Energy Storage as a Transmission Asset in MISO
MIPSYCON 2020 Virtual Conference

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November 3, 2020
Agenda

- ATC Background
- Storage as Transmission Benefits
- Project Need
- FERC Policy on Storage as Transmission
- MISO SATOA Tariff Filing
- Project Design Considerations
- Waupaca Area Project Description
- MISO Evaluation
- Battery Operations
- Storage as Transmission Asset Used in Market
- Next Steps

Source: https://www.dreamstime.com
ATC Background

• Began operations in 2001 as the nation’s first multi-state, transmission only utility
• Headquartered in Pewaukee, Wis.
• Grew from $550 million in assets in 2001 to more than $5 billion today
• Operate 9,890 miles of lines and 568 substations in Wisconsin, Michigan, Minnesota and Illinois
• Projecting $2.9 to $3.6 billion in investment over the next 10 years
Interest in Storage as Transmission

- Promising tool for addressing transmission issues
  - Capital costs are declining
  - Battery technology is maturing
  - Flexibility of applications
  - Evolution of utility needs

Source: Desert Sun
Source: T&D World
Waupaca Area Project Need

- The battery helps address multiple outage issues during certain system load conditions.
- Existing system requires reconfiguration or radialization during some scenarios
  - Risk of consequential load loss.
- Provides voltage support and operational flexibility in responding to multiple contingencies and maintenance.
- As SATOA, will only be used in specific multiple contingency conditions, automatic action.
- Operated per operating guide (under development).

Figure 4.5.1-#15947-1: Geographic transmission map of project area.
Benefits of Storage vs. Traditional Wires

- Transmission deferral
- Voltage support
- Faster deployment
- Little to no permitting and easement issues
- Smaller footprint
- Smaller economic impact
- Better aesthetic
- Easily scaled to adapt to different time horizons
- Configured to sizing constraints
- Less financial risk than traditional transmission asset (40 years)

Source: [https://www.123rf.com](https://www.123rf.com)
FERC Policy About Storage as Transmission

• Western Grid Development order (EL10-19)
  ▪ Classified a group of batteries as transmission facilities based on how they were to be operated

• Cost Recovery Policy Statement (PL17-2)
  ▪ Determined that energy storage devices could provide both transmission and market services and raised issues to consider related to cost recovery

• Generator interconnection reform (Order No. 845)
  ▪ Affirmed storage could serve as a transmission asset

Source: https://www.ferc.gov
Treatment of Storage as Transmission in MISO

- Since April 2018, MISO stakeholder process to develop rules to treat storage as transmission

- MISO filed “Storage as Transmission Only Asset (SATOA)” tariff revisions with FERC on 12/12/19
  - Projects evaluated for ability to address transmission issues
  - Operated under MISO’s functional control
  - Not required to be evaluated in interconnection queue

- FERC issued order for a technical conference 3/11, held the conference 5/4, issued order effective 8/11

- MISO expected to transition to developing rules for using storage as transmission assets to provide market services
MISO SATOA Tariff Filing

- SATOA are wholesale transmission facilities used to solve transmission performance issues identified in the MISO transmission planning process.
- If selected and included in MTEP as the preferred transmission solution, the SATOA would be subject to cost-based transmission rate recovery.
- SATOA only would operate under MISO functional control to address transmission issues, same as for any transmission asset.
- SATOA owner would not participate in the MISO market, and would be responsible for maintaining the state of charge necessary to address the transmission issue under MISO direction.
- Net revenues will be used to offset the transmission charges to customers.
Project Design Considerations

• Define the Problem / Usage of battery
  ▪ Cycles/day
  ▪ SOC/Availability
  ▪ Duration/C-Rate
  ▪ Degradation
  ▪ Applications

• Siting and sizing analysis
  ▪ MW and MWh sizing (PF) to solve
  ▪ Siting indices
  ▪ Thermal and voltage needs

• Hourly load profile analysis
  ▪ 8760 hour look
  ▪ Size to solve majority of hours and condition

Source: blog.adafruit.com
Project Design Considerations Cont.

- Site visits
- Vendor discussions
- Facility layout and topology design
  - Building or containers (20’, 40’, or 53’)
- Interconnection requirements
  - Interconnecting at transmission
  - Communication and control needs
  - Network Upgrades?
- Consider inverter needs
- Initially considered multiple sites
  - Hybrid
- In-house analysis and work with consultant
  - Verify performance and location
  - Dynamic performance
- Comparable traditional/conventional project solution
- Techno-economic evaluation
  - Lifetime economics comparison
  - Revenue stacking opportunities considered

Source: Quanta-technology.com

Source: okorder.com
Waupaca Area Storage

- Includes 2.5 MW/5 MWh lithium ion battery, designed for low PF
- Combined 14 MVAr of shunt capacitance at Arnott and Harrison North
- Estimated capital cost $8.1 million
- Estimated ISD 12/31/21
MISO Evaluation - Project Assumptions

