Price Responsive Demand education

DRS
May 11th, 2017
Price Responsive Demand (PRD) – load that will automatically respond to energy prices and be off the grid during PJM emergency in exchange for reduction in capacity requirement.
PRD in RPM auction process

PRD will shift or change the demand curve which will reduce the overall capacity requirement.
Key PRD Processes

- **PRD Plan Submittal**: 3 yrs in advance of DY
- **Obligation Process – Calculation of End-Use Customer Peak Load Contributions (PLCs)**: Dec prior to DY
- **PRD Registration**: Prior to DY
- **Submittal of PRD Curves in eMKT**: During DY
- **PRD Commitment & Max Emergency Event Compliance**
What is Supervisory Control and why is it required for PRD?

- Supervisory control of customer load committed as Price Responsive Demand is required on the part of the EDC, LSE or CSP acting as PRD Provider.
- Supervisory Control shall mean the capability to curtail, in accordance with applicable RERRA requirements, load registered as Price Responsive Demand at each PRD Substation identified in the relevant PRD Plan or PRD registration in response to a Maximum Generation Emergency declared by the Office of the Interconnection.
- Since capacity has not been procured for PRD load, supervisory control is necessary to ensure reliability during emergency conditions.
Automated Response to Real Time LMPs

• PRD Providers with committed PRD are required to have automation of PRD that is needed to respond to Real Time LMPs for the PRD Curves that are submitted.
• The PRD Provider (EDC, LSE, or CSP) is required to have the remote capability to decrease the load at each location contained in the PRD Registration to the required service level
  – when a PJM Maximum Emergency event has been declared,
  – and the LMP at the applicable location has exceeded the level at which the load has committed to reduce,
  – to the extent load was not already reduced based on price.
Exception to Automation

- PRD Providers may request an exception to the automation requirement for end-use customers that are a single site, a single location and a single end-use customer with supervisory control over processes with which load reduction would be accomplished.
- In this case, the end use customer site is eligible for this specific exception from standard automation requirement.
What is the definition of “Dynamic Retail Rates”?

- To be eligible to be committed as PRD, the retail rates must be based on wholesale prices (real-time LMPs).
- The retail rate structure must be dependent on the Real-time LMP to ensure that PJM has a way to account for price-sensitivity in real-time operations.
  - “.....served under a dynamic retail rate that varies through time and that is linked to or based upon the PJM real-time LMP at the location applicable to the load, and that results in predictable response to varying wholesale electricity prices”
Examples of Dynamic Retail Rates

- Dynamic retail rate structures, based on PJM Real-time LMP, that qualify as Price Responsive Demand may include:
  - **Critical Peak Pricing** that allows retail rates to rise when the wholesale market price exceeds a threshold level;
  - **Critical Peak Rebate pricing** which provides bill credits to consumers who reduce their usage below a baseline quantity during periods when the wholesale market price exceeds a threshold level; or
  - **Real-Time Pricing based on LMP**.

- These types of retail rates provide the necessary exposure to market prices to reduce consumption during high demand periods.
Examples of Common Dynamic Retail Rates

Critical Peak Pricing

Sample Critical Peak Pricing Structure

Price ($/kWh)

$1.40

$1.20

$1.00

$0.80

$0.60

$0.40

$0.20

$0.00

Hour of the Day

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

Flat Rate $0.12/kWh
TOU Rate
CPP $1.25/kWh
A PRD Provider will be required to register price responsive load in a PJM software application.

End-use customer loads as Price Responsive Demand may not, for such Delivery Year,

a) be registered as Economic Load Response or Emergency Load Response;

b) be used as the basis of any Demand Resource Sell Offer or Energy Efficiency Resource Sell Offer in any RPM Auction; or

c) be identified in a PRD Plan or PRD registration of any other PRD Provider.
• What happens if end-use customers switch LSEs?
  – LSE needs to separate end-use customers participating in PRD from other customers
  – If an end-use customer participating in PRD switches to another LSE, the customer PLC value and PRD commitment will be transferred to the new LSE

