Power System Engineering, Inc.

The Future of North Dakota Transmission Capacity

Minnesota Power System Conference

November 3, 2020

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Helping Clients and Colleagues **ACHIEVE** Their **Goals.**

www.powersystem.org

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Covered Topics

- Introduction
- Existing Transmission System
- Powerflow Models
- Generator Interconnection Requests
- Modeling and Powerflow Analysis
- Energy Storage Analysis
- Nodal Pricing Analysis
- Conclusions
- Ongoing Efforts

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About PSE

- Power System Engineering, Inc. (PSE) est. in Madison, WI in 1974.
- Full-service engineering and consulting firm consisting of professional engineers, economists, and financial analysts.
- Focus on Utility Engineering & Operations; Energy Resources; Technology, Communications, and Automation; Industrial Engineering; and Economics, Rates, and Business Planning.
- PSE is employee-owned and independent.
- Around 80 employees in Madison, WI; Blaine, MN; Prinsburg, MN; Marietta, OH; Sioux Falls, SD; and Topeka, KS
- Forward-Thinking Professionals Helping Clients and Colleagues Achieve Their Goals.

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Introduction

- Power System Engineering, Inc. (PSE) was engaged by the North Dakota Transmission Authority (NDTA) to perform a study assessing the capacity of the North Dakota transmission system.
- The purpose for which the authority is created is to diversify and expand the North Dakota economy by facilitating development of transmission facilities to support the production, transportation, and utilization of North Dakota electric energy.
- PSE Study Team: Tom Butz, Laura Couillard, Peter Koegel, and Curt Lyons.
- Study was motivated by reports that numerous Renewable Energy projects in MISO and SPP queues were being assessed expensive Network Upgrades that were not financially feasible for the projects to be successful.
- PSE looked at the existing transmission capacity along with future trends based on the existing generation mix, generation interconnection queues, transmission expansion projects, and nodal pricing analysis.

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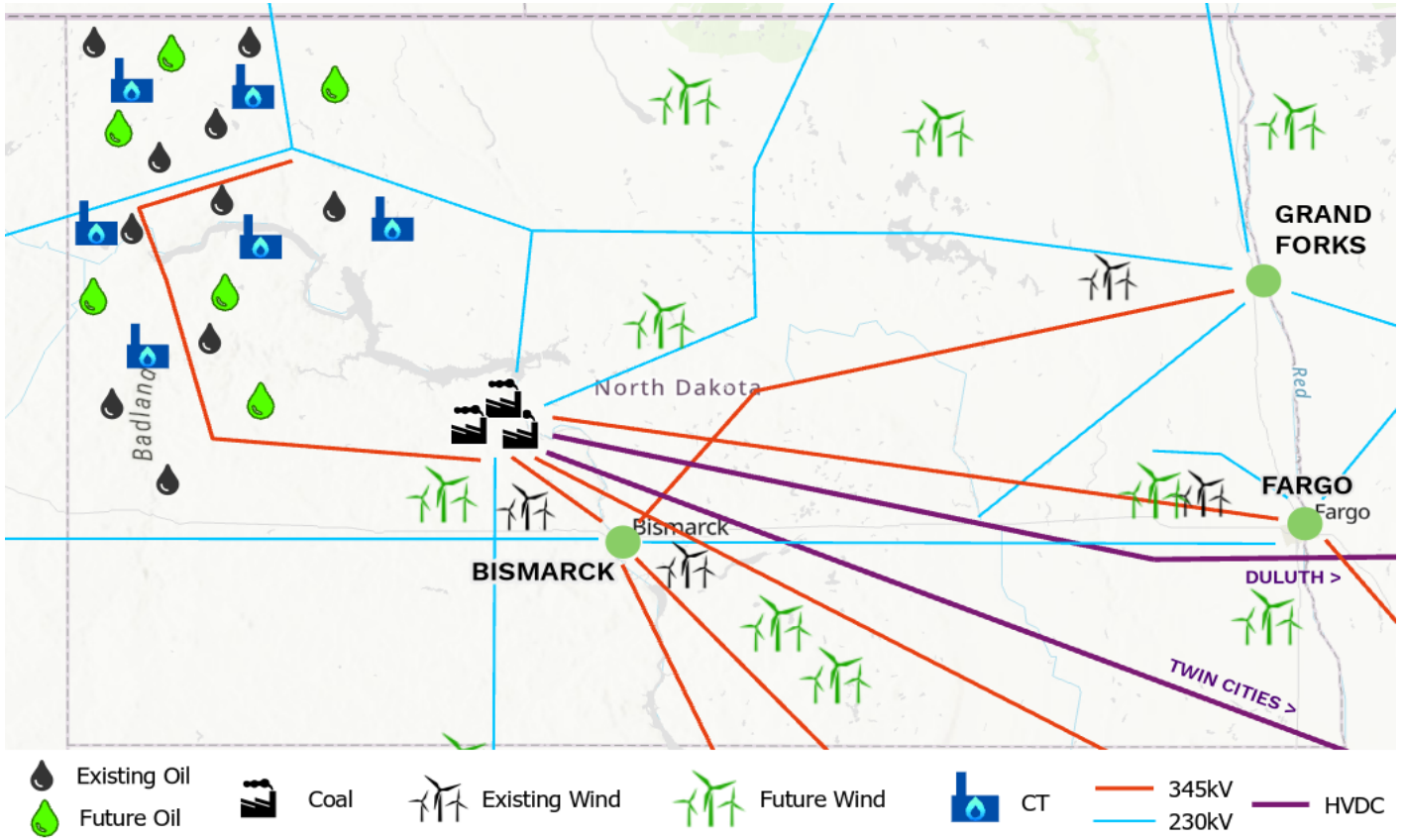
Existing Transmission System



- 230kV, 345kV, and HVDC lines primarily used to export power to MISO and SPP markets.
- Williston Load Pocket in NW.
- Centrally located Coal Plants.
- Existing and Future Wind generation.
- CapX2020 built out.

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Powerflow Models

- MISO 2021 Spring Light Load (21SLL).
- SPP 2022 Summer Peak (22SUM).
- MISO 2026 Summer Peak (26SUM).
- SPP 2027 Winter Peak (27WIN).
- PSE Developed 2038 Summer Peak (38SUM).
- GIRs dispatched in accordance with MISO and SPP dispatch criteria.
  - MISO DPP-West & SPP DISIS Groups 16 & 18
- Existing fossil generation dispatch unchanged.
- Few ND TEP projects identified to be added to models.

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Generation Interconnection Requests

- As of September 1, 2019, 86 GIRs (11.7 GW) active in MISO, MPC, and SPP queues for ND.
  - 31 (2,964 MW Summer, 2,988 MW Winter) projects were in service;
  - 2 (450 MW) projects were under construction or proceeding towards construction; and
  - 53 (8,252 MW) projects were under study in the MISO, MPC, or SPP GI processes.
- Existing ND Generation 5 GW.
- Existing ND Load 4 GW.

