Resource Adequacy and Capacity Markets: Overview, Trends, and Policy Questions

Prepared for:
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Agenda

Resource Adequacy

Market Design Options

Market Design Trends and Policy Questions

Appendix
Resource Adequacy vs. Reliability

Estimates for U.S.-wide customer cost of power outages range from $20 billion to $150 billion per year.

For end users, “reliability” is a combination of three distinct components:

♦ Distribution system reliability
♦ Transmission system reliability
♦ **Resource adequacy** (bulk power supply vs. load)

Resource adequacy is only a minor factor in customer reliability:

♦ Typical planning reserve margins yield less than 2,000 MWh of “expected unserved energy” and 2 minutes of average annual customer outages ➔ Stigma of “blackouts” disproportional to scope of impact

♦ Compare to 100-300 minutes of average annual customer outages at distribution level (1,000-10,000 minutes during years with major storms)
Current resource adequacy (planning reserve margin) requirements often based on “1-day-in-10-year” standard:

- Does not consider MW size of event nor size of system
- Does not consider duration of events
- Has not been updated in decades
- Is not defined and applied uniformly

Total costs first decrease but then increase with reserve margins (risks decrease)

Resource Adequacy

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Appendix
Market Design Options for Resource Adequacy

♦ Administrative Mechanisms
  • Resource adequacy achieved through administrative means
  • **Examples:** Regulated utility planning, administrative PPAs, administratively-determined capacity payments
  • Cost recovery through regulated approval or contract payments
  • Risk of uneconomic investment decisions borne by customers

♦ Market-Based Mechanisms
  • Utilize market forces to achieve resource adequacy
  • **Examples:** Energy-only markets, RA requirements for LSEs, near-term or forward Capacity markets
  • Challenge: achieve revenues to attract and retain supply when/where needed for resource adequacy; discourage investments during surplus
  • Risk of uneconomic investment decisions borne by suppliers (but increases investment and financing costs)
  • Price volatility and uncertainty are a key concern
### Market Design Options for Resource Adequacy

<table>
<thead>
<tr>
<th>Administrative Mechanisms (Customers Bear Risk)</th>
<th>Market-based Mechanisms (Suppliers Bear Risk)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulated Utilities</td>
<td>LSE RA Requirement</td>
</tr>
<tr>
<td>PPAs or Capacity Payments</td>
<td>Capacity Markets</td>
</tr>
<tr>
<td>Examples</td>
<td>Energy-Only Markets</td>
</tr>
<tr>
<td>SPP, BC Hydro, SaskPower, most of WECC,</td>
<td>California, MISO</td>
</tr>
<tr>
<td>Southeast U.S.</td>
<td>PJM, NYISO, ISO-NE, Brazil, Russia</td>
</tr>
<tr>
<td>Resource Adequacy Requirement?</td>
<td>Australia’s SWIS, Italy, Russia</td>
</tr>
<tr>
<td>Yes (Utility IRP)</td>
<td>Texas, Alberta, Australia’s NEM, NordPool,</td>
</tr>
<tr>
<td>(Yes through PPAs; No if relying on capacity payments)</td>
<td></td>
</tr>
<tr>
<td>How are Capital Costs Recovered?</td>
<td>Energy market only</td>
</tr>
<tr>
<td>Regulated retail rate recovery</td>
<td></td>
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<tr>
<td>Long-term PPAs or capacity payment plus energy market</td>
<td></td>
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<tr>
<td>Bilateral capacity payments and energy market</td>
<td></td>
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<tr>
<td>Capacity and energy markets</td>
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</tbody>
</table>