• An PRD Provider may use a PRD Bilateral to transfer obligation to another LSE
  – LSE may transfer the obligation to provide PRD bilaterally to another LSE during the Delivery Year.
  – As a result of the transfer, the LSE that is assuming the obligation will receive the Daily PRD Credit and be subject to performance requirements and any penalties (PRD Commitment Compliance and PRD Maximum Emergency Event Compliance Penalty) during the term of the transfer.
There are two penalties in RPM for Price Responsive Demand:

- **PRD Commitment Compliance Penalty**
- **PRD Max Emergency Event Compliance Penalty**
(1) Shortfall expressed in terms of a Daily Unforced Capacity Obligation not satisfied (MW)

Shortfall (MW) * Forecast Pool Requirement

(2) RPM PRD Commitment Compliance Penalty rate ($/MW-Year)

[Weighted Final Zonal Capacity Price in $/MW-Day + Higher of 0.2 * Weighted Final Zonal Capacity Price or $20/MW-day].

- LSE’s Weighted Final Zonal Capacity Price is the average of the Final Zonal Capacity Price and the price component of the Final Zonal Capacity Price due to the Third Incremental Auction, weighted by the Nominal PRD Values committed in BRA and Third IA.

PRD Compliance Penalty for RPM LSE ($/Year) = (1) * (2)
PRD Max Emergency Event Compliance Penalty during the Delivery Year

- Assessed upon Max Emergency Event
- Actual Loads during Emergency Events used to measure and verify compliance.
- A tolerance in MESL value will be applied when the actual load exceeds the forecast in calculating the penalty
  - Measurement of shortfall is based on MESL increased by the ratio of actual load to forecast load in zone
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<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Maximum Emergency Service Level (MESL)</td>
<td>900 MW</td>
<td></td>
</tr>
<tr>
<td>Forecast zonal peak load</td>
<td>10,000 MW</td>
<td></td>
</tr>
<tr>
<td>Actual zonal peak load at the Max Emergency condition</td>
<td>10,500 MW</td>
<td></td>
</tr>
<tr>
<td>Ratio of actual load to forecast load</td>
<td>10,500/10,000</td>
<td>1.05</td>
</tr>
<tr>
<td>Tolerance MESL</td>
<td>900 * 1.05</td>
<td>945 MW</td>
</tr>
<tr>
<td>LSE reduces the load to</td>
<td>955 MW</td>
<td></td>
</tr>
<tr>
<td>Shortfall (Load in Excess of Tolerance MESL)</td>
<td>955 – 945</td>
<td>10 MW</td>
</tr>
</tbody>
</table>
Penalty Equation

MW shortfall
   *
  [Forecast Pool Requirement]
   *
[ Weighted Final Zonal Capacity Price in $/MW-Day + Higher of 0.2 * Final Zonal Capacity Price or $20/MW-day] * 365 days.

• Because PRD is demand, not a supply resource, Forecasted Pool Requirement (FPR) should be included in penalty equation.
• In the case of FRR Entities, penalties for non-performance will be based on the Final Zonal Capacity Price for the Zone encompassing the FRR Entities Zone.
## LSE Charges for Capacity Obligation

<table>
<thead>
<tr>
<th>Provider</th>
<th>Expected Peak Load Value (MW)</th>
<th>UCAP Obligation (MW) (see Note 1)</th>
<th>Final Zonal Capacity Price ($/MW-Day) (see Note 2)</th>
<th>Locational Reliability Charge ($/Day) (see Note 3)</th>
<th>PRD Credit Quantity (MW) (see Note 4)</th>
<th>PRD Credit ($/Day) (see Note 5)</th>
<th>Net Load Charge ($/Day) (see Note 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>20,000.0</td>
<td>21,695.7</td>
<td>$253.38</td>
<td>$5,497,232.03</td>
<td>502.2</td>
<td>$127,250.74</td>
<td>$5,369,981.29</td>
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<tr>
<td>B</td>
<td>35,000.0</td>
<td>37,967.5</td>
<td>$253.38</td>
<td>$9,620,156.05</td>
<td>502.2</td>
<td>$127,250.74</td>
<td>$9,492,905.31</td>
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<tr>
<td>C</td>
<td>28,000.0</td>
<td>30,374.0</td>
<td>$253.38</td>
<td>$7,696,124.84</td>
<td>1,004.4</td>
<td>$254,501.48</td>
<td>$7,441,623.36</td>
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<tr>
<td>D</td>
<td>30,000.0</td>
<td>32,543.6</td>
<td>$253.38</td>
<td>$8,245,848.04</td>
<td>0.0</td>
<td>$0.00</td>
<td>$8,245,848.04</td>
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<tr>
<td>E</td>
<td>25,889.0</td>
<td>28,084.1</td>
<td>$253.38</td>
<td>$7,115,892.00</td>
<td>0.0</td>
<td>$0.00</td>
<td>$7,115,892.00</td>
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<tr>
<td></td>
<td>138,889.0</td>
<td>150,665.0</td>
<td></td>
<td>$38,175,252.97</td>
<td>2,008.9</td>
<td>$509,002.97</td>
<td>$37,666,250.00</td>
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</table>