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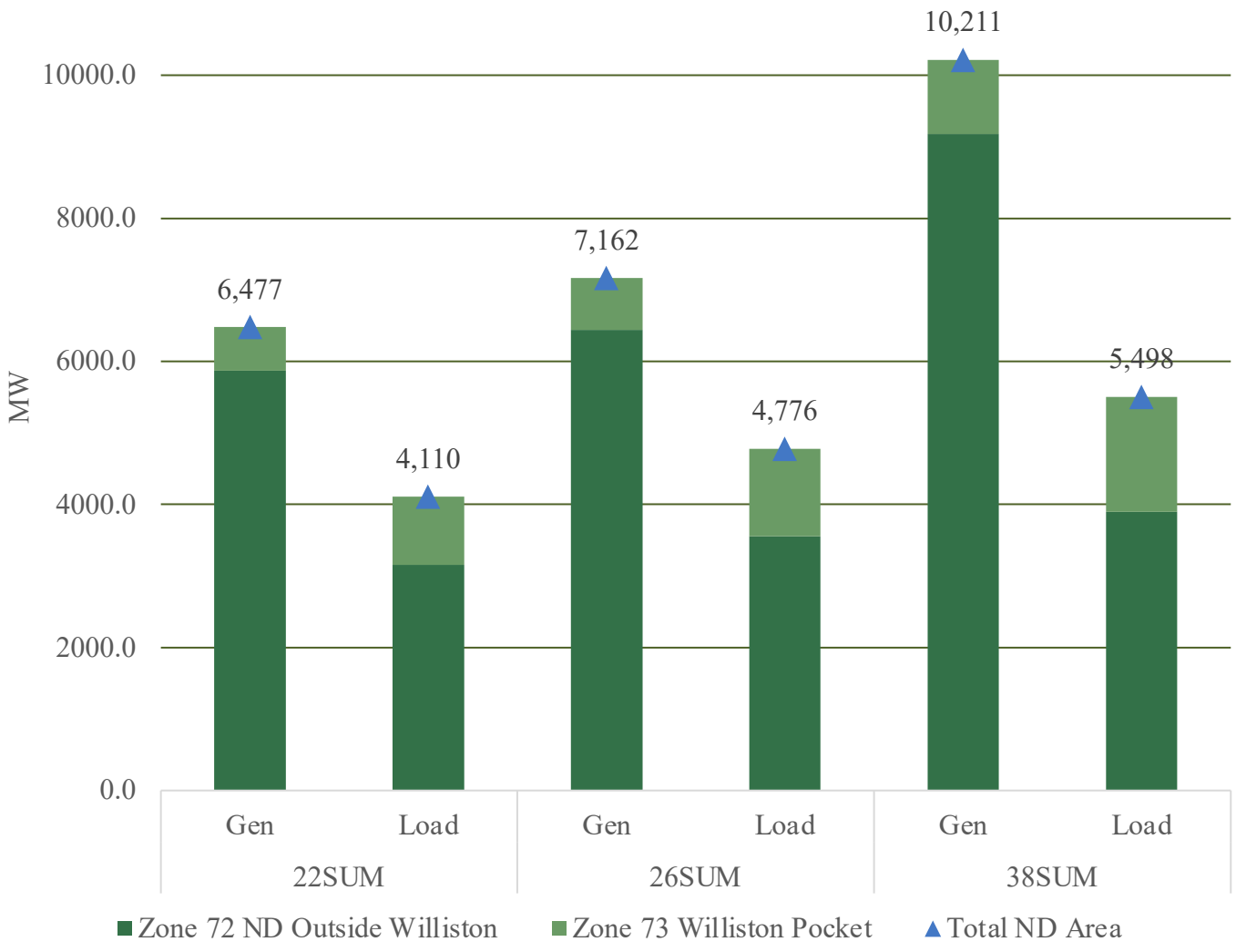
Load Growth Assumptions



- Load levels as modeled in 22SUM and 26SUM models.
- 38SUM Assumptions
  - 1.2% Annual Load Growth in Williston Load Pocket.
  - 0.8% Annual Load Growth in remaining ND area.
  - Generation added at 20% GIR success assumption and standard dispatch criteria.

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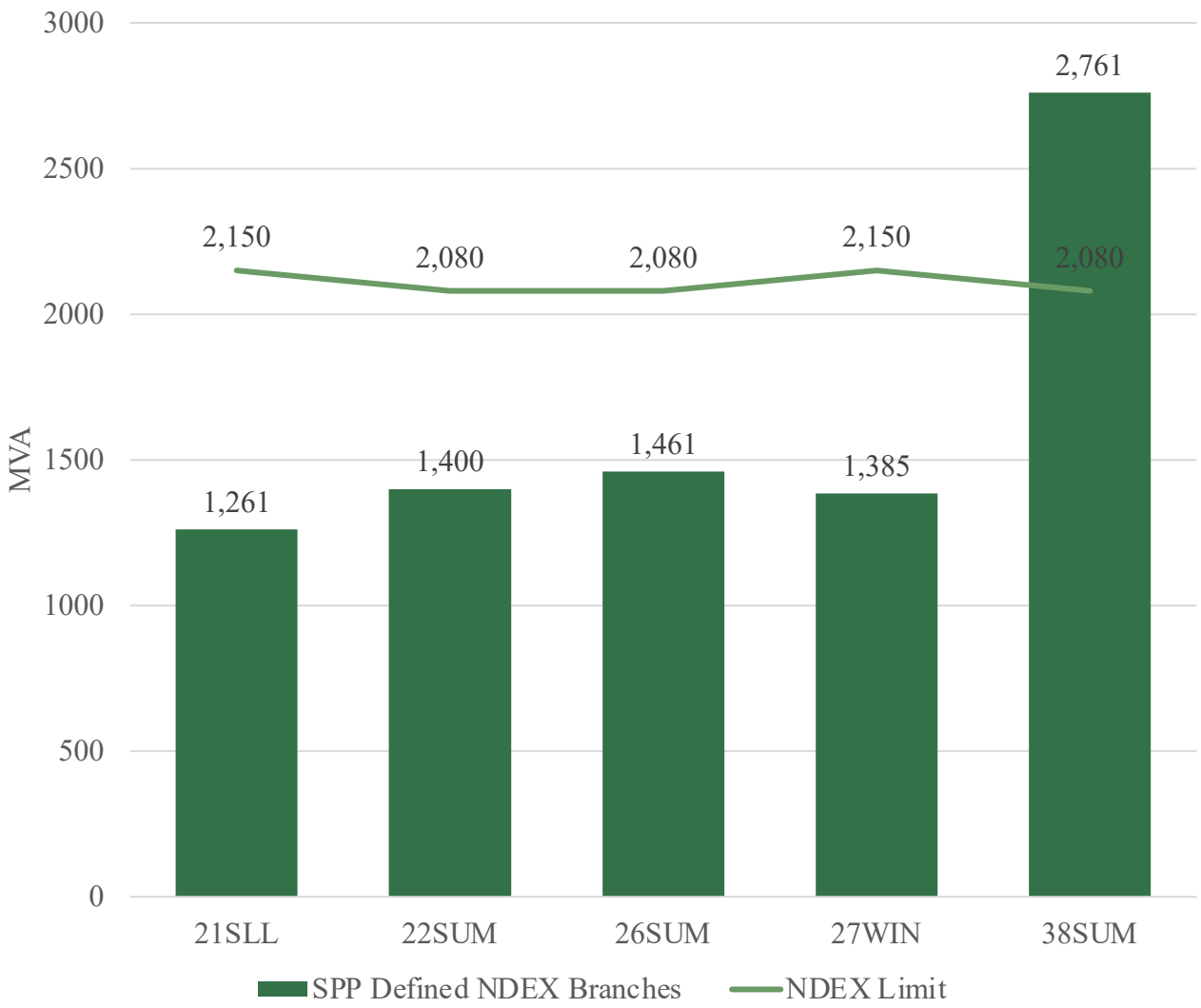
NDEX Flows



- NDEX retired as an IROL flowgate.
- Defined set of transmission facilities to measure powerflows.
- NDEX flows increase to 133% of current rating with gen and load growth.
- Indicates need for transmission.

