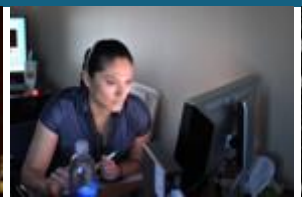
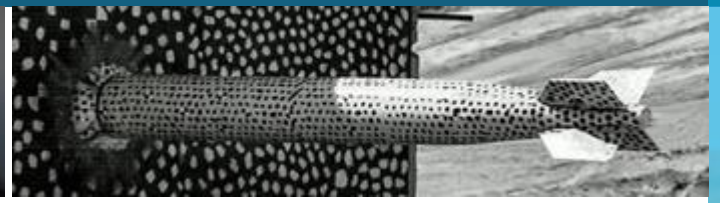
EVALUATION OF ENERGY STORAGE AS A TRANSMISSION ASSET





PRESENTED BY

Tu A. Nguyen and Raymond H. Byrne

2020 DOE OE Energy Storage Peer Review

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

PROJECT OBJECTIVE

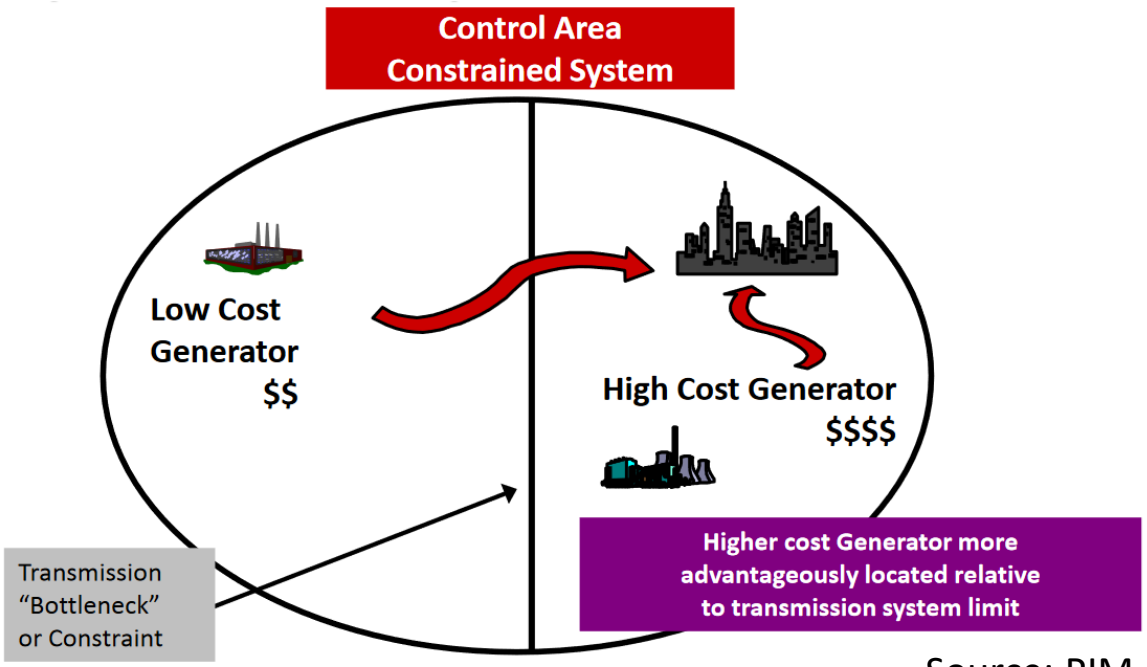
<u>Objective:</u> this task is to evaluate the benefits of energy storage providing virtual transmission capacity to relieve congestion in wholesale market settings.

