Ensuring Adequate Power Supplies

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The Electric Markets Research Foundation (EMRF) formed in 2012 as a result of concerns about the operation of electric markets given today’s challenges

- Non-profit 501(c)(3) Corporation
- Independent Board of Directors
- Further information at www.emrf.net
Initial Studies

- First Study, conducted by Navigant Consulting, looked at how we got to the current bifurcated market structure we have today in the U.S.
- Second study designed to look at how electric markets were working to ensure that adequate capacity is built to meet consumer needs
- Christensen Associates Energy Consulting hired to perform this study
What is Resource Adequacy?
Physics requires:
- supply match demand in real time; and
- voltages stay within tight limits.

Reliability problems occur when system operators lack the resources, information, or judgment to maintain power balance and voltages.
- Deviations can erode grid reliability and in extreme cases cause blackouts.
Dimensions of
Power System Reliability

- **Security** – short-term concept
  - refers to the system’s ability to withstand real-time contingencies, particularly outages of major power system facilities
  - depends upon power system operations, including real-time deliverability, resource commitment, and dispatch

- **Adequacy** – long-term concept
  - refers to having planned supply- and demand-side resources that exceed forecasted peak loads plus a planning reserve margin to account for unavailability of some resources
  - depends upon resource planning and investment, particularly in generation, transmission, and demand-side resources
Security and Adequacy Depend Upon Reserves

- Security depends upon operating reserves.
  - *Operating reserves* are the amount by which available resources exceed load, where availability depends upon resources’ capacities and responsiveness.

- Adequacy depends upon planning reserves.
  - *Planning reserves* are the amount by which resources’ total capacity exceeds annual peak loads.

- Operating reserves and planning reserves are indicators of system reliability in short- and long-term timeframes, respectively.
The Two Market Models
The Resource Adequacy Approaches of Two Market Models

- **Traditional regulatory model**
  - State regulatory agencies set prices based upon utilities’ average costs of service.
  - Investments are based upon integrated resource plans.

- **Restructured market model**
  - Competitive bidding sets wholesale market prices of energy, operating reserves, and capacity based upon supply and demand.
  - Investment responds to market prices.
Traditional Regulatory Model

- Vertically integrated utilities manage security and adequacy through self-supply and bilateral contracts.
- Capacity markets are bilateral and non-centralized.
- Utilities participate in reserve-sharing arrangements allowing them to rely on each other’s capacity, thereby reducing overall reserve requirements.
- States have integrated resource planning (IRP) processes that determine resource requirements and identify resources that meet those requirements at lowest cost.
Restructured Market Model

- Regional Transmission Organizations (RTOs, aka ISOs) direct resource commitment and dispatch and administer centralized energy and capacity markets.
  - Resources may be procured through self-supply, bilateral contracts, and the RTO capacity markets.
  - Originally, markets were energy only – theory was that when there were shortages, prices would rise to attract new capacity.
  - Missing money problem discovered – plants operating only hours a year could not recover enough revenue.
  - Some RTOs have thus developed capacity markets.
Regional Transmission Organizations (RTO/ISOs)
Capacity Cost Recovery Under the Two Market Models

- Traditional regulatory model:
  - Investors receive return of capital based on annualized costs of actual capital investments, including an allowed rate of return.

- Restructured market model:
  - Investors receive whatever return is achievable through market prices for energy (and capacity in some RTOs).
  - Capacity prices are determined through a variety of regulatory/administrative rules, including:
    - Minimum Offer Price Rules; and
    - penalties for load-serving entities (LSEs) that fail to procure sufficient capacity.
Problems with the Restructured Market Model
Market Model – In Theory (1)

- Investment responds to price expectations.
  - Investors develop resources when they expect to profit from sales at projected market prices, hedged by bilateral and derivatives contracts.
  - Capital and operating costs recovered solely through revenues from the sale of these services.
  - Locational prices induce generators to locate where generation services are most valuable.

- Long-term markets develop to facilitate hedging against price uncertainty.
Market Model – In Theory (2)

- When demand threatens to exceed available capacity:
  - high energy and ancillary services prices encourage immediate load reductions; and
  - customers do not receive service in excess of the resources to which they have purchased rights.
- There is no “capacity” product.
- Market rules are stable.
Public policy will not allow the price mechanism to work under shortage conditions.

- Market participants do not want the extreme and unpredictable price volatility of unfettered electricity markets.
- Price caps are used to limit upside volatility, which reduces incentives to invest in or postpone retirement of resources.
Public policy distorts the price mechanism under all conditions.