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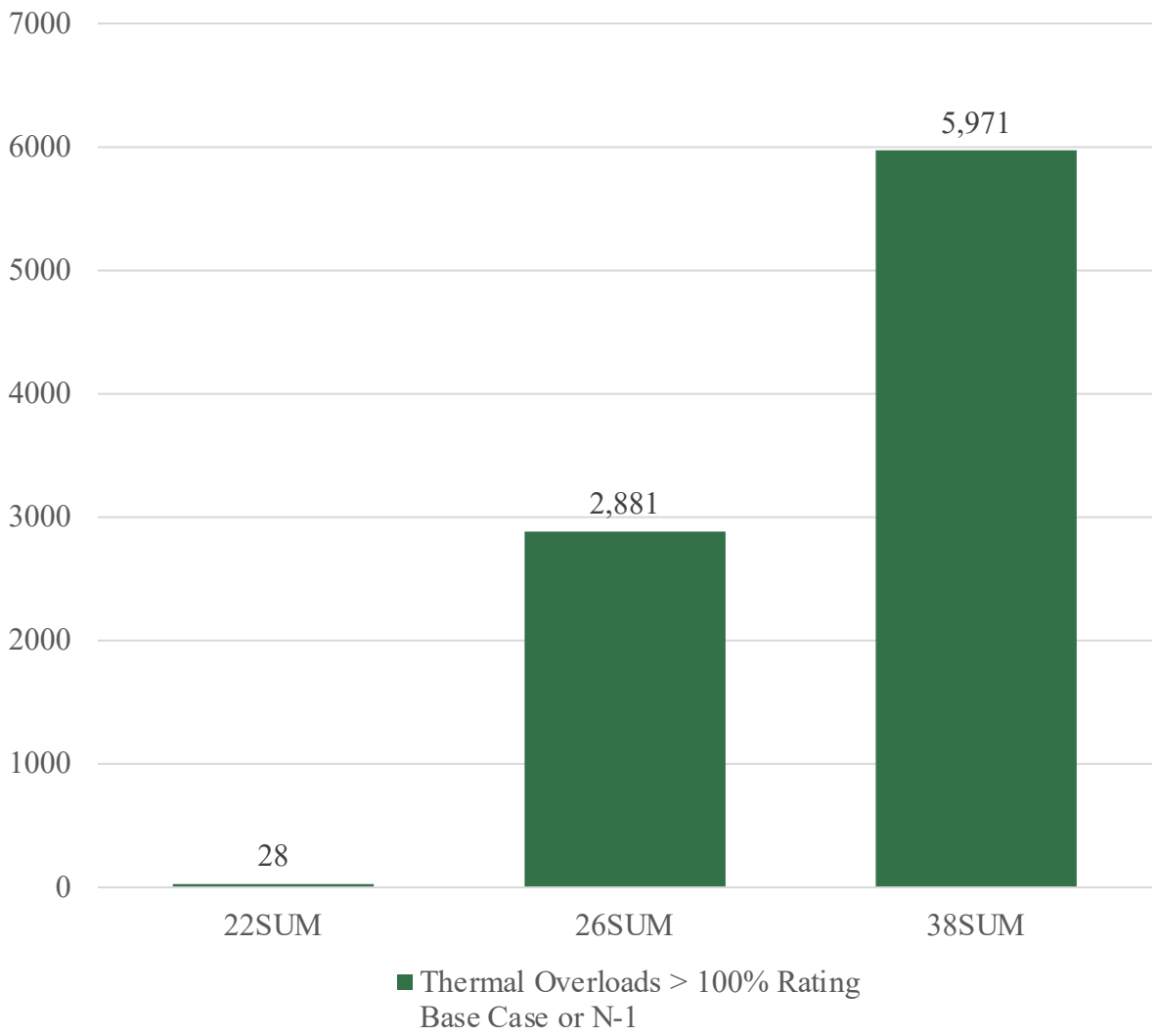
Thermal Violations

- Thermal overloads indicate MVA flow greater than 100% of applicable rating.
- Instances of thermal overloads on ND transmission facilities increased dramatically in the study models.
- Indicates need for transmission.



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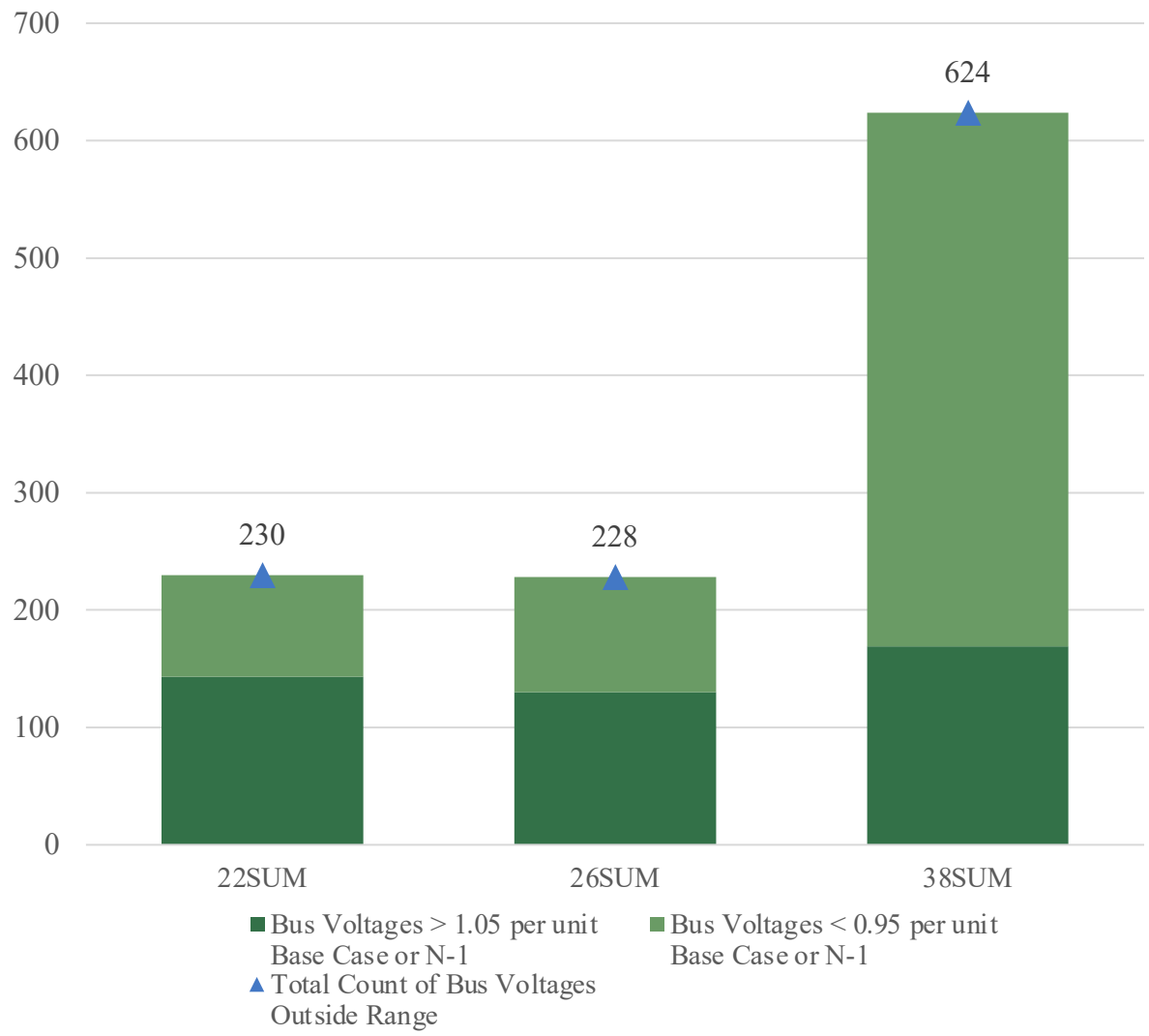
Voltage Criteria Violations