Summary of RA and Capacity Market Constructs

**Forward Period**

- **California**
  - Mandatory Auction
  - Voluntary or Readjustment Auction

- **MISO**
  - Bilateral Only

- **NYISO**
  - Bilateral + Voluntary Auction

- **PJM**
  - Bilateral + Mandatory Auction

- **ISO-NE**
  - Bilateral + Mandatory Auction

**Procurement**

- **California**
  - Bilateral Only

- **MISO**
  - Bilateral + Voluntary Auction

- **NYISO**
  - Bilateral + Mandatory Auction

- **PJM**
  - Bilateral + Mandatory Auction

- **ISO-NE**
  - Bilateral + Mandatory Auction

**Demand Curve**

- **California**
  - n/a

- **MISO**
  - n/a

- **NYISO**
  - n/a

- **PJM**
  - n/a

- **ISO-NE**
  - n/a

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Market Design Trends and Policy Questions

1. Market design trends in the Northeast and elsewhere
2. Are capacity prices too uncertain?
3. Did capacity markets actually attract new resources?
4. Can capacity markets attract merchant generation?
5. Can capacity markets address retirement threats?
6. Do Markets Create an Over-Dependence on Natural Gas?
7. Will states support capacity markets as prices rise?
1. Market Design Trends in the Northeast

<table>
<thead>
<tr>
<th></th>
<th>PJM</th>
<th>NYISO</th>
<th>ISO-NE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MOPR</strong></td>
<td>Widespread dissatisfaction, potential reform</td>
<td>Recent litigation</td>
<td>FERC requires MOPR a la PJM; maybe different exemptions</td>
</tr>
<tr>
<td><strong>Ensuring Performance and Right Types of Capacity</strong></td>
<td>IMM concerns, Dealt w/Limited DR</td>
<td></td>
<td>Revising performance requirements; “Tranching” idea</td>
</tr>
<tr>
<td><strong>Demand Curves</strong></td>
<td>CONE litigation</td>
<td></td>
<td>Introduce a demand curve?</td>
</tr>
<tr>
<td><strong>Other Auction Parameters/Rules</strong></td>
<td>Revisiting whether to transition to a forward construct</td>
<td></td>
<td>De-list thresholds</td>
</tr>
</tbody>
</table>
### 1. Market Design Trends Elsewhere

<table>
<thead>
<tr>
<th>Status</th>
<th>MISO</th>
<th>CAISO</th>
<th>ERCOT</th>
</tr>
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<tbody>
<tr>
<td>New locational 1-year market to be implemented in June 2013 but most of footprint builds according to traditional planning</td>
<td>Inefficiencies of disjointed processes for new and existing gen and DR have come to a head</td>
<td>Currently energy-only w/no RA requirement</td>
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<tr>
<td>Declining reserve margins are forcing a reevaluation (by year end)</td>
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<table>
<thead>
<tr>
<th>Hot Topics</th>
<th>MISO</th>
<th>CAISO</th>
<th>ERCOT</th>
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<tbody>
<tr>
<td>Cross-border deliverability</td>
<td>How to prevent premature retirements</td>
<td>What are the reliability objectives?</td>
<td></td>
</tr>
<tr>
<td>FERC ordered MISO to implement new auction without any MOPR</td>
<td>Need to retain/attract flexible capacity</td>
<td>What is the best market construct to achieve those objectives?</td>
<td></td>
</tr>
<tr>
<td>Once-through cooling</td>
<td>Introduce Forward RA requirement?</td>
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2. Are Capacity Prices Too Uncertain?

Example: our PJM review

♦ Single biggest concern for all stakeholder sectors was price volatility and uncertainty
♦ Related concerns about the lack of long-term hedging options

Causes of price uncertainty:

♦ Market Fundamentals – not a concern, prices should move with market fundamentals
♦ Previous Design Changes – design improvements contributed to volatility, but not a persistent concern
♦ Ongoing Administrative Uncertainties – uncertain administrative parameters is an ongoing concern
3. Did Capacity Markets Actually Attract New Resources?

