones: Summer Peaking
  - Summer median (50/50) and summer “extreme” (90/10) peaks are well above the Winter 50/50 and 90/10 peaks
  - A few zones are winter peaking
  - Peaks in the Spring and Fall seasons are lower
  - This presentation focuses on the “extreme” (90/10) peaks, as these values, more than the 50/50 peaks, determine the amount of capacity for resource adequacy
  - See: 2016 PJM Load Forecast Report, Tables B-1, B-2, D-1, D-2

Resource adequacy: requires sufficient committed capacity all year (in all seasons)
For the PJM RTO, the winter extreme peak is 85% of the summer extreme peak.

source: 2016 PJM Load Forecast Report, Tables D1, D2
Difference in Forecast 2020/21 Summer and Winter Extreme Peaks (MW)

source: 2016 PJM Load Forecast Report, Tables D1, D2

Wilson Energy Economics
PJM Resource Mix and Capacity Value:
The Seasonal Aspect Has Become More Important

- Many years through 2013: RRS Study says all LOLE in summer, large excess in winter; little perceived value in winter availability, winterization……..

- More recently:
  - Polar vortex wake-up call on value of winter capacity
  - Increasing penetration of inherently seasonal resources: demand response, gas-fired generation with winter fuel challenges, energy efficiency, wind, solar

- Seasonal price signals are valuable to guide decisions about seasonal resources and service
Resource mix shown is roughly based on 2019/20 cleared quantities, but is illustrative (e.g. winter challenged generation).
2. RPM as a Seasonal Construct: Proposed Approach

- Two seasons, each with a separate Reliability Requirement for RPM:
  - “Summer”: Months of June through October plus May
  - “Winter”: Months of November through April (seasons as proposed by PJM)

- In RPM base residual auctions, use two sloped demand curves to acquire capacity to meet the two seasonal requirements

- Most resources likely submit “Annual” offers with no seasonal aspect

- All resources permitted to reflect seasonality in their offers
  - Seasonal ratings (UCAP – unforced capacity)
  - Seasonal costs and risks – minimum summer, winter prices
  - Subject to must-offer requirement and offer price caps
Seasonal Capacity MW Reliability Requirements: Proposed Approach (other approaches possible)

- PJM bases resource adequacy on the “One Day in Ten Years” criterion (also known as Loss of Load Expectation, or LOLE, = 0.10)

- Proposed approach: LOLE allocated 90%/10% to summer/winter
  - Summer requirement based on LOLE 0.09, Winter requirement uses LOLE 0.01
  - Winter requirement also reflects higher levels of outages

- Result of proposed approach for RTO:
  - Summer Reliability Requirement is slightly greater than Annual requirement (+ ~ 500 MW) due to the slightly lower LOLE target
  - Winter Reliability Requirement TBD. Perhaps 15,000 MW or more lower.

- Zones: Analogous approach can be used (allocate LOLE 90%/10%)
Other RPM Design Elements That Could Be Adapted

A seasonal construct creates an **opportunity** (but in most cases not a **necessity**) to revisit various other RPM features.

- **Likely elements to reconsider:**
  - Seasonal UCAP ratings
  - Seasonal penalties and stop loss

- **Could revisit other RPM features, such as:**
  - VRR curve parameters (especially Net CONE) for Winter season
  - Cost allocation
3. Illustrative Simulation of a Seasonal RPM Construct

● Scope:
  – Simulate results for an Annual-Only construct with aggregation, to compare to seasonal proposals
  – Use illustrative assumptions roughly based on the most recent RPM auction
  – RTO only (zones not modeled)

● Goals:
  – Illustrate potential impact of seasonal approaches (cleared quantities, prices, reliability, cost, etc.) under one set of realistic assumptions
  – Rough idea of potential impacts and benefits relative to Annual-Only
  – Identify key drivers; surface issues about how a seasonal construct might work
  – Not intended to be predictive!
Results of Illustrative Simulation: Annual Only w/Aggregation

Observations:

- Supply curve assumptions determine $148/MW-day clearing price – not a predicted value
- Assumed 1,000 MW of Wind/DR aggregation
- Further details of simulation are in Appendix