<u>Methodology:</u> 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:

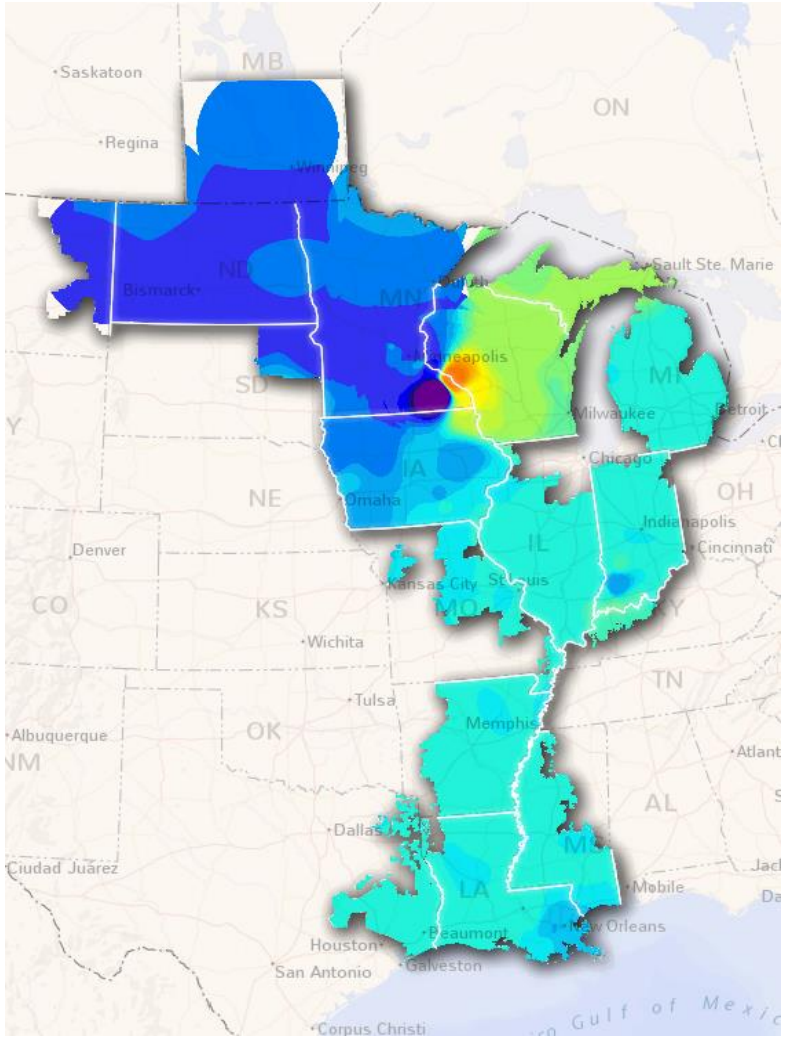
- Overview of transmission congestion cost
- Virtual transmission by energy storage
- Virtual transmission vs. upgrade deferral
- Virtual transmission vs. transmission upgrade
- Case study in ISO-NE

