

Energy Storage as a Transmission Asset in MISO

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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)

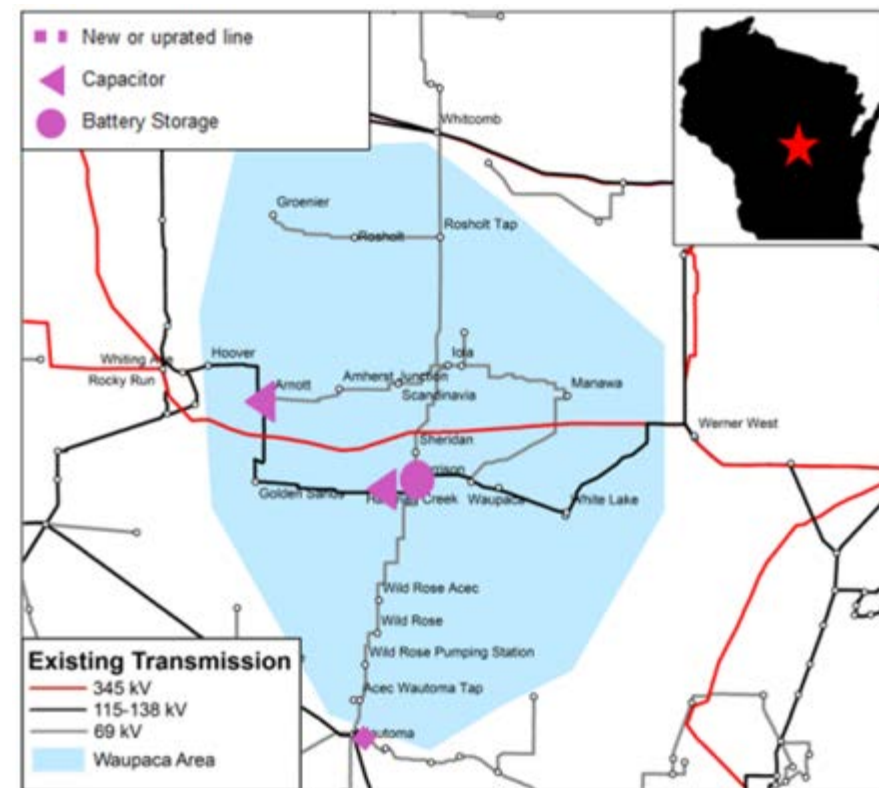


Figure 4.5.1-#15947-1: Geographic transmission map of project area

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>

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



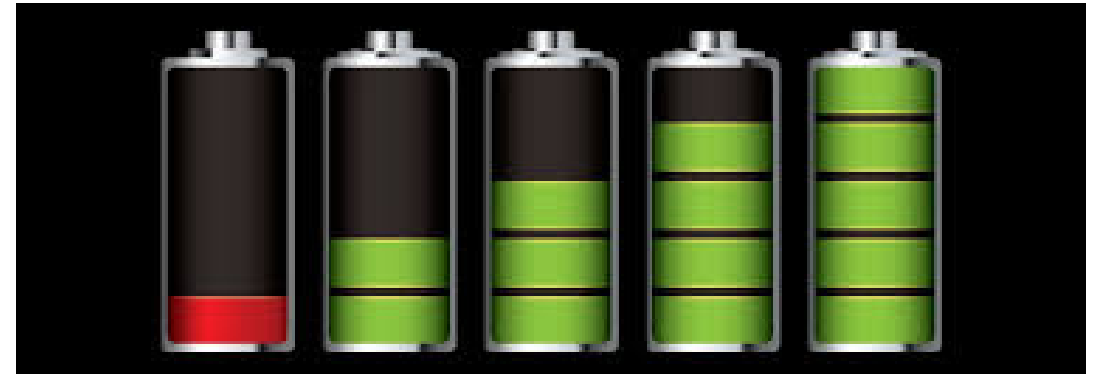
Source: clipartkey.com

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

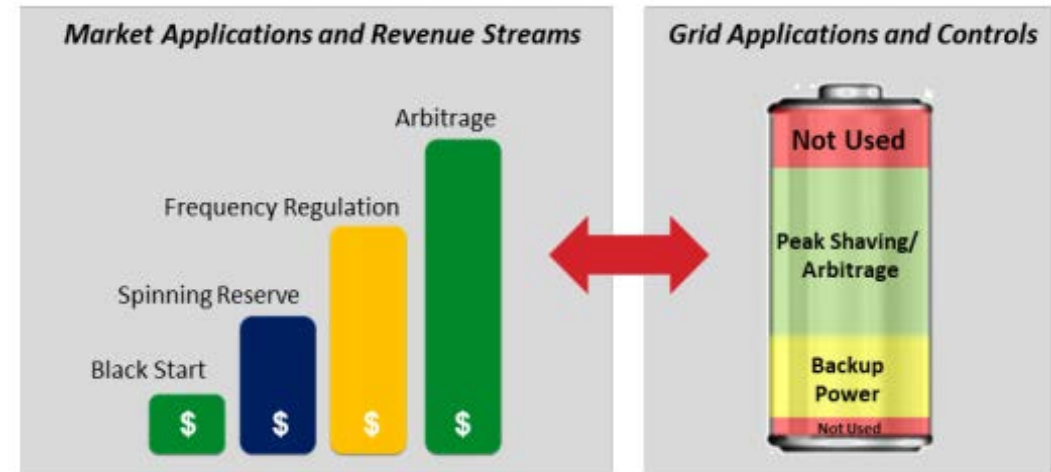
- Define the Problem / Usage of battery
 - Cycles/day