Comparative life cycle cost evaluation for wires and non-wire solutions

Useful life Estimates

- Useful life estimates depending on the type of storage technology
- A 20 year useful life estimate assumed for Li-Ion battery
- A 40 year book life for conventional wire solution
- Storage components are assumed to be replaced once reaching the end of their useful life, at a 50% of new system cost
- Present values over a 40 year period calculated for cost comparison among solutions

Life Cycle and Degradation

- Capacity of storage is upsized to account for annual degradation at a nominal 2-2.5% rate, assuming a few cycles per year for reliability
- Storage asset is assumed to have a lifecycle of 4,500 full cycles with 100% depth of discharge
- Inverter is assumed to be replaced every 7-10 years
- Battery augmentation is assumed to be every 7-8 years
## MISO Evaluation - Project Alternative & Comparison

<table>
<thead>
<tr>
<th>Solution Considered</th>
<th>Wire Solution</th>
<th>Non-Wire Solutions (proposed SATOA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rebuild Whiting Avenue – Hoover 115kV as double circuit, install 10MVAR capacitor at Arnott 138kV substation and upgrade Wautoma 69kV bus</td>
<td>Install a 2.5MW/5MWh battery at Harrison North 138kV substation, and a 8 MVAR capacitor at Arnott 138kV and a 6 MVAR capacitor at Harrison North 138kV substation, and upgrade Wautoma 69kV bus</td>
<td></td>
</tr>
<tr>
<td>Reliability Performance</td>
<td>Address identified needs comparable load serving risk reduction</td>
<td>Address identified needs Comparable load serving risk reduction</td>
</tr>
<tr>
<td>Estimated Capital Cost ($2019)</td>
<td>$11.3M</td>
<td>$8.1M</td>
</tr>
<tr>
<td>Present Value of Revenue Requirements (PVRR) for 40 year Life cycle Costs</td>
<td>$13.07M</td>
<td>$12.24M</td>
</tr>
</tbody>
</table>
| Overall Comparison | Comparable performance  
More expensive  
Need for expanded ROW  
No online time restrictions | Comparable performance  
Less expensive  
No public impacts on ROW  
2-hour discharge period |
MISO Evaluation - Result

- MISO identified project in MTEP19 report as preferred solution
  - No further analysis anticipated
  - Project would be the first storage as transmission asset in MISO
- Transmission asset and revenue requirement recovered under cost-based rate
- The MISO Board will consider including project in Appendix A subject to FERC acceptance of the proposed SATOA tariff revisions

Source: https://www.misoenergy.org
Battery Operations

• Battery under functional control of MISO
• ATC working with MISO to establish operating guide for the device providing transmission service
  ▪ Required in proposed tariff revisions
  ▪ ATC to control battery for transmission service
• ATC and WEC are in process of framing Market Participant Agent Agreement to be filed at FERC
  ▪ As SATOA, mostly consist of registering device and energy settlements
Storage as Transmission Asset Used in Market

- The Market Subcommittee will lead process for developing rules, Reliability Steering Committee and Planning Advisory Committee also involved
- When MISO rules allow, battery would be used to provide market services when available
- Market Participant Agent will operate battery per agreement filed at FERC
- ATC’s intention is that all market service revenues – net agents’ fee for operating battery – will be used to offset charges to transmission customers
- Interconnection agreements expected to be required in order for all storage as transmission assets to be used in market (next Phase)
Takeaways and Next Steps

General
• Energy storage costs are declining
• Storage as transmission is a tool to address issues seen on the transmission system
• SATOAs/SATAs considered transmission assets, will be their priority use
• Talk to vendors/consultants early
• Many design considerations, include on front-end
• Multiple applications and revenue stacking are good, but keep expectations realistic

ATC
• MISO identified project in MTEP19 report as preferred solution
• Continue efforts on Waupaca Area Storage Project
  ▪ Work with an Owner’s Engineer
  ▪ Coordinate on MISO Op Guide
  ▪ Work on market participant agent agreement
• Additional Discussion at MISO (include in markets)
Appendix - Wire Alternative

Traditional Wires Solution Alternative was evaluated and compared with proposed SATOA

- **Project Description:**
  - Rebuild Whiting Avenue – Hoover 115 kV as double circuit,
  - 10 Mvar capacitor at Arnott 138 kV,
  - Upgrade Wautoma 69 kV bus
- **Estimated Cost:** $11.3M (2019$)
- **Expected ISD:** December 31, 2021
- **Other considerations:**
  - Need for expanded ROW
  - No online time restrictions

![Map of existing transmission lines]

*MISO, using data from MISO East © 2014*