OVERVIEW OF TRANSMISSION CONGESTION COST



Source: PJM

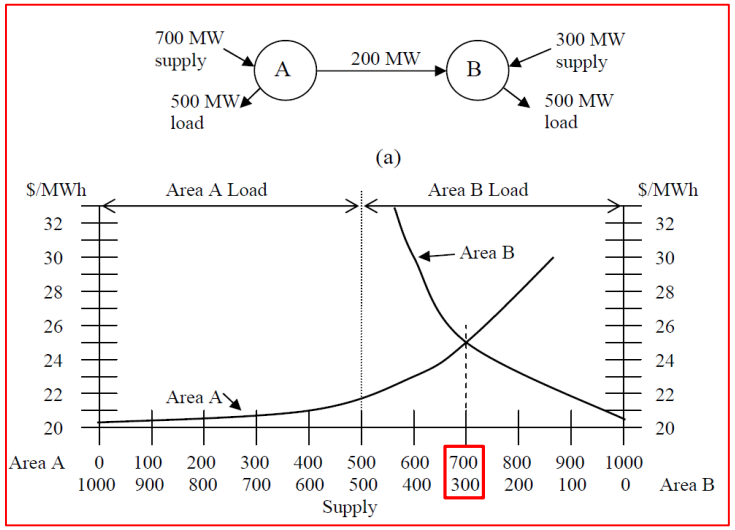
MISO Real time LMP on 09/14/2020 -12pm



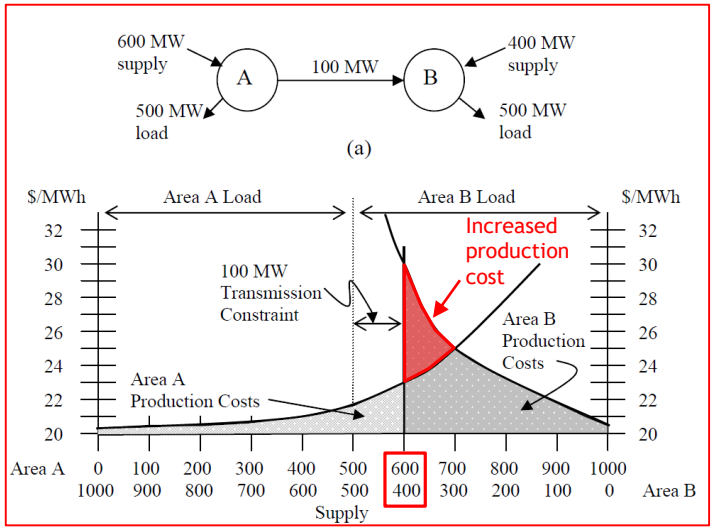
- Congestion occurs when there is insufficient transmission capacity to deliver cheaper generation to loads, requiring the use of more expensive generators closer to loads.
- In vertically integrated utilities, congestion leads to higher total production cost.
- In ISO/RTO whole sale markets, congestion creates differences in LMPs at different locations.

