Financial Challenges of Operating U.S. Nuclear Power Plants

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Agenda

• Introduction and Overview of U.S. Nuclear Power
• Actual, Planned, and Potential Reactor Closures
• Merchant Nuclear Power Plant Economics
  • Generation Costs
  • Wholesale Electricity Prices
  • How Natural Gas Impacts Wholesale Electricity Prices
  • Locational Marginal Prices
  • Other Revenue Sources
  • Case Study: Quad Cities
  • Plant-Level Analysis
• Policy Options and Considerations
Overview of U.S. Nuclear Power

- 60 operating power plants
- 99 reactors
- 99,316 Megawatts of Net Summer Generating capacity
- Approximately 20% of total power generation
- Most of existing capacity started operating in the 1970’s and 1980’s

History of U.S. Power Reactor Orders, Startups, and Shutdowns

<table>
<thead>
<tr>
<th>Years</th>
<th>Orders</th>
<th>Cancellations</th>
<th>Startups</th>
<th>Shutdowns</th>
<th>Operating at end of decade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950s</td>
<td>16</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>3</td>
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<tr>
<td>1960s</td>
<td>87</td>
<td>0</td>
<td>21</td>
<td>8</td>
<td>16</td>
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<tr>
<td>1970s</td>
<td>153</td>
<td>57</td>
<td>58</td>
<td>7</td>
<td>67</td>
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<tr>
<td>1980s</td>
<td>0</td>
<td>58</td>
<td>48</td>
<td>4</td>
<td>111</td>
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<tr>
<td>1990s</td>
<td>0</td>
<td>5</td>
<td>3</td>
<td>10</td>
<td>104</td>
</tr>
<tr>
<td>2000s</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>104</td>
</tr>
<tr>
<td>2010s</td>
<td>0</td>
<td>6</td>
<td>1</td>
<td>6</td>
<td>99</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>264</td>
<td>126</td>
<td>134</td>
<td>35</td>
<td></td>
</tr>
</tbody>
</table>

Source: Nuclear Energy Institute, Nuclear Regulatory Commission.
Orders, Startups, and Shutdowns

Most of existing capacity started operating in the 1970s and 1980s

Source: Nuclear Energy Institute, Nuclear Regulatory Commission.
Nuclear Power Plants

Operating in 2010

Source: Map by CRS using data from S&P Global Platts geospatial data layers, 2016; and Esri Data & Maps, 2014.

Notes: No nuclear power plants are located in Alaska or Hawaii.
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Nuclear Power Plants

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Merchant Nuclear Power Plant Economics
How Competitive Wholesale Electricity Prices Are Determined

Source: CRS
Notes: Not representative of actual RTO/ISO market clearing results. Actual values for electricity prices and electricity supply are not indicated in this figure, as they will vary by market, generation mix, time-of-day, and location.
How Natural Gas Prices Impact Wholesale Electricity Prices, Compared with Nuclear Costs

Dollars per Megawatthour (MWh) of Electricity (Nominal)


Notes: Nuclear power average total costs include fuel, O&M, and capital.
Locational Marginal Prices (LMP) for Nuclear Plants

LMP and Nuclear Average Total Costs (Nominal)
Dollars per Megawatthour (MWh)


Notes: LMPs for each nuclear plant were obtained from the Bloomberg terminal, which also includes forward price projections through 2019. Nuclear power average total costs through 2015 are from NEI, with 2016 to 2018 projections calculated based on NEI's "Delivering the Nuclear Promise" stated goals.
Other Electricity Revenue Sources

Case Study: Quad Cities

Plant-Level Analysis: Electricity Sales Revenue and Fuel and O&M Costs

Federal Policy Options
Federal Policy Options

- Power Market Price Formation Changes
- Tax Incentives
- Carbon Price
- Federal Power Purchase Agreements

To Date, All Policy Action to Support Operational Nuclear Plants Has Occurred at the State Level: New York, Illinois, Ohio, Connecticut
QUESTIONS?
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