- Voltage Criteria monitored against typical 0.95 – 1.05 p.u. range.
- Increasing criteria violations could indicate greater risk for voltage instability.
- Indicates need for transmission.



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Energy Storage Resources

- MISO Energy Storage Options
  - Energy Resource (ERIS) & Network Resource (NRIS) Interconnection Service
  - Surplus Interconnection Service(FERC ER19-1823 & ER19-1960)
  - 19 Active MISO-West GI Energy Storage Projects totaling 900 MW
  - 80 Active MISO GI Energy Storage Projects totaling 4,240 MW
- SPP Energy Storage Options
  - Energy Resource (ERIS) & Network Resource (NRIS) Interconnection Service
  - Surplus Interconnection Service (FERC ER19-1954)
  - 1 Active SPP ND GI Energy Storage Projects totaling 74 MW
  - 90 Active SPP GI Energy Storage Projects totaling 9,260 MW

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Energy Storage Analysis

- With 8,252 MW and 53 GI projects being Studied
  - Expecting Studies to Identify Significant Transmission System Improvement Needs.
- Consider Evaluation of Electric Storage in Lieu of Transmission Improvements
  - Process Not Defined in Current Interconnection Process.
  - Included in MISO Renewable Integration Impact Assessment (RIIA).
- Methodology
  - Use Historic Hourly Dispatch Data – MW by Fuel Type.
  - Scale Historic Wind Shape to Match a Simulated Retired Coal MWh.

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Energy Storage Analysis (Cont.)

- Methodology (Cont.)
  - Assume Retirement of 900 MW of Coal.
    - 5,600 GWh of Energy.
  - Replace with Same Annual Amount of Wind Energy.
    - 1,727 MW of Wind.
  - Show Wind Curtailment at 900 MW max Wind gen output.
  - Implement Adequate Energy Storage to Store curtailed Output and Dispatch Storage when Wind Generation is less than 900 MW.

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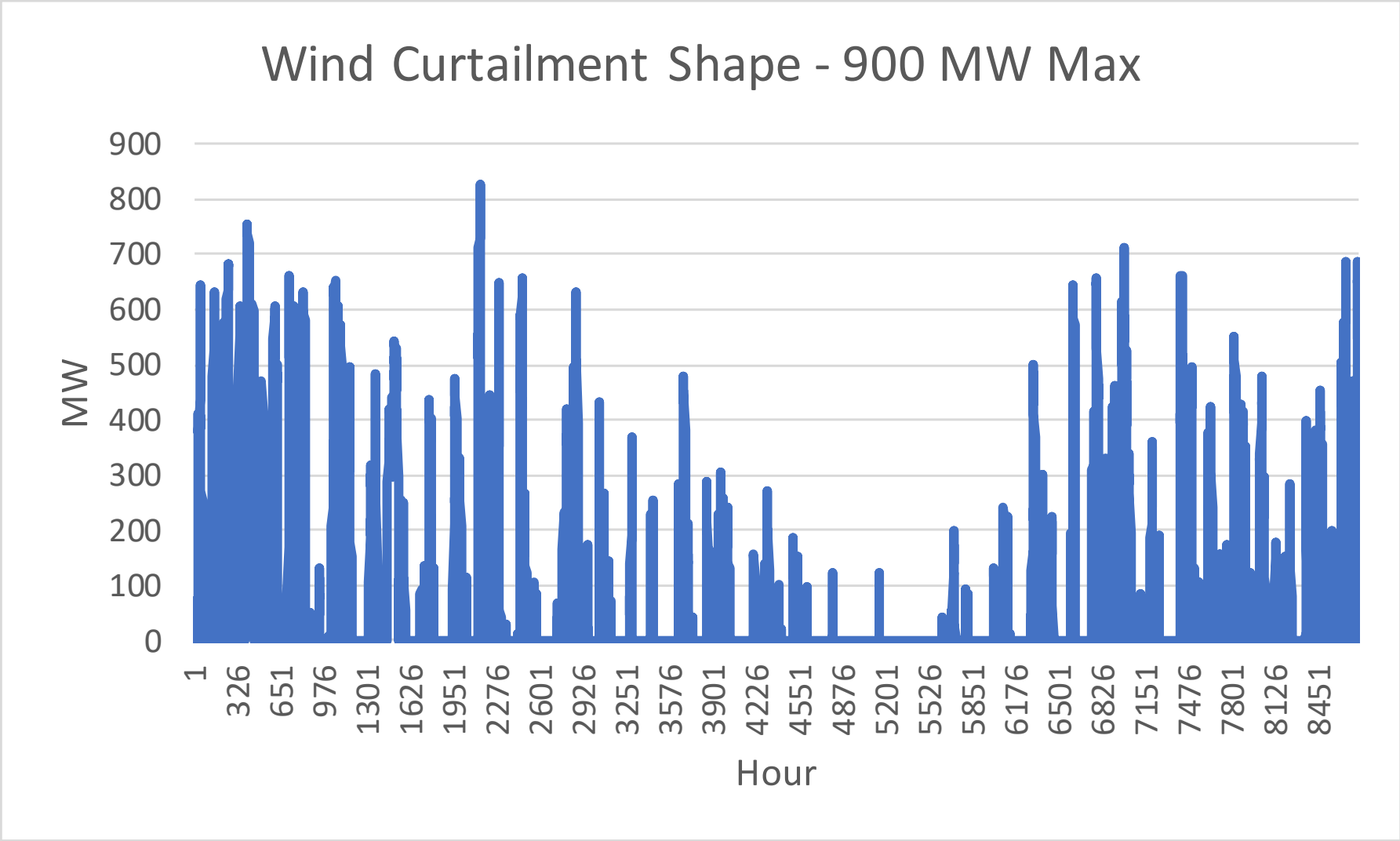