OVERVIEW OF TRANSMISSION CONGESTION COST

Vertically Integrated Utilities

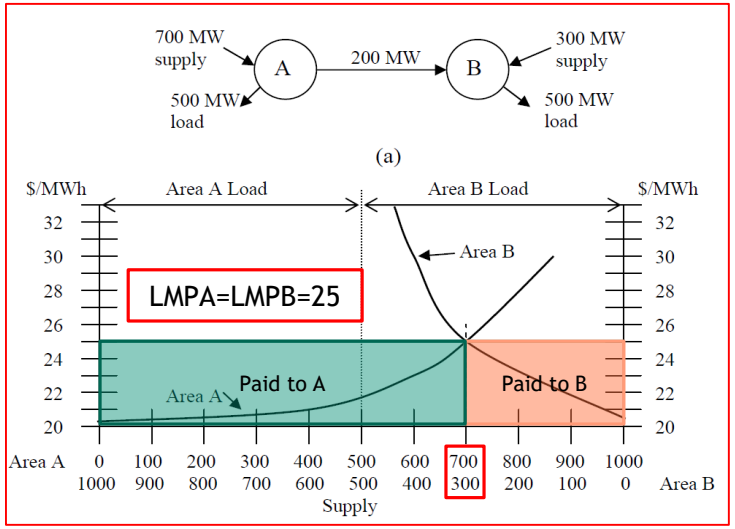


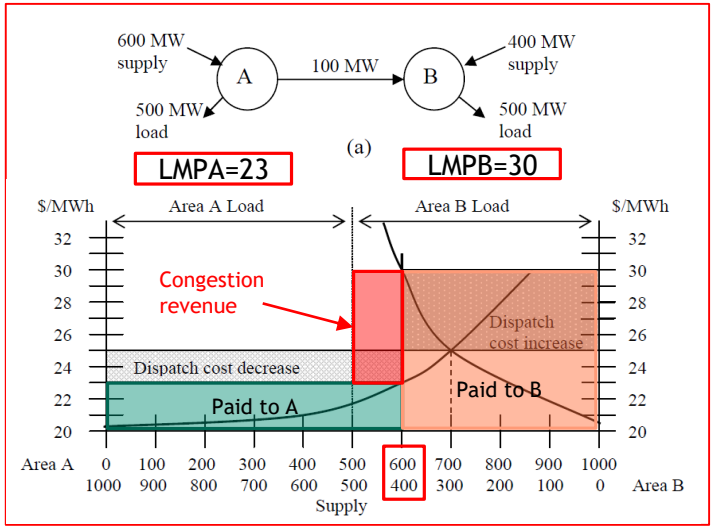
Unconstrained Case



100MW constrained line

Wholesale Markets





- **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. *Electricity transmission congestion costs: A review of recent reports*. United States: N. p., 2003. Web. doi:10.2172/821764.

OVERVIEW OF TRANSMISSION CONGESTION COST

Figure 11-4 Location of the top 10 constraints by PJM total congestion costs: 2019

