EVALUATION OF ENERGY STORAGE AS A TRANSMISSION ASSET

PRESENTED BY

Tu A. Nguyen and Raymond H. Byrne

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**Objective:** this task is to evaluate the benefits of energy storage providing virtual transmission capacity to relieve congestion in wholesale market settings.

**Methodology:** the task is performed by developing an optimization to maximize the monetized benefits of energy storage providing virtual transmission together with market-based services.

**Outlines:**

- Overview of transmission congestion cost
- Virtual transmission by energy storage
- Virtual transmission vs. upgrade deferral
- Virtual transmission vs. transmission upgrade
- Case study in ISO-NE
• Congestion occurs when there is insufficient transmission capacity to deliver cheaper generation to loads, requiring the use of more expensive generators closer to loads.
• In vertically integrated utilities, congestion leads to higher total production cost.
• In ISO/RTO whole sale markets, congestion creates differences in LMPs at different locations.
OVERVIEW OF TRANSMISSION CONGESTION COST

• In VTU:
  • congestion cost is the increase in production cost due to congested transmission.
  • congestion cost is passed to the loads.

• In markets:
  • congestion cost can be the system redispatch cost, the congestion revenue or combination of the two.
  • congestion cost is returned to the loads through Auction Revenue Rights (ARR) and Financial Transmission Rights (FTR).

Reference: Lesieutre, Bernard C, and Eto, Joseph H. 
OVERVIEW OF TRANSMISSION CONGESTION COST

- Congestion costs in ISO/RTO markets tend to increase over the last few years.
- This indicates the need for upgrading transmission lines or putting cheaper generators in congested areas.
- This also creates opportunity for non-wire alternatives for transmission congestion relief.

Congestion Cost in ISO/RTO Markets (Millions $)

<table>
<thead>
<tr>
<th>RTO</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERCOT</td>
<td>497</td>
<td>976</td>
<td>1,260</td>
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<tr>
<td>ISO-NE</td>
<td>38.9</td>
<td>41.4</td>
<td>64.5</td>
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<tr>
<td>MISO</td>
<td>1,400</td>
<td>1,500</td>
<td>1,400</td>
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<tr>
<td>NYISO</td>
<td>529</td>
<td>481</td>
<td>596</td>
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<tr>
<td>PJM</td>
<td>1,023.7</td>
<td>697.6</td>
<td>1,310</td>
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<tr>
<td>SPP</td>
<td>273.7</td>
<td>405.3</td>
<td>380.9</td>
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<tr>
<td>Total</td>
<td>3,762.3</td>
<td>4,101.3</td>
<td>5,011.3</td>
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</table>
• ESSs are placed at both ends of a line, providing both cost-based transmission and market-based services:
  • when the line is congested, ESSs simultaneously charge and discharge mimicking line flow and support voltage stability to further increase line dynamic rating.
  • when the line is not congested, ESSs provide other market services

• In line with FERC’s 2017 policy statement “Utilization of Electric Storage Resources for Multiple Services When Receiving Cost-Based Rate Recovery” (PL17-2).

• ISO/RTOs in the US are investigating the opportunities under Storage as Transmission Assets Frameworks.
• Maximize the benefits from cost-base services together with market-based services:
  • Congestions relief: maximize opportunity for upstream generators to sell more energy at higher prices; minimize overall congestion cost
  • Market activities: energy arbitrage, ancillary services
• Evaluate the impact of virtual transmission in transmission planning: reduce the amount of transmission to meet N-1 security requirement.
VIRTUAL TRANSMISSION VS. TRANSMISSION UPGRADE

- Faster to deploy
- Smaller foot print
- More flexible and relocatable
- Providing multiple services
- Shorter life (10-15 years)

- Longer to get permitted and build.
- Need much more land
- Fixed assets
- Longer life (~50-60 years)
• Congestions make the marginal wind plant in region A curtail its output.
• Congestion component of LMP are negative indicating that if the congestions are relieved, more wind energy in region A can be sold to region B at higher LMPs
• In this case study:
  • Maximize the revenue for generators in region A by using storage as virtual transmission.
  • Compare with arbitrage benefit from wind curtailment.
**CASE STUDY – RESULTS**

10MW/20Wh Case - Charge/discharge 24h Profile Example

LMP_A increases $5/MWh at hour 18 due to 10MW congestion Relief

**Congestion Relieve Revenue $ vs. ESS size**

10MW/20Wh Case - LMP Improvement in $/MWh

10MW/20MWh Case - Region A Revenue Increase ($)

Total Revenue Increase = $850K vs. Curtailment Utilization = $302K
OUTCOMES AND NEXT STEPS

Outcomes:
• A conference paper for 2021 IEEE PES General Meeting.
• A presentation for a panel session at 2021 IEEE ISGT.

Next steps:
• Study the stacked benefit of ES providing virtual transmission, energy arbitrage and ancillary services.
• Investigate the voltage stability support from ESS while providing virtual transmission and the impact on dynamic line rating.
• Investigate the large scale impact of storage as virtual transmission on ISOs/RTOs markets.
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Analytics Team:
• David Rosewater
• Rodrigo Trvezan
• Alvaro Furlani Bastos
• Hyungjin Choi
• Ujjwol Tamakar
• Tu Nguyen
• Ray Byrne

Contact: Tu Nguyen, tunguy@sandia.gov
REFERENCES