Resources decommitted and committed in PJM’s Forward Capacity Market (RPM)

- Gross Additions Commited through RPM Auctions
- Energy Efficiency
- Demand Response
- Interruptible Load For Reliability
- Increased Imports
- Net Additions Comitted through RPM Auctions
- Gross Capacity Added or Retained through RPM Auctions
- 2006/07 ICAP
- Reliability Target

Gross Capacity Excluding FRR, AISL, and DEOK (ICAP GW)

- Uncleared Offers for Existing Resources in 2014/15 BRA
- FRR Capacity Removed from Auctions
- New Generation
- Reactivations
- Reduced Exports
- Uprates
- Retained Generation Bids ≥ $200/MW-d
- Retained Generation Bids ≥ $150/MW-d

PJM Capacity Excluding FRR, AISL, and DEOK (ICAP GW)

- Pre-RPM 2007/08
- Pre-RPM 2008/09
- Pre-RPM 2009/10
- Pre-RPM 2010/11
- Pre-RPM 2011/12
- Pre-RPM 2012/13
- Pre-RPM 2013/14
- Pre-RPM 2014/15

- 2007/08
- 2008/09
- 2009/10
- 2010/11
- 2011/12
- 2012/13
- 2013/14
- 2014/15

- Retirements
- Derates
- Excused Capacity

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4. Can Capacity Markets Attract Merchant Generation?

PJM’s 2015/16 auction shows “YES”

- 4,899 MW of new generation cleared:
  - 3,259 MW of regulated or state contracts
  - 1,650 MW Merchant and other new builds
- Prices cleared far below estimated Net CONE (almost exactly Net CONE in ATSI)
- 1,945 MW uncleared at higher offer prices

State contracts well above market

- 1,949 MW cleared, 660 MW uncleared
- Cleared with cost-based MOPR mitigation
  - Clearing price: $167/MW-d (equal to $61/kW-yr)
  - MOPR price: $242/MW-d (90% of CC Net CONE)
  - Exemptions allowed lower cost-based offer prices
- NJ contract prices far above market:
  - $220/MW-d Hess Newark (rising to $260 by 2030)
  - $286/MW-d CPV Woodbridge (rising to $433 by 2030)

Sources and Notes: PJM 2014/15 BRA Results, SNL Energy; Capacities may be inexact, reported in UCAP where available.
5. Can Capacity Markets Address Retirement Threats?

Yes, especially with forward markets

**PJM 2014/15 auctions successful**
- HAP rule was an important “stress test”
- PJM prices increased substantially (still below Net CONE)
- Some uncleared generation (from coal likely to retire), partly offset by DR increases

**Remaining concerns**
- Retirements may be co-located in unmodeled subzones
- Shorter-term markets yet to pass test
6. Do Markets Create an Over-Dependence on Natural Gas?

Recent ISO-NE and MISO studies highlight:

- Concern that resources built in wholesale market are mostly natural gas,
- Reliability challenge feared due to limited natural gas pipeline capacity during coinciding winter peak loads for heating and electricity use

Dual-fuel capability of the natural gas fleet (mostly ignored in these studies) may fully address these concerns, if operational:

Focus should be on standards for and reliability of dual-fuel capability (along with scheduling, coordination, and other operational challenges)
7. Will States Support Capacity Markets as Prices Rise?

Capacity market prices have a “PR challenge”

- (Mis)perceptions:
  - Not a “real” market, just a regulated construct
  - Only provides a windfall to existing generators
  - Keeps “dirty” old plants around without attracting new resources
- Transparency makes total costs more visible than bilateral markets

Observed price signals are efficient; discrimination wouldn’t work

- It is efficient for new generation, existing/uprates/retrofits, and DR to compete on the same basis
- Price discrimination undermines market, deters merchant entry, and causes uneconomic retirements
- Prices of state-sponsored long-term contracts turned out to be well above market

Improving market design helps increase efficiency and reduce the price of resource adequacy

- Enable price-setting DR and improve scarcity pricing
- Correct impact of out of market commitment on energy and A/S prices
- Ensure all types of capacity resource can compete, even if different operationally
- Review resource adequacy standard? Lower target reserve margin?

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Appendix

References and Additional Reading
ERCOT Resource Adequacy Results
Causes of Outage Events
About The Brattle Group
Speaker Bio and Contact Information
References and Additional Reading


LaCommare and Eto, Understanding the Cost of Power Interruptions to U.S. Electricity Consumers, Ernest Orlando Lawrence Berkeley National Laboratory, September 2004.