<table>
<thead>
<tr>
<th></th>
<th>Ann. Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearing price *</td>
<td>$148.0</td>
</tr>
<tr>
<td>Cleared quantity</td>
<td>165,605</td>
</tr>
<tr>
<td>% of Rel. Req’t</td>
<td>105.4%</td>
</tr>
<tr>
<td>LOLE</td>
<td>0.016</td>
</tr>
<tr>
<td>Total cost ($ bil.)</td>
<td>$9.2</td>
</tr>
<tr>
<td>Trad. Gen</td>
<td>157,105</td>
</tr>
<tr>
<td>DR</td>
<td>6,000</td>
</tr>
<tr>
<td>EE</td>
<td>700</td>
</tr>
<tr>
<td>Wind</td>
<td>800</td>
</tr>
<tr>
<td>Wind/DR agg.</td>
<td>1,000</td>
</tr>
<tr>
<td>Solar</td>
<td>0</td>
</tr>
</tbody>
</table>

Disclaimer: Illustrative assumptions and results – alternative, reasonable assumptions might give very different results!
Results of Illustrative Simulation: Seasonal Construct

Observations:

- Winter price roughly $\frac{1}{4}$ Summer price; reflects assumptions about generation offers for winter service
- Sum of Summer + Winter prices lower than Annual Only mainly due to accommodation of seasonal resources (DR, EE, Solar, gen.)
- Some generation clears summer-only
- Seasonal results in better reliability, lower cost; overall savings in this illustrative simulation: $1$ bil./year

Disclaimer: Illustrative assumptions and results – alternative, reasonable assumptions might give very different results!

<table>
<thead>
<tr>
<th></th>
<th>Ann. Only</th>
<th>Sum.</th>
<th>Win.</th>
<th>Sum +Win</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearing price *</td>
<td>$148.0</td>
<td>$104.8</td>
<td>$31.2</td>
<td>$136.0</td>
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<tr>
<td>Cleared quantity</td>
<td>165,605</td>
<td>167,668</td>
<td>154,076</td>
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</tr>
<tr>
<td>% of Rel. Req’t</td>
<td>105.4%</td>
<td>106.4%</td>
<td>108.1%</td>
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<tr>
<td>LOLE</td>
<td>0.016</td>
<td>0.010</td>
<td>0.001</td>
<td>0.011</td>
</tr>
<tr>
<td>Total cost ($ bil.)</td>
<td>$9.2</td>
<td></td>
<td></td>
<td>$8.2</td>
</tr>
<tr>
<td>Trad. Gen</td>
<td>157,105</td>
<td>154,518</td>
<td>145,576</td>
<td></td>
</tr>
<tr>
<td>DR</td>
<td>6,000</td>
<td>10,000</td>
<td>6,000</td>
<td></td>
</tr>
<tr>
<td>EE</td>
<td>700</td>
<td>1,000</td>
<td>700</td>
<td></td>
</tr>
<tr>
<td>Wind</td>
<td>800</td>
<td>800</td>
<td>800</td>
<td></td>
</tr>
<tr>
<td>Wind/DR agg.</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td></td>
</tr>
<tr>
<td>Solar</td>
<td>0</td>
<td>350</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

* Note: seasonal prices assumed paid 365 days; so summer and winter prices are additive; annual resources earn the sum.
## Seasonal Construct: Price Signals; Price Formation Expectations

<table>
<thead>
<tr>
<th></th>
<th>Annual Only</th>
<th>Seasonal Construct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price signal for Annual resources</td>
<td>B.R.A. price (Net CONE concept applies)</td>
<td>Summer price plus Winter price (Net CONE concept applies)</td>
</tr>
<tr>
<td>Price signal for incremental</td>
<td>No summer or winter price signals (<em>aggregation may be understood to create a</em></td>
<td>Explicit price signal: likely reflects incremental annual value (Net CONE concept)</td>
</tr>
<tr>
<td>Summer capacity</td>
<td><em>price signal that is not transparent, and also not consistent with</em></td>
<td><em>net of anticipated net winter value</em></td>
</tr>
<tr>
<td></td>
<td><em>incremental summer, winter reliability value)</em></td>
<td></td>
</tr>
<tr>
<td>Price signal for incremental</td>
<td></td>
<td>Explicit price signal: price required to entice sufficient annual resources to</td>
</tr>
<tr>
<td>Winter capacity</td>
<td></td>
<td>provide winter service</td>
</tr>
</tbody>
</table>
4. Seasonal RPM Construct: Summary of Potential Benefits