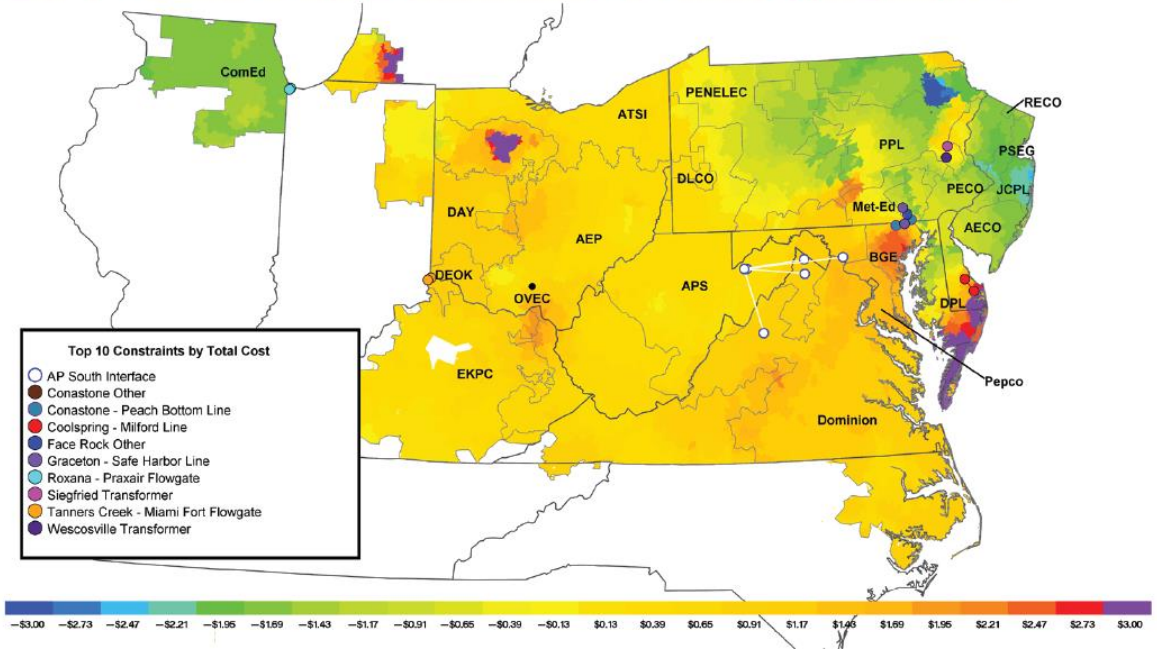


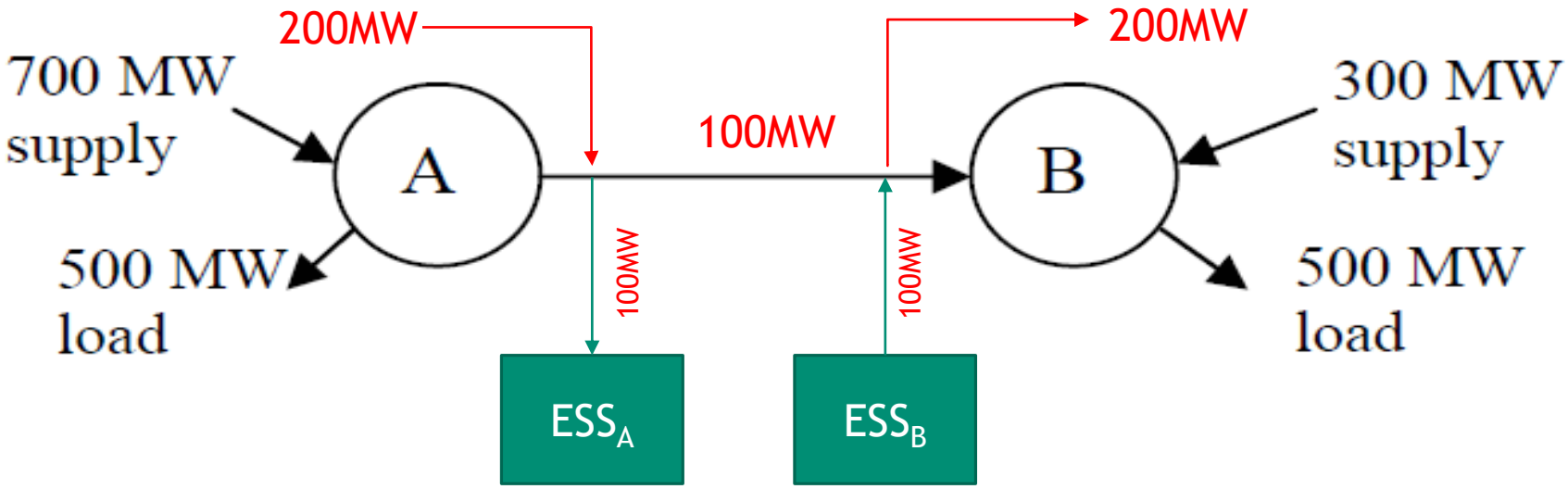
Image Credit: Monitoring Analytics – 2019 PJM Market Annual Report

Congestion Cost in ISO/RTO Markets (Millions $)

RTO	2016	2017	2018
ERCOT	497	976	1,260
ISO-NE	38.9	41.4	64.5
MISO	1,400	1,500	1,400
NYISO	529	481	596
PJM	1,023.7	697.6	1,310
SPP	273.7	405.3	380.9
Total	**3,762.3**	**4,101.3**	**5,011.3**

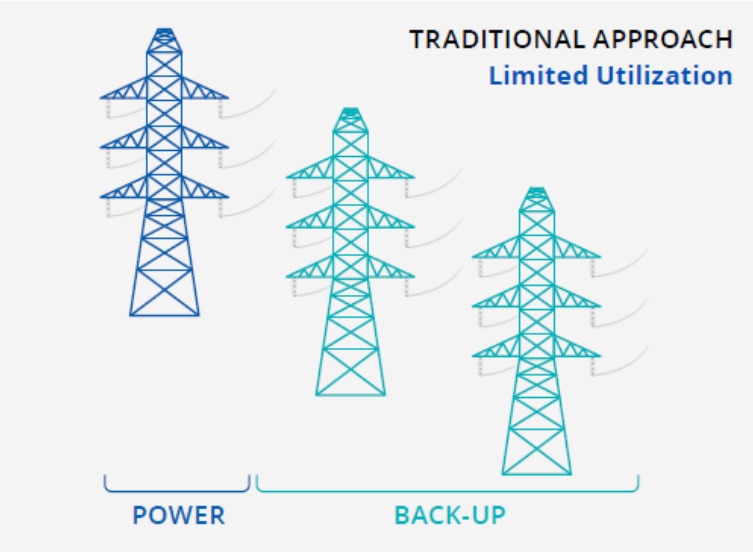
- Congestion costs in ISO/RTO markets tend to increase over the last few years
- This indicates the need for upgrading transmission lines or putting cheaper generators in congested areas.
- This also creates opportunity for non-wire alternatives for transmission congestion relief.