## Appendix: ERCOT Resource Adequacy Results

Our recent resource adequacy and investment incentive review for ERCOT (a 70,000 MW market) estimated:

<table>
<thead>
<tr>
<th>Planning Reserve Margin</th>
<th>10%</th>
<th>15%</th>
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<tbody>
<tr>
<td>Resulting resource adequacy</td>
<td>24 hours in 10 years</td>
<td>1 event in 10 years</td>
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</thead>
<tbody>
<tr>
<td>Loss of load events (LOLE)</td>
<td>0.95 events/yr</td>
<td>14 events/yr</td>
<td>0.1 events/yr</td>
<td>1.5 events/yr</td>
</tr>
<tr>
<td>Loss of load hours (LOLE)</td>
<td>2.4 hours/yr</td>
<td>35 hours/yr</td>
<td>0.18 hours/yr</td>
<td>2.7 hours/yr</td>
</tr>
<tr>
<td>Exp. Unserved Energy (EUE)</td>
<td>2,700 MWh</td>
<td>40,000 MWh</td>
<td>130 MWh</td>
<td>2,000 MWh</td>
</tr>
<tr>
<td>Average customer outage due to resource adequacy</td>
<td>2.8 min/yr/cust</td>
<td>42 min/yr/cust</td>
<td>0.1 min/yr/cust</td>
<td>2.0 min/yr/cust</td>
</tr>
</tbody>
</table>

**Compare to:**

- Distribution-level customer outage w/o major storms: 100 – 300 minutes per year per customer
- ....with major storms: 1,000 – 10,000 min/year/customer (e.g. 2008)
Causes of Outage Events

Major Outage Events

- Insufficient Generation (81) 15%
- Human Error (59) 11%
- Equipment Failure (165) 31%
- Sabotage (16) 3%

All Retail Service Outages

- Weather & Fire (208) 40%
- Utility Error 2%
- Transmission 4%
- Substation 6%
- Animal 7%
- Public 8%
- Tree Related 16%
- Equipment Overhead (OH) 12%
- Weather 16%
- Equipment Underground (UG) 22%
- Other 7%

About The Brattle Group

The Brattle Group provides consulting and expert testimony in economics, finance, and regulation to corporations, law firms, and governmental agencies around the world.

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Our services to the electric power industry include:

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- Cost of Capital and Regulatory Finance
- Demand Forecasting and Weather Normalization
- Demand Response and Energy Efficiency
- Electricity Market Modeling
- Energy Asset Valuation
- Energy Contract Litigation
- Environmental Compliance
- Fuel and Power Procurement
- Incentive Regulation
- Rate Design, Cost Allocation, and Rate Structure
- Regulatory Strategy and Litigation Support
- Renewables
- Resource Planning
- Retail Access and Restructuring
- Risk Management
- Strategic Planning
- Market-Based Rates
- Market Design and Competitive Analysis
- Mergers and Acquisitions
- Transmission
Johannes (Hannes) Pfeifenberger is an economist with a background in power engineering and over 20 years of experience in the areas of public utility economics and finance. He has published widely, assisted clients and stakeholder groups in the formulation of business and regulatory strategy, and submitted expert testimony to the U.S. Congress, courts, state and federal regulatory agencies, and in arbitration proceedings.

Hannes has extensive experience in the economic analyses of electricity wholesale markets and transmission systems. His recent experience includes reviews of RTO capacity market and resource adequacy designs, testimony in contract disputes, and the analysis of transmission benefits, cost allocation, and rate design. He has performed market assessments, market design reviews, asset valuations, and cost-benefit studies for investor-owned utilities, independent system operators, transmission companies, regulatory agencies, public power companies, and generators across North America.

Hannes received an M.A. in Economics and Finance from Brandeis University and an M.S. in Power Engineering and Energy Economics from the University of Technology in Vienna, Austria.