State and Federal Nuclear Support Schemes in Dynamic Electricity Market Conditions: Insights from NYISO and PJM

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Agenda

1. Motivation
2. State level support schemes
3. Federal level support schemes
4. Methods and Data
5. Results and policy implications
Nuclear Support Schemes
Motivation

- Gradual decline in wholesale electricity market prices across the U.S.
- Thirteen nuclear reactors (10.2 GW) retired between 2009 and 2022.
- Rapid introduction of nuclear support schemes at state and federal levels.

Source: Bah (2023)
Research Question

1. Test whether out-of-market support schemes for NPPs were justified in wholesale electricity markets

2. Quantify the potential profit magnitude for NPPs in a dual state and federal support scheme environment

3. Provide policy suggestions on redesigning support schemes to meet the policy objective of keeping only financially vulnerable plants online
**literature assessment**

- **Area 1:** Economic challenges facing NPPs (Joskow, 2006; Lovins, 2013; Szilard et al., 2016; Roth and Jaramillo, 2017)

- **Area 2:** Ongoing debate on phasing-out or retaining NPPs (Lovins, 2022, 2017; Richards and Cole, 2017; Cebulla and Jacobson, 2018)

**Insights**

- Cebulla and Jacobson 2018: NPPs would need between $8 to $44/MWh to break-even.
- Szilard et al. 2016: Estimated revenue gap for NPPs is $5 to $15/MWh

**Contribution**

- Preceding studies do not fully take into account **revenue streams** from state or newly proposed federal schemes, potentially **underestimating true profitability estimates** of NPPs.
- No recent study on potential double dipping from both state and federal funding pools.
Nuclear support schemes
State level

- Direct Credit Payment Scheme: New York, Illinois and New Jersey
- Power Purchase Agreements: Connecticut and New Hampshire
- Covers 19 operating reactors
- Total capacity of 19.4 GW (~ 20% of nationwide nuclear capacity)
Nuclear support schemes
Federal level

Civil Nuclear Credit (CNC)
- Approx. $6 billion over 10 years (2022-2031)
- **First round:** targeted NPPs with announced shutdown dates before 2026
- **Second round:** open to all NPPs in wholesale markets including NPPs that shutdown before Nov. 2021
- Credit price determined through sealed bids

Nuclear Power Production Credit (NPPC)
- Introduced in 2022 Inflation Reduction Act (IRA)
- Only operating NPPs eligible
- Nine-year coverage (2024-2032) estimated at $30 billion (JCT, 2022)
- Credit value: $3/MWh to $15/MWh

State and Federal nuclear support scheme coverage in the U.S.

Source: Bah (2023)
# Methods and Data

## New York
- Three active NPPs (or 4 reactors)
- Nuclear accounts for 15% of state installed capacity
- Lucrative subsidies

## PJM
- Nuclear accounts for 18% of total installed capacity in PJM.
- State subsided plants located in Illinois and New Jersey (12 reactors)

## Timeframe
- Five-year ex-post time frame from 2017-2021
- Corresponds to the earliest introduction of state support schemes
- Representative sample of electricity market developments

## Data
- Historical annual plant generation data
- Average zonal day-ahead market prices
- Plant specific capacity market prices
- Average operating costs (fuel & O&M)
- Published state credit prices
- Assumptions on federal support credit prices
Results

NYISO

• NPPs were able to cover their total operating costs over entire sample

• Low price environment 2017:
  • Net profit market only revenues ~$11.2 million (Ginna) to $38.6 million (Nine Mile)
  • With a ZEC scheme ~$93.3 million (Ginna) to $313.3 million (Nine Mile)

• High price environment 2021:
  • Combined market and ZEC revenues far exceeded operating costs
  • If NPPs are eligible for a single federal support (CNC), profits range from $202 million to $699.1 million

Profitability estimates of nuclear power plants in NYISO.
Results

PJM Market

• Similar trends observed in the PJM market

• Findings consistent with independent expert reports;
  • “Hope Creek and Salem are able to sufficiently cover their operating costs from 2019 to 2021… should not be eligible for state support” (Monitoring Analytics, 2019)
  • PJM Power Provider Group: collective evidence will find that NPPs in “Salem County are solidly profitable and extremely unlikely to close in the next four years - even in the absence of a ZEC payment” (NJBPU, 2018, p. 3)

• If state and single federal scheme co-exist ~Profits range from $311.5 million (Hope Creek) to $672.9 million annually (Quad Cities)

Profitability estimates of nuclear power plants in PJM

Notes: Illinois NPPs (Quad Cities, Clinton), New Jersey NPPs (Hope Creek, Salem). ZEC program for Hope Creek and Salem started in 2019
Results
Robustness

Profitability estimates of NPPs in PJM (Illinois) subsidized under the CMC scheme.
## Conclusion and policy implications

### Insights

- NPPs are in an economically viable condition to operate without support scheme.
- On the basis of the profitability assessments alone, there is no economic justification for the introduction of federal support scheme.

### Co-existence of state and federal support schemes

- Introduce/activate ineligibility clauses in both state and federal support schemes
  - Example: CNC and NPPC scheme does not prohibit state subsidized NPPs from applying
- Disqualify rate-regulated NPPs from applying for federal support

### Dynamic electricity markets

- Fixed credit price (i.e., Illinois, New Jersey) or upward revising (New York) is not optimal
- Introduce flexible market linked thresholds that is regularly revised
References


Background paper

WWZ Working Paper 2023/05: State and federal nuclear support schemes in dynamic electricity market conditions: Insights from NYISO and PJM

https://edoc.unibas.ch/93914/1/20230307175634_64076cc25d93e.pdf
Thank you!

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## Overview of state subsidy schemes

<table>
<thead>
<tr>
<th>Reactor</th>
<th>Capacity [MW]</th>
<th>State</th>
<th>Market</th>
<th>Age*</th>
<th>License expiry</th>
<th>State support scheme</th>
<th>Coverage</th>
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<td>Fitzpatrick</td>
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<td>NYISO</td>
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<td>ZEC</td>
<td>2017-2029</td>
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### Nuclear plant average operating costs ($/MWh)

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### O&M Categories
- Engineering
- Fuel management
- Training
- Loss prevention
- Operations
- Work management
- Materials and Services
- Support Services
Policy assessment relative estimates

Relative profitability estimates of nuclear power plants in NYISO.

Relative profitability estimates of nuclear power plants in PJM.