The Potential for Continued Growth in Demand Response and Energy Efficiency Participation in Organized Capacity Markets

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Important Notice

The analysis and conclusions presented here are those of the authors and not necessary those of Navigant Consulting, Inc.
1 » Market Overview

2 » Navigant’s Capacity Market Model

3 » Model Results

4 » Conclusions

5 » Authors and Contacts
In recent years, energy efficiency (EE) and demand response (DR) resources have provided an increasingly large proportion of capacity procured in organized capacity markets.

» Demand-side resources are often lower cost than new generation.

» Market designers have emphasized demand-side resources as an important alternative to generation.

» The ability of central aggregators to control large numbers of demand-side capacity has lowered barriers to entry.

» DR has made substantial strides in the reliability rate allowing it to be used nearly interchangeably with generation to provide reliability.

### EE/DR in Specific Markets

<table>
<thead>
<tr>
<th>Market</th>
<th>Capacity Procured</th>
<th>Eligibility Rules</th>
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<tbody>
<tr>
<td>PJM RPM</td>
<td>15,800 MW or 9.3%</td>
<td>Tightened eligibility rules recently tightened</td>
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<tr>
<td>ISONE FCM</td>
<td>3,634 MW or 10.0%</td>
<td>Loose eligibility rules</td>
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<tr>
<td>NYISO ICAP</td>
<td>2,573 MW or 7.0%</td>
<td>EE does not enter the market but is procured by LSEs</td>
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Key Disruptive Trends for the Markets

» Environmental regulations
  – EPA’s proposed RICE NESHAP rules
    o Would preclude diesel generator backed DR from participating in PJM market as unlimited resources
    o Could effect up to 20% - 50% of PJM’s DR
  – EPA’s coal plant regulations
    o Coal retirements increase the need for new capacity to be procured

» FERC order 745
  – Requires the DR be allowed to participate in wholesale energy markets
  – Gives an additional source of revenue for DR providers

» Changes to capacity market rules
  – Markets may tighten eligibility requirements to preserve system reliability
  – PJM has already split DR into limited, seasonal, and unlimited

» Additional capacity markets
  – MISO is starting in 2013
  – ERCOT is considering a capacity market

» Limited technical potential for DR
  – As DR provides a large component of capacity margins, it is more likely to be called upon and may become more expensive to procure
# Table of Contents

1 » Market Overview

2 » Navigant’s Capacity Market Model

3 » Model Results

4 » Conclusions

5 » Authors and Contacts
» The model is consistent with the rest of Navigant’s modeling suite, meaning that the results and scenarios are consistent with environmental policies, market regulations, etc.

» Provide a forecast of locational capacity prices
  – Includes a forecast of capacity transfer limits between locational demand areas
  – Allows limited inter-ISO capacity trading

» Scenario analysis of capacity prices consistent with PROMOD runs and assumptions
  – Varying levels of DR/EE offered into auction
  – Removal of annual/extended summer/limited DR resource classification
  – Altering DR capacity derate values and minimum annual/extended summer resource requirements
  – High coal retirement
  – Changing natural gas prices

» Sensitivity analysis of capacity prices using modeled capacity supply curves
  – Evaluate where various DR/EE units are located on the supply curve
  – Effect on amount and type of DR cleared at varying market clearing prices by locational demand area (LDA)
  – Evaluate the stability of the equilibrium (i.e., how much the clearing price would change in the event that a single additional asset was cleared in the market)
Methodology – General

»Plant dispatch and revenue forecasts are taken from PROMOD runs

»Auction parameters are forecast from historic auction parameter values
  – Net cone
  – Required reserve margin
  – Administratively determined demand curves

»Capacity prices are forecast by solving for the intersection of locational supply and demand curves
  – Intra-ISO capacity transfers are allowed depending on economics and forecasted transmission constraints
  – Inter-ISO capacity transfers are allowed after 2017 depending on economics and limits

»The model considers ISO specific rules
  – Differentiating between annual, extended summer, and limited DR resources in PJM
  – The price floor in ISONE
Capacity Supply Curves

»Capacity supply curves
  – Model’s implied bids
  – A plant’s bid is assumed to be the minimum required to make plant net revenue positive
    o Revenue considered
      › Energy market
      › Ancillary services
    o Costs considered
      › Fuel costs
      › Plant VOM and FOM
      › New plant capital costs
      › Emissions costs and capital costs for retrofitting to comply with emissions regulation
  – DR/EE is modeled with an estimated offered/cleared curve
    o DR/EE offered is assumed to grow in proportion to demand
    o A current project is to improve this representation