- Policy favoring particular resources – RPS and PTC – subsidize those resources while implicitly taxing other resources.

Institutional limitations inhibit the price mechanism.

- Limited demand-side participation restricts the extent to which prices reflect consumer value.
- There has been little development in practice of long-term markets for energy and ancillary services.
The price mechanism does not suffice to get resources in the right locations. Consequently:

- RTO rules specify the quantities and locations of resources that must be procured.
- RTOs regularly make large out-of-market payments to resources to ensure reliable operations.
Market Model – In Practice (4)

- Resource investment depends upon RTOs’ determinations of capacity needs.
  - Capacity obligations are imposed on individual LSEs for specified present and future periods.
  - At best, the price mechanism serves as a means of incenting least-cost provision of resources to meet RTO-determined needs, not as a means of determining needs.

- Market rules occasionally change.
Resource Costs, Prices, and Net Revenues
Levelized Cost of Generation Technologies, 2008-2013 (2011 $/MWh)
RTO Capacity Market Prices ($/MW-month)
## Net Revenue for Combustion Turbine Gas Plant ($/MW-month)

<table>
<thead>
<tr>
<th>Year</th>
<th>CAISO</th>
<th>ERCOT</th>
<th>ISO NE</th>
<th>MISO</th>
<th>NYISO</th>
<th>PJM</th>
<th>Levelized Cost</th>
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<tbody>
<tr>
<td>2005</td>
<td>4,333</td>
<td>3,333</td>
<td></td>
<td></td>
<td>1,917</td>
<td>833</td>
<td>6,000</td>
</tr>
<tr>
<td>2006</td>
<td>5,083</td>
<td>7,583</td>
<td></td>
<td></td>
<td>3,167</td>
<td>1,250</td>
<td>6,667</td>
</tr>
<tr>
<td>2007</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4,167</td>
<td>4,083</td>
<td>7,583</td>
</tr>
<tr>
<td>2008</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5,667</td>
<td>4,250</td>
<td>10,333</td>
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<td></td>
<td></td>
<td>5,250</td>
<td>4,833</td>
<td>10,750</td>
</tr>
<tr>
<td>2010</td>
<td>4,417</td>
<td>3,750</td>
<td>2,500</td>
<td>2,250</td>
<td>3,833</td>
<td>7,667</td>
<td>10,917</td>
</tr>
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<td>4,500</td>
<td>9,417</td>
</tr>
</tbody>
</table>
Resource Adequacy Outcomes
Forecast Summer Reserve Margins – Traditional Regions
Forecast Summer Reserve Margins – RTO Regions

![Chart showing forecast summer reserve margins for different regions over 2014, 2018, and 2023. The chart includes data for California (N), California (S), ERCOT, MISO, New England, New York, PJM, and SPP.]
Projected DSM Load Reductions by Program Type, 2012-2023
Fuel Mix, Non-RTO & RTO Regions, 2012

The chart shows the fuel mix for different regions in 2012. Each region is represented by a bar chart showing the percentage of various energy sources:

- **Reg Non-RTO**
- **CA ISO**
- **ERCOT**
- **ISONE**
- **MISO**
- **NYISO**
- **PJM**
- **SPP**

The energy sources include:

- Other
- Pumped Strg
- Wind
- Petrol
- Hydro
- Nuke
- NG
- Coal

The chart indicates the proportion of each energy source in the total energy mix for each region.
Intermittent Resource Issues
Reliability Impacts of Intermittent Resources

- Intermittency of wind & solar create system control problems that are costly to resolve
- As wind & solar shares of total capacity increase, other generation must provide backup
- At the same time, subsidized wind & solar output depresses wholesale energy market prices, which dampens investment in other generation
Coal & EPA Issues
EPA Clean Power Plan
CAA §111(d)

- Issues CPP June 2; Final Rule June 2015.
- State implementation plans due June 2016, or June 2017 if state exemption granted, or June 2018 if multiple states.
- Sets a CO2 intensity target (pounds of CO2 emitted per MWh of generation) for each state for the year 2030, as well as an “interim goal” applied as an average of the 2020-2029 period (based on Best System of Emission Reduction (BSER)).
- Requires every state to create its own plan to achieve the CO2 reduction target set for the state.
## CPP “Building Block” Approach