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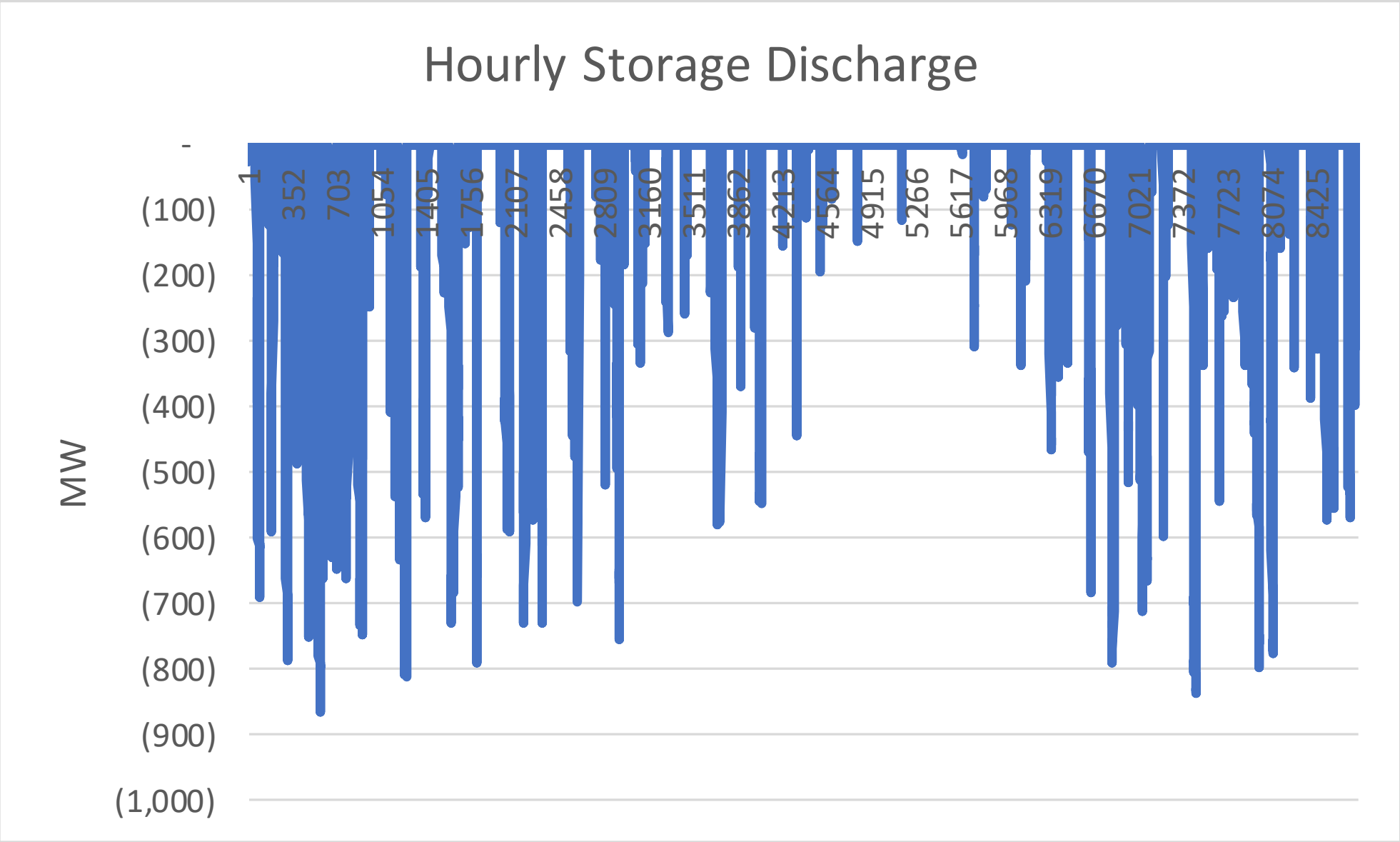

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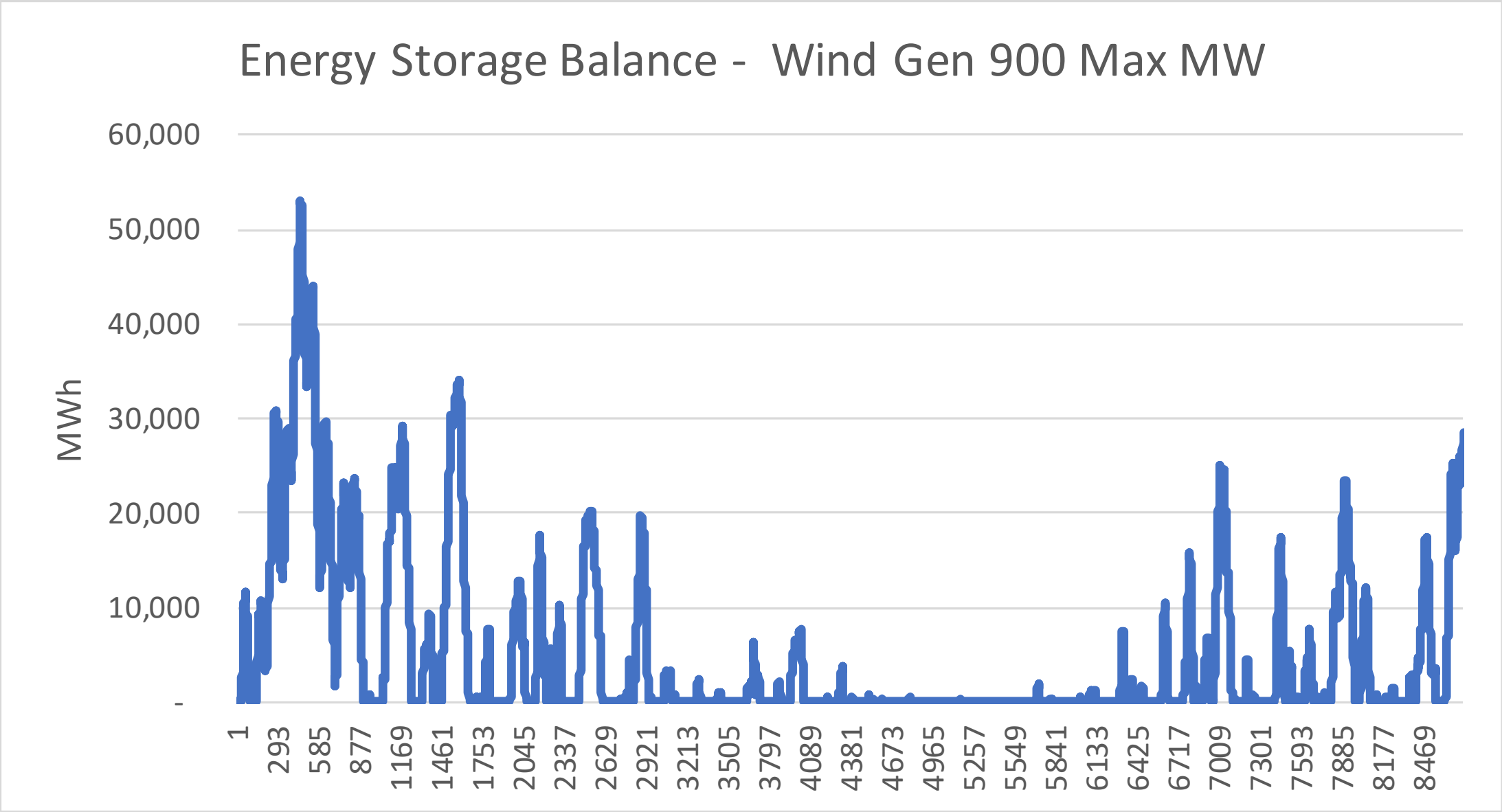

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Energy Storage Analysis (Cont.)