 - SOC/Availability
 - Duration/C-Rate
 - Degradation
 - Applications
- Siting and sizing analysis
 - MW and MWh sizing (PF) to solve
 - Siting indices
 - Thermal and voltage needs
- Hourly load profile analysis
 - 8760 hour look
 - Size to solve majority of hours and condition



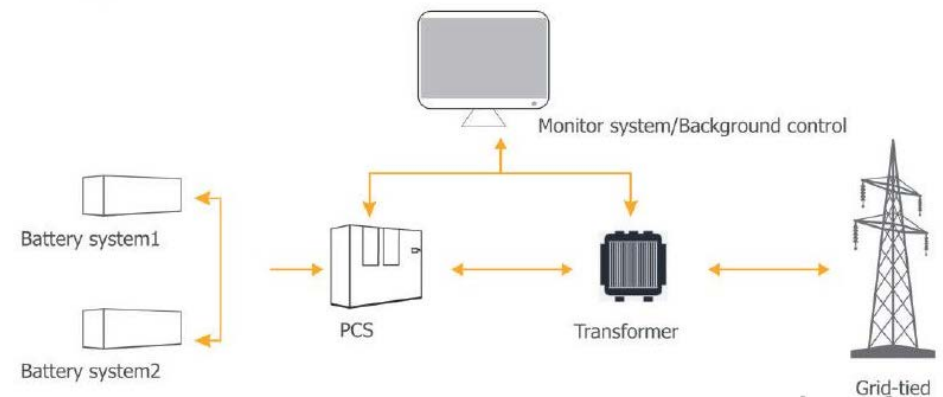
Source: blog.adafruit.com

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



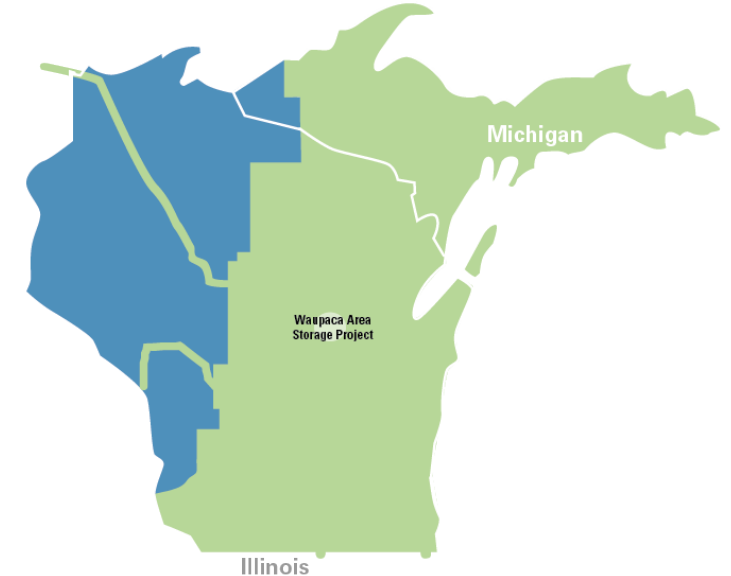
Source: Quanta-technology.com



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 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