<table>
<thead>
<tr>
<th>#</th>
<th>Building Blocks</th>
<th>Description</th>
<th>Assumptions Used by EPA</th>
<th>Inside the Fence?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Improving Existing Coal Plant Efficiency</td>
<td>Improve the “heat rate” of existing power plants to make them more efficient, reducing CO2 output per MWh generated</td>
<td>An average of 6% improvement in the heat rate of existing coal-based generation units</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>Using Existing Natural Gas Plants More to Displace Coal</td>
<td>Reduce CO2 emissions by closing or curtailing coal plants (the most CO-intensive), and substituting that generation with power from less CO2-intensive natural gas plants currently operating or under construction</td>
<td>Existing natural gas combined cycle power plants can be dispatched above their current utilization, up to 70% capacity factor</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>Increase Renewable and Nuclear Power</td>
<td>Reduce CO2 emissions by closing or curtailing coal plants (the most CO2-intensive), and substituting that generation with power from existing and new zero-CO2-emitting nuclear and renewable power sources</td>
<td>Existing nuclear power plants that are “at risk” of shutting down could be continued; additional renewable power generation sources can be added nearly nationwide</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>Increase End-use Energy Efficiency</td>
<td>Reduce electricity demand, thereby reducing the amount of electric generation needed to meet demand</td>
<td>Energy efficiency by consumers can reduce electricity demand by 1.5% annually nationwide by 2030</td>
<td>No</td>
</tr>
<tr>
<td>Regulation</td>
<td>Status</td>
<td>Pollutant Targeted</td>
<td>Compliance Options</td>
<td>Expected Date of Compliance</td>
</tr>
<tr>
<td>------------------</td>
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<td>-------------------------------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>MATS</td>
<td>Final</td>
<td>HAPs (mercury, acid gases, PM)</td>
<td>ACI, baghouse, FDG/DSI</td>
<td>2015/2016</td>
</tr>
<tr>
<td>111(d)</td>
<td>Proposed June 2014</td>
<td>GHG</td>
<td>Improve heat rate, fuel switch, increase gas cap factor, CCS, retirement</td>
<td>2017/2020 SIPS by 2016 if single, 2017 for group</td>
</tr>
<tr>
<td>316(b)</td>
<td>Proposed</td>
<td>Cooling water intake structures</td>
<td>Impingement: Mesh Screens; Entainment: case-by-case, may include cooling towers</td>
<td>2018?</td>
</tr>
<tr>
<td>Combustion by-products (ash)</td>
<td>Final Dec 2014</td>
<td>Ash, control equipment waste</td>
<td>Bottom ash dewatering, dry fly ash silos, etc.</td>
<td>2020?</td>
</tr>
<tr>
<td>Regional Haze</td>
<td>Final</td>
<td>NOx, SO2, PM</td>
<td>SCR/SNCR, FGD/DSI, baghouse/ESP, combustion controls</td>
<td>5 years after ruling</td>
</tr>
<tr>
<td>CSAPR</td>
<td>Vacated by Court</td>
<td>NOx, SO2</td>
<td>SCR/SNCR, FGD/DSI, fuel switch, allowance purchases</td>
<td>Potential replacement rule after 2015?</td>
</tr>
</tbody>
</table>
Actual & Projected Coal Plant Retirements, 2005 - 2026
Reported Coal Plant Retirements
2012 - 2016
EPA 111(d) Retirements

- EIA (AEO 2014) projects about 54 GW of generating capacity will retire by 2016, primarily due to MATS
- EPA modeling projects 132 GW of generating capacity will retire between 2016 and 2020
  - 68 GW to retire in response to 111(d)
    - 46 GW of low-cost, base load coal generation
    - 11 GW of oil/gas steam generation
  - 44 GW to retire by 2016
    - 28 GW of coal units + 11 GW of oil/gas steam units
    - Retirement likely has not been considered within reliability planning efforts
“Costly” Power Plan – Round 2

- EPA issues NODA October 27 to address stakeholder issues with proposed CPP
  - Compliance trajectory – 2020-2029
    - Insufficient flexibility – too heavy reliance on gas
    - Technological & infrastructure hurdles
  - Building block methodology
    - Block 2 – higher gas utilization not feasible
    - Block 3 – double counting renewables; nuclear
  - State CO2 goals computation
    - Inconsistent treatment of Blocks 2 vs. 3 & 4
    - Use of single year 2012 data
Conclusions - 1

- Restructured markets are struggling to meet capacity needs under current environment
- 111(d) will exacerbate problems many fold, with significant additional coal plant retirements
- Southwest Power Pool has already indicated they expect reliability issues, others are studying
Conclusions - 2

- Clean Power Plan will result in a sea change in the way markets operate – added complexity, added costs, questions about reliability
- EPA requesting additional comments
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