- Better accommodates participation by resources with seasonal differences
- Allows tailoring capacity quantity to seasonal needs (which are much lower in Winter for RTO, MAAC, nearly all zones)
- Creates separate price signals for incremental summer, winter MW
- More efficient: results in higher reliability at lower total cost (cost savings result from accommodating seasonal resources, tailoring winter capacity quantity to actual need)
- Can be combined with other SCRSTF proposals (M&V, aggreg.)
- More consistent with seasonal capacity constructs in neighboring regions (NYISO, MISO (proposed), IESO (proposed))
Appendix A:
Additional details of the illustrative simulation
Illustrative Simulation Assumptions: Seasons, Requirements, VRR curves

- Assumptions based on 2019/20 base residual auction parameters
  - Reliability Requirement, VRR curve shape, Net CONE

- Summer (June-October plus May): Reliability Requirement = Annual Reliability Requirement + 500 MW
  - Consistent with LOLE = 0.09 (PJM RRS report)

- Winter (November through April): Reliability Requirement = Summer Requirement – 15,000 MW (value used for simulation purposes)
  - Conservative assumption, allows for much more outage time in winter
  - Cleared quantities >> Rel. Req’t due to use of annual VRR curve for winter
  - (FYI: summer extreme peak – winter extreme peak approx. 26,000 MW)
Illustrative Simulation Assumptions: Resources, Offers

- Roughly based on quantities from 2019/20 base residual auction
- Five resource categories: Wind, Solar, EE, DR, Traditional generation
- *Seasonal* offers: separate offer prices for Summer and Winter; used to reflect seasonal availability of wind, solar, EE, DR (details below)
- *Annual* offers: single annual offer price; resource clears if offer is at or below sum of seasonal clearing prices
- Offer *quantities* not varied by season or offer type (prices control clearing)
- Note: for Summer and Winter seasons, offer and clearing prices expressed as $/MW-day but assumed paid 365 days (not just during performance period)
  - So $120/MW-day Summer price + $30/MW-day Winter price = $150/MW-day Annual
Resource Assumptions:
Traditional Generation Category

- Supply curve based on slope of $4 per 1,000 MW
  - somewhat gentler than in 2018/19 auction (last available sensitivity analysis)

- Traditional generation make “Annual” offers with Winter minimum
  - Clear as Annual if sum of summer and winter prices exceeds annual offer price and winter price exceeds winter minimum price
  - Clear as summer-only if summer price exceeds annual offer price, and winter price falls short of winter minimum price

- Assumption about generation winter minimum offers drives winter clearing price
  - Assumption used: 1/3 offer @ 10% of Annual offer price, 1/3 @ 30%, 1/3 @ 50%
<table>
<thead>
<tr>
<th>Resource Type</th>
<th>FYI: 2019/2020 Actual Cleared</th>
<th>Annual-Only</th>
<th>Summer</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>As CP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demand Response</td>
<td>10,348</td>
<td>614</td>
<td>6,000</td>
<td>11,000</td>
</tr>
<tr>
<td>Energy Efficiency</td>
<td>1,515</td>
<td>1,058</td>
<td>700</td>
<td>1,000</td>
</tr>
<tr>
<td>Wind</td>
<td>969</td>
<td>89</td>
<td>800</td>
<td>800</td>
</tr>
<tr>
<td>Wind/DR aggr.</td>
<td></td>
<td></td>
<td>1,000</td>
<td></td>
</tr>
<tr>
<td>Solar</td>
<td>335</td>
<td>0</td>
<td>0</td>
<td>350</td>
</tr>
</tbody>
</table>
Supply and Demand Curves: Annual-Only, Summer, Winter

- Annual-Only VRR curve
- Summer VRR curve
- Winter VRR curve
- Annual-Only supply curve
- Summer supply curve
- Winter supply curve

Note: Summer, winter prices assumed paid on a 365 day basis
Appendix B:
Planned and maintenance outage information
Figure 5-9 PJM equivalent outage and availability factors: 2007 to 2015

Source: 2015 SOM PJM
Figure 5-8 PJM outages (MW): 2012 through December 2015

Source: 2015 SOM PJM
PJM Forecasted Generation Outages
(From three month ahead forecasts as of 10/22/15, 1/22/16, 4/22/16, 7/22/16)