»Coal plant retrofit costs
  – Coal plant bids include incremental costs due to environmental retrofits
  – Capacity prices are highly sensitive to retrofit costs and retirements
  – Uses coal retirement data from proprietary tool to incorporate these costs into the capacity model
  – A model output is a list of coal plants that fail to clear in the capacity market model by year and by amount of the shortfall
Table of Contents

1 » Market Overview

2 » Navigant’s Capacity Market Model

3 » Model Results

4 » Conclusions

5 » Authors and Contacts
## Modeled Cases

<table>
<thead>
<tr>
<th>Case</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base Case</strong></td>
<td>• Assume Navigant’s internal natural gas price forecast and load growth</td>
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</table>
| **RICE NESHAP rules**       | • In PJM, DR backed by diesel generators can no longer participate in the market as an annual resource  
                                • Assume immediate 25% drop in DR participation in PJM          |
| **High DR Participation**  | • Assume DR participation grows at double load growth rate                  |
Base Case Results

» Prices start rising over the next 5-10 years as capacity margins tighten and new generation capacity is required to maintain them.

» Over the long term, prices approach net cone to give sufficient incentive for new generation capacity.

» Prices in the 3 ISOs are fairly closely correlated as price differences are arbitrated away through changes in net imports.
DR/EE Participation in PJM

» Demand-side resource account for nearly 11% of total capacity procured by 2035

» The explosive growth over the last few years of the amount of DR/EE on offer is assumed to slow to the level of load growth

» As the capacity price rises, all of the DR/EE on offer clears in the auction as it tends to bid lower than new greenfield generation

» One likely limitation on the penetration of DR/EE in the market is the discount for limited DR vs. annual resources which increases from $15/MW-day to $40/MW-day

» Another risk is that as DR increases its proportion in the market, providers will be called upon to reduce load more often than they expected when bidding
» Demand-side resources account for 12% of capacity resources procured by ISONE in 2035

» There is an initial dip in capacity resources clearing due to the removal of the price floor in the 2016/2017 auction

» Unlike PJM, EE resource in ISONE do not have a time limit for how many auctions they can clear so there is a higher proportion of EE resource in this auction

» A major risk for demand-side resources in ISONE is that the ISO will tighten qualification requirements similar to how PJM has done it
» By 2035, demand-side resources account for 8% of total capacity procured by NYISO

» EE resources cannot bid into the auction and are instead accounted for in the procurement requirements of load serving entities

» NYISO does not have a forward capacity market which may limit the ability for aggregators to bid into the market and then procure the resources later
The proposed RICE NESHAP rules limit the amount a diesel generator can run to 100 hours per year.

This prevents DR resources that are backed up by diesel generators to bid in as annual resources in PJM and forces them to bid as limited resources.

The case is modeled by assuming that 25% of DR drops out of the market due to the rules.

The result is a 33% price spike in the early years that lessens in magnitude over time until there is little difference between cases in the last few years.
Impacts of Greater DR Participation on PJM Capacity Market

» In this case, DR offered into the market increases at twice the rate of load growth which is still slower growth than has been seen in the last few years.

» Capacity prices for generation and annual DR/EE resources do not decrease by much.

» DR/EE increases are a proportion of total capacity procured to 14% by 2035 but the discount for limited DR reaches over $100/MW-day.

» At this point, nearly the entire capacity margin is provided by DR/EE so the resources could expect to be called upon to reduce load with most demand spikes.

» If combined with the RICE NESHAP rules, it seems likely that many DR providers would be unwilling to reduce load as often as would be necessary.
Table of Contents

1 » Market Overview
2 » Navigant’s Capacity Market Model
3 » Model Results
4 » Conclusions
5 » Authors and Contacts
Tightening capacity margins lead to higher capacity market prices in all 3 ISOs which will provide even more incentive for the development of new DR/EE resources to enter the market.

Demand-side resources have increased their reliability to the point that ISOs are more comfortable using them as replacement for traditional generation. This will help maintain the trend of an increasing proportion of procured capacity being EE and DR.

PJM prices are more sensitive to reduction in demand-side participation than increases due to qualification rules.

Furthermore, PJM is likely to have less room for increases in DR participation than other resources especially if the RICE NESHAP rules are implemented.

The other two ISOs do not have as stringent of requirements at the moment and so will not have the same limitations on demand-side penetration.

Despite increasing comfort with demand-side resources, a major risk for any DR/EE resource entering capacity markets is changing market rules since a proportion of capacity procured that is demand-side is much higher than was expected when the markets were designed.
Table of Contents

1 » Market Overview

2 » Navigant’s Capacity Market Model

3 » Model Results

4 » Conclusions

5 » Authors and Contacts
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