VIRTUAL TRANSMISSION BY ENERGY STORAGE



- 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.

EVALUATION OF STORAGE AS VIRTUAL TRANSMISSION



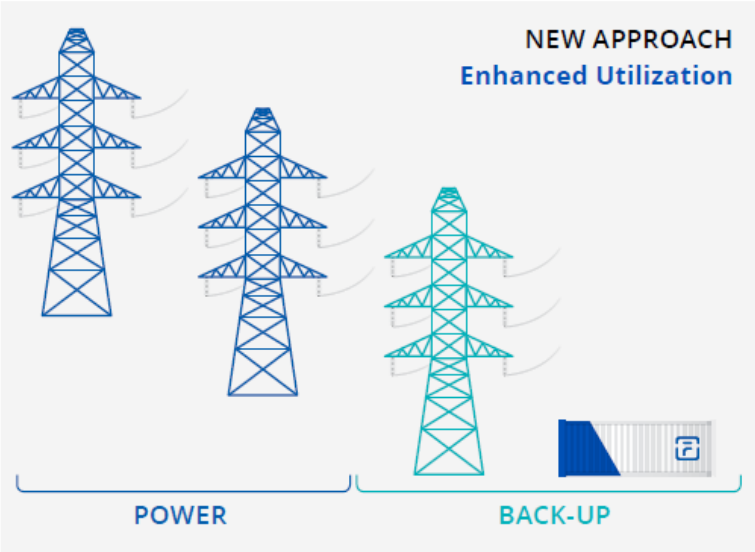


Image Credit: FLUENCE- Storage as Transmission White Paper

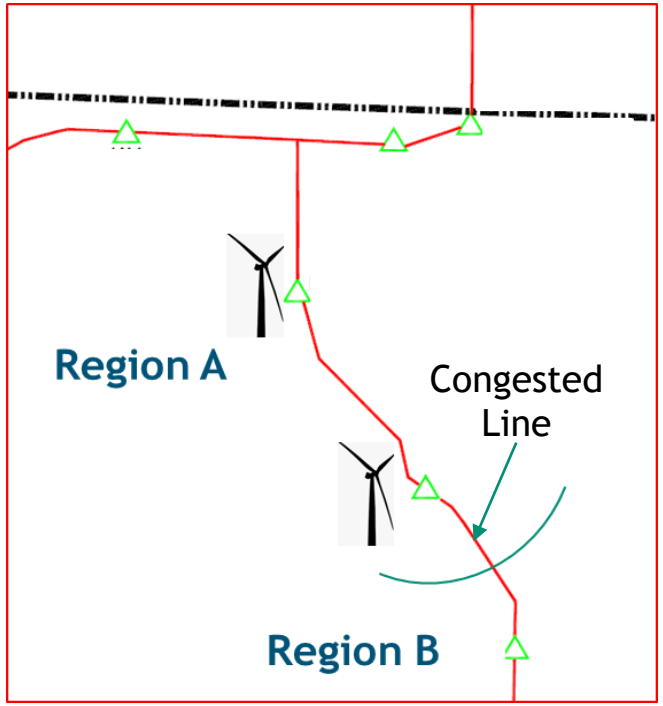
- Maximize the benefits from cost-base services together with market-based services:
  - Congestions relief: maximize opportunity for upstream generators to sell more energy at higher prices; minimize overall congestion cost
  - Market activities: energy arbitrage, ancillary services
- Evaluate the impact of virtual transmission in transmission planning: reduce the amount of transmission to meet N-1 security requirement.