- Results
  - Raw Curtailments / Energy Stored
    - 11% of the wind energy
    - 609 GWh 826 MW
  - Implementing Energy Storage
    - 555 GWh 867 MW discharged to the system.
    - Maximum storage energy level → 53 GWh to establish capital costs for storage.
- Conclusions
  - Storage Provides Means of Meeting Renewable Energy Target.
  - Raw Curtailment to max of 900 MW Much Lower Costs.
  - Transmission Improvements May Still be Required for Curtailment Only Case.

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Nodal Pricing Analysis

- Evaluate System Transmission Congestion via Locational Marginal Price(LMP) Values.
- Locational Marginal Price(LMP) Components
  - Marginal Energy Component (MEC)
  - Marginal Loss Component (MLC)
  - Marginal Congestion Component (MCC)
- Transmission Constrained Areas – Generation Greater Than Load
  - LMP Pricing Showing Negative Marginal Congestion Component.
  - Combination of MLC and MCC

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Nodal Pricing Analysis (Cont.)

- Compared Pricing in Areas With Higher Levels of Wind Generation vs. Areas with less wind generation
- Nodes Near Higher Concentrations of Wind Generation
  - Bison, Oliver, and Coyote
- Nodes Further Away from Higher Concentrations of Wind Generation
  - Ashtabula and Hoot Lakea

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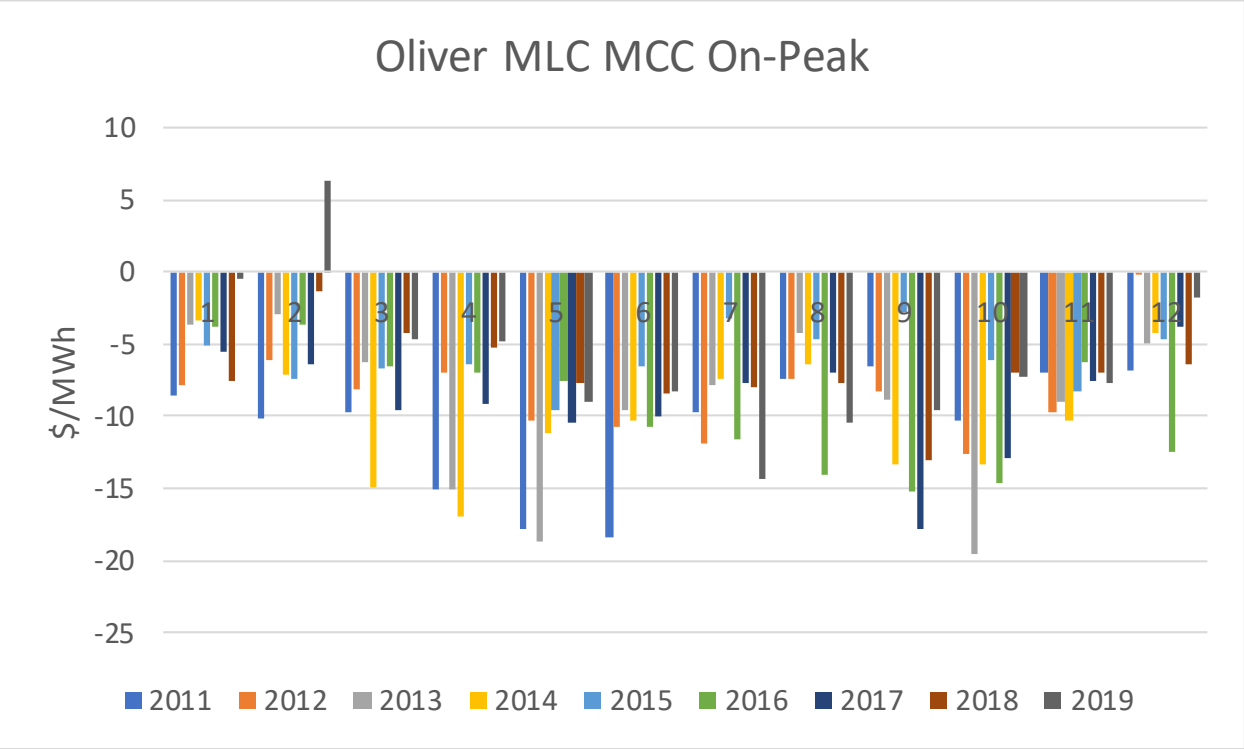
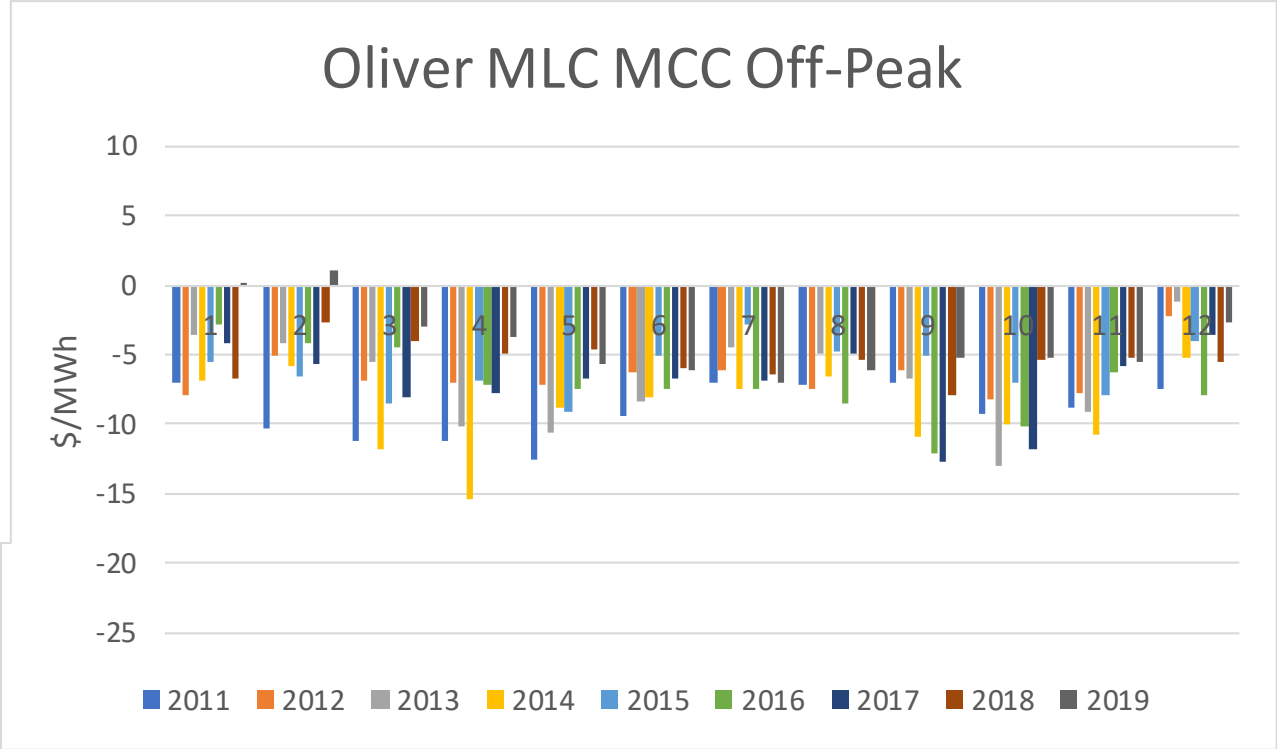
MLC MCC Near More Wind Generation