Useful life Estimates



- 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

Life Cycle and Degradation



MISO Evaluation - Project Alternative & Comparison

	Wire Solution	Non-Wire Solutions (proposed SATOA)
Solution Considered	Rebuild Whiting Avenue – Hoover 115kV as double circuit, install 10MVAR capacitor at Arnott 138kV substation and upgrade Wautoma 69kV bus	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
Reliability Performance	Address identified needs comparable load serving risk reduction	Address identified needs Comparable load serving risk reduction
Estimated Capital Cost (\$2019)	\$11.3M	\$8.1M
Present Value of Revenue Requirements (PVRR) for 40 year Life cycle Costs	\$13.07M	\$12.24M
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

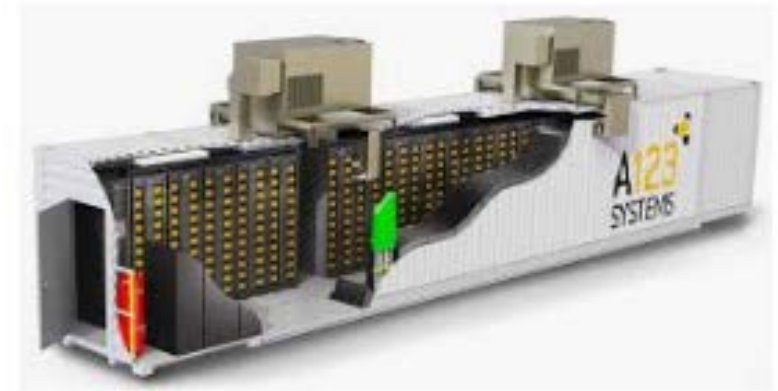
- MISO identified project in MTEP19 report as preferred solution
 - No further analysis anticipated
 - Project would be the first storage as transmission asset in MISO
- Transmission asset and revenue requirement recovered under cost-based rate
- The MISO Board will consider including project in Appendix 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



Source: <http://www.globalenergyworld.com>

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)



Source: <https://www.123rf.com>



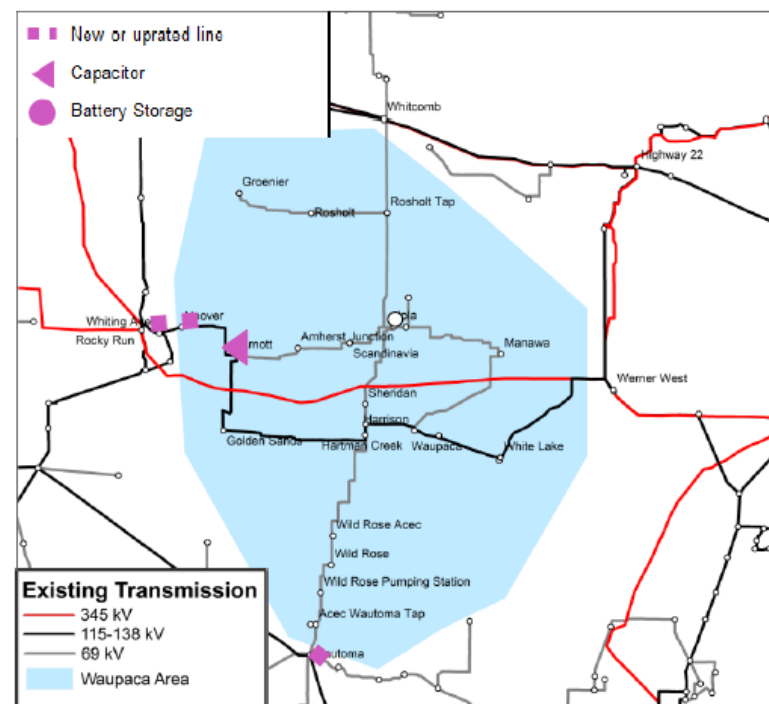
Source: <https://www.123rf.com>



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



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