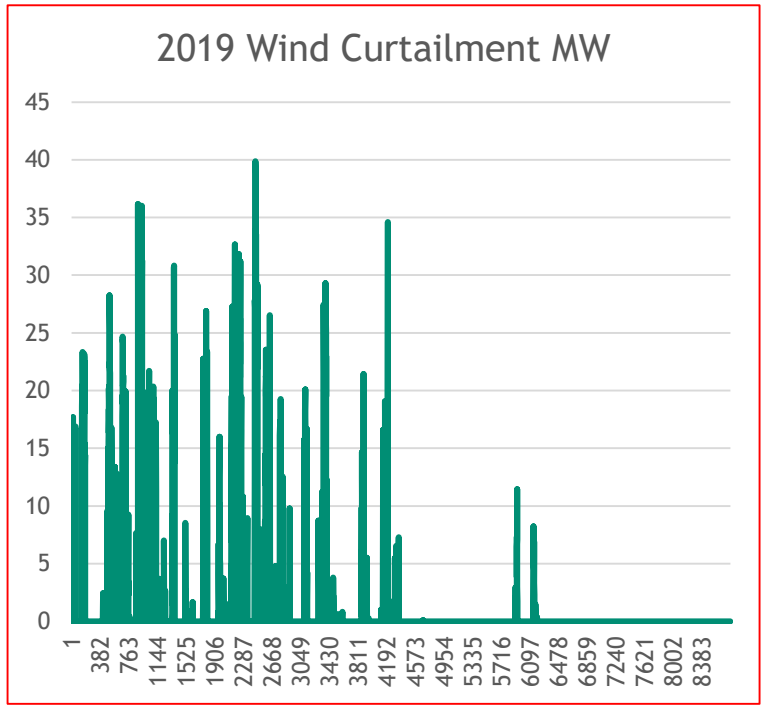
VIRTUAL TRANSMISSION VS. TRANSMISSON UPGRADE

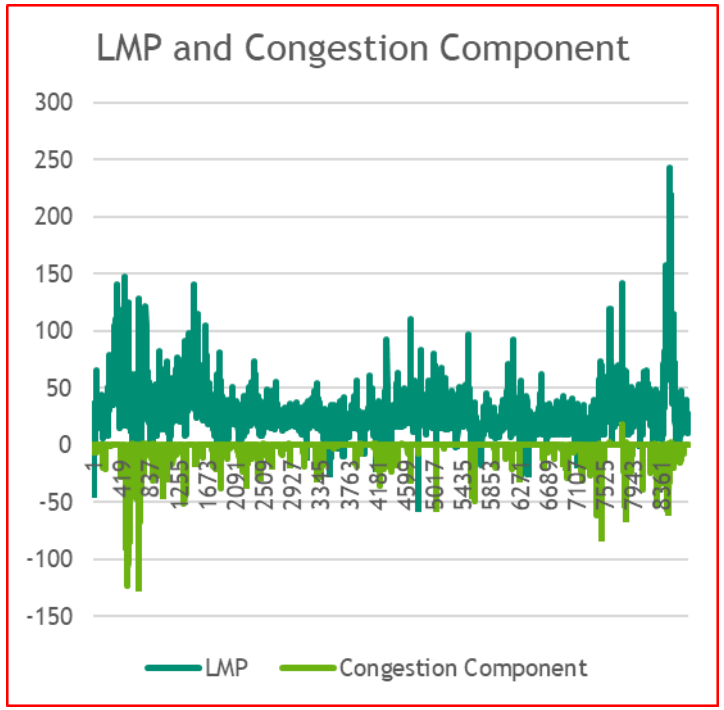
- Faster to deploy
- Smaller foot print
- More flexible and relocatable
- Providing multiple services
- Shorter life (10-15 years)

- Longer to get permitted and build.
- Need much more land
- Fixed assets
- Longer life (~50-60 years)

A CASE STUDY in ISO-NE