**Notes**

1. Total cleared resource quantity (150,665 MW) is allocated to each LSE in proportion to the LSE share of total Expected Peak Load Value.
2. The Final Zonal Capacity Price is the RPM Auction clearing price adjusted upward in order to compensate PRD credits.
3. Locational Reliability Charge is equal to LSE UCAP Obligation multiplied by Final Zonal Capacity Price.
4. PRD Credit Quantity is equal to cleared Nominal PRD Value times (Total UCAP Obligation / Expected Peak Load).
5. PRD Credit is equal to PRD Credit Quantity multiplied by Final Zonal Capacity Price.
6. Net Load Charge is equal to Locational Reliability Charge minus PRD Credit.
LSE UCAP Obligation Process

No change in the LSE UCAP Obligation Process

EDC* allocates the prior summer’s Zonal Summer Weather Normalized Peak to end-use customers and produces PLCs (“capacity tickets”) for the DY

EDC uploads the obligation peak load for wholesale areas in zone by December 31 prior to DY in the eRPM system

PJM calculates daily LSE UCAP Obligation in eRPM during DY

EDC uploads daily LSE obligation peak loads (i.e., sum of an LSE’s customers’ PLCs) for retail area in zone in eRPM system during DY

XML uploads submitted at least 36 hours prior to start of delivery day

*If PRD is located in wholesale area, muni/coop is expected to calculate the PLC for end-use customer in their wholesale area for use in the PRD registration process.
Use of PLCs in Obligation & PRD Registration Processes

LSE with PRD* reduces load to MESL during Max Emergency Event (Summer Prior to DY)

*If there is PRD committed during summer prior to DY

PJM produces load drop estimates (add-backs), Zonal Summer Weather Normalized Peaks, and PJM 5 CPs for Summer Prior to DY

EDC allocates their Zonal Summer Weather Normalized Peak to end-use customers and produces PLCs (“capacity tickets”) for the DY

EDC uploads LSE obligation peak loads (i.e., sum of an LSE customers’ PLCs) in eRPM

PJM calculates daily LSE UCAP Obligation in eRPM

PRD Provider registers end-use customer for the DY (includes PLC and MESL).

EDC goes through normal registration verification process (check PLC, etc) and adds PNODE

PJM calculates LSE’s actual Daily Nominal PRD Value in Sub-zone/Zone based on registration in eLRS.
PRD Provider registers PRD in eLRS (similar to DR FSL registration)

EDC verify registration and adds PNODE

PJM approves or denies PRD registration based on accuracy of information

Initial Registration

PRD Provider must terminate PRD registration if lose PRD customer(s) during the DY

Updated Registration
PJM aggregates the Daily Nominal PRD values for all PRD Provider PRD registrations in a Sub-zone/Zone to calculate LSE’s Daily Nominal PRD Value in Sub-zone/Zone.

Nominal PRD Value = Expected Peak Load – MESL

Expected Peak Load = PLC * Zonal Peak Load Forecast Scaling Factor

Zonal Peak Load Forecast Scaling Factor = DY Final Zonal Peak Load Forecast/Zonal Summer Weather Normalized Peak for summer prior to DY

PJM compares PRD Provider’s Daily Nominal PRD Value in Sub-zone/Zone to PRD Provider’s Committed Nominal PRD Value in Sub-zone/Zone.