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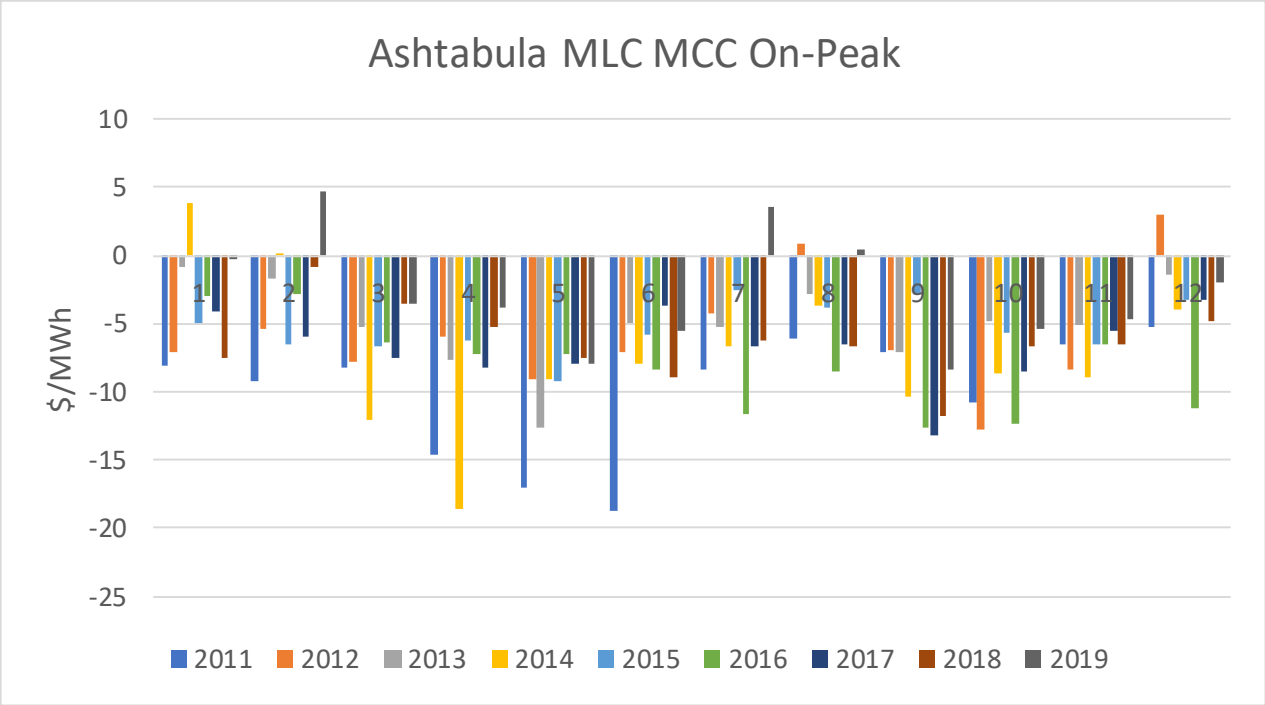
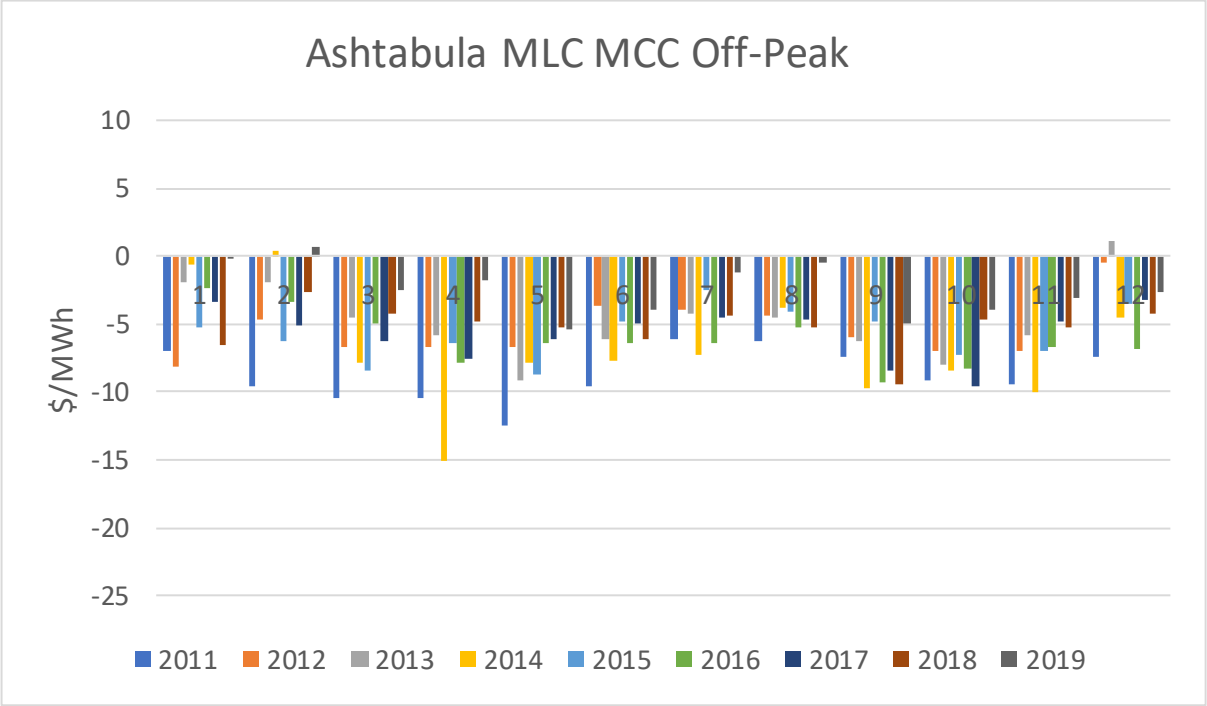
MLC MCC Near Less Wind Generation