If LSE’s Daily Nominal PRD Value < Daily Committed PRD Value, LSE will be assessed a Daily PRD Commitment Penalty.
PJM declares Max Emergency
PRD required to curtail load down to MESL
LSE provides PJM hourly load data in DR Hub for end use customers to verify compliance
EDC reviews hourly load data for accuracy
PJM calculates compliance
PJM assesses penalties as necessary
What are the Testing Requirements for Price Responsive Demand

- Testing Requirements for PRD will be comparable to testing requirements for Load Management resources, as defined in Section 8 of PJM Manual 18: PJM Capacity Markets.
- Testing is required to ensure that the committed load LSE has the ability to achieve the committed Maximum Emergency Service Level (MESL) via either:
  - Respond to the Real-time LMP signal; or
  - Reducing load in response to a supervisory control signal
- Tests may be executed for all resources in a given transmission zone.
- Testing is required to demonstrate compliance for a one hour period
Requirements to Incorporate PRD Into Dispatch

1. Close coordination with LSEs on quantities and prices

2. Locational detail of PRD quantities

3. Recognition in dispatch and pricing software
Same area of detail

Load Curve

Load Curve without PRD

Dispatch $85 resources

$88 Price-Responsive Demand

Dispatch $90 resources

No dispatch of additional resources due to demand response at indicated price level
Primary Reserve Warning

Voltage Reduction Warning and Reduction of Non-critical Plant Load Warning

Energy price set by both reserve Demand Curves and marginal energy unit

Price of marginal energy unit continues to increase as reserves go shorter

Load Management called in advance;

Load Maximum Emergency Generation

Manual Load Dump Warning

Price at max; all PRD off system

Manual Load Dump

Voltage Reduction Curtailment of Non-Essential Building load
### PRD vs DR/CP comparison in capacity market

<table>
<thead>
<tr>
<th>Process</th>
<th>PRD</th>
<th>DR/CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPM</td>
<td>BRA or 3rd IA if forecast goes increases, No replacement, Submit PRD plan, PRD provider only. Credit based on the Base Capacity rates</td>
<td>BRA and IAs, replacement allowed, Submit DR plan, CSPs provide. Credit based on new CP rates (higher than base rates)</td>
</tr>
<tr>
<td>Revenue</td>
<td>No revenue – bill credit to LSE based on FZCP if cleared in BRA. No energy market revenue. If PRD provider different from LSE then they must work our arrangements</td>
<td>Revenue to CSP based on auction clearing price. Energy market revenue based on full LMP</td>
</tr>
<tr>
<td>Registration</td>
<td>LSE required and pnode required (and limits aggregation), Dynamic retail rates (linked to nodal LMP). Not allowed to participate as economic DR</td>
<td>No LSE required. Registration not permitted after start of DYs.</td>
</tr>
<tr>
<td>Reporting</td>
<td>PRD hourly curve (load and LMP) by pnode</td>
<td>Expected reductions by dispatch group</td>
</tr>
<tr>
<td>Dispatch &amp; Notification</td>
<td>PRD provider dispatches from price curve and supervisory control during Max Emergency. Eligible to set LMP. May have price curve of 1 point at energy offer cap</td>
<td>PJM dispatch/release by zone/subzone by type by lead time. Eligible to set LMP. PJM dispatches based on system needs when short on reserves</td>
</tr>
<tr>
<td>Verification</td>
<td>Adjusted MESL (compared to PLC) – max hour of event</td>
<td>Summer FSL (compared to PLC) and Winter FSL (compared to WPL). Hourly basis</td>
</tr>
<tr>
<td>Penalty</td>
<td>Daily deficiency charge (FZCP * &gt; of 1.2 or $20/mwday Event – same as daily deficiency charge * 365</td>
<td>Daily deficiency charge (RPM price * &gt; of 1.2 or $20/mwday Event – Net Cone * 365/30</td>
</tr>
<tr>
<td>Testing</td>
<td>Same</td>
<td>same</td>
</tr>
<tr>
<td>Add Back</td>
<td>Based on emergency event and 5 CPs</td>
<td>Based on emergency and economic events</td>
</tr>
</tbody>
</table>