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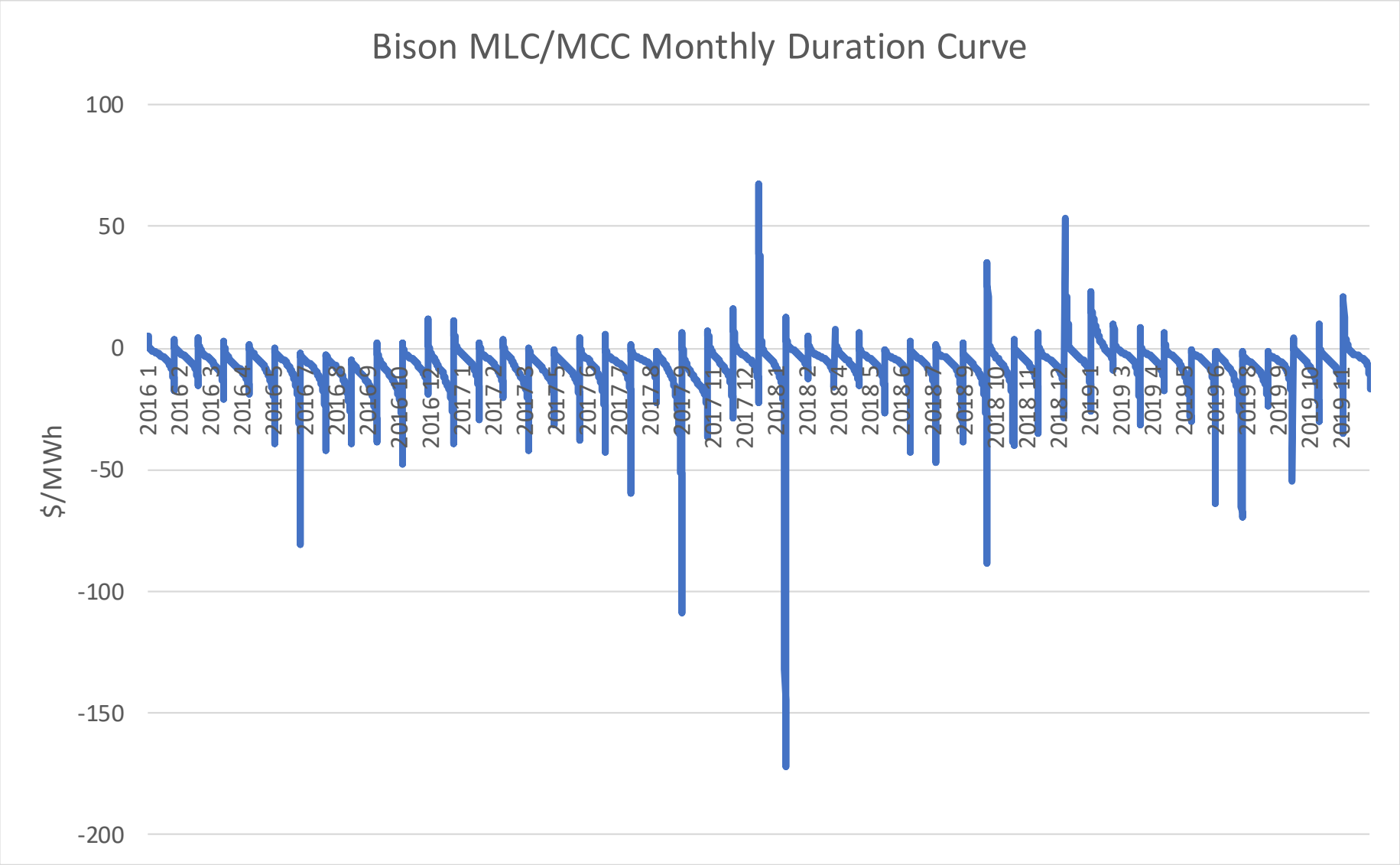
MLC/MCC Monthly Duration Curves - Bison



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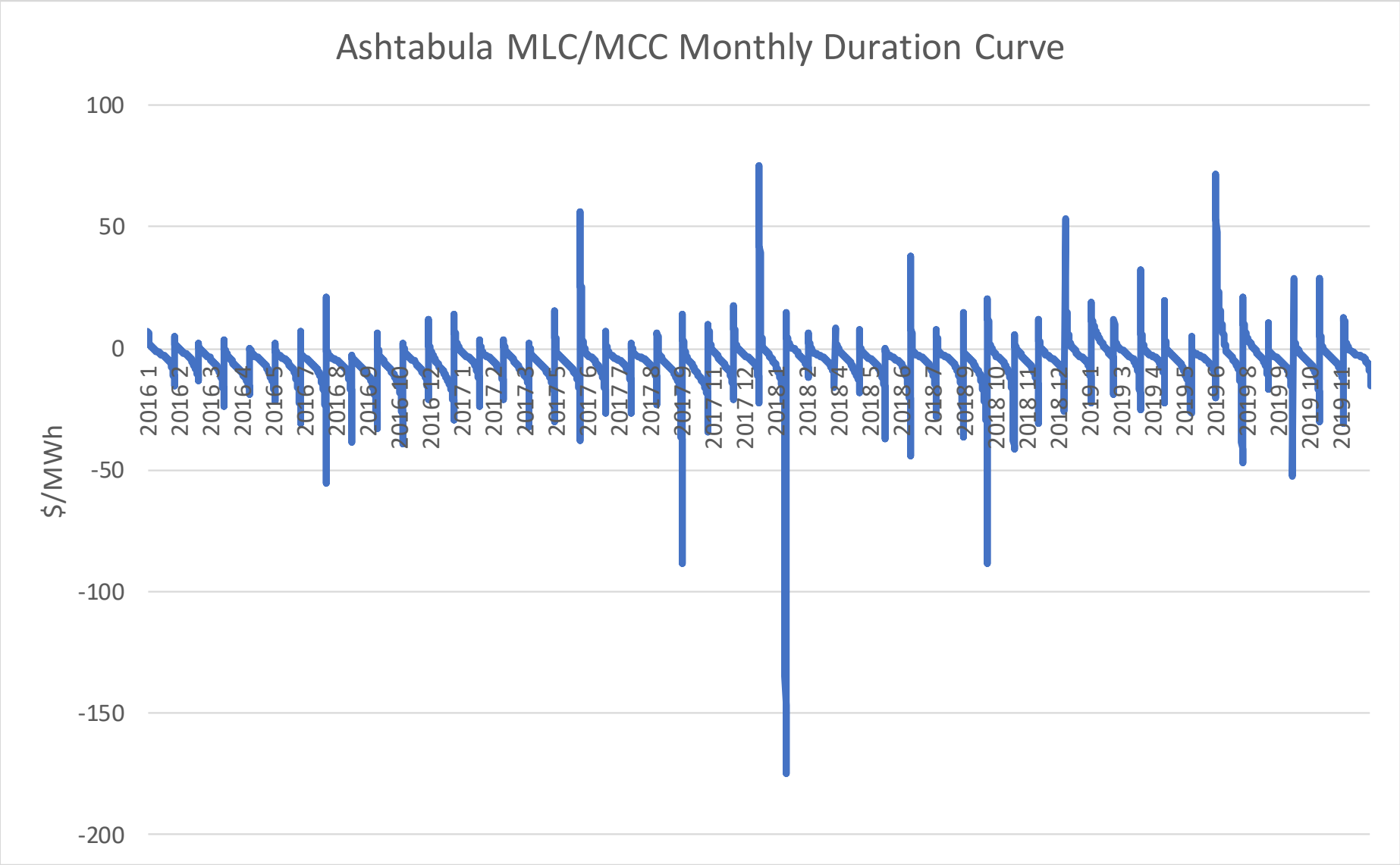
MLC/MCC Monthly Duration Curves - Ashtabula



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Pricing Analysis

- Snapshot of Pricing Provides Insight into Congestion.
- Case by Case Basis of Evaluating Market Pricing by Location.
- Distribution of Results Provides Additional Insight into Pricing.
  - Distribution of Prices Weighted with Generation Output.

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Conclusions

- MISO and SPP GIRs are greatly outpacing forecasted load growth and transmission expansion projects in ND.
- 80% of recent MISO and SPP GIRs were unsuccessful in ND.
- Energy Storage implementation may prove to be a viable alternative to transmission expansion and provide additional system benefits.
- Basis/LMP Pricing Analysis demonstrates that 2016-2019 MISO and SPP (MLC/MCC) values are more negative near concentrated wind generation areas in North Dakota.
- New transmission will need to be built or new uses for the existing transmission system will be needed in order to tap into more of North Dakota's significant wind and solar resources.

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Ongoing Efforts

- CapX2050 Transmission Vision Report
- MISO RIIA
- MISO-SPP Coordination Study

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Reference Information

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Report:

North Dakota Transmission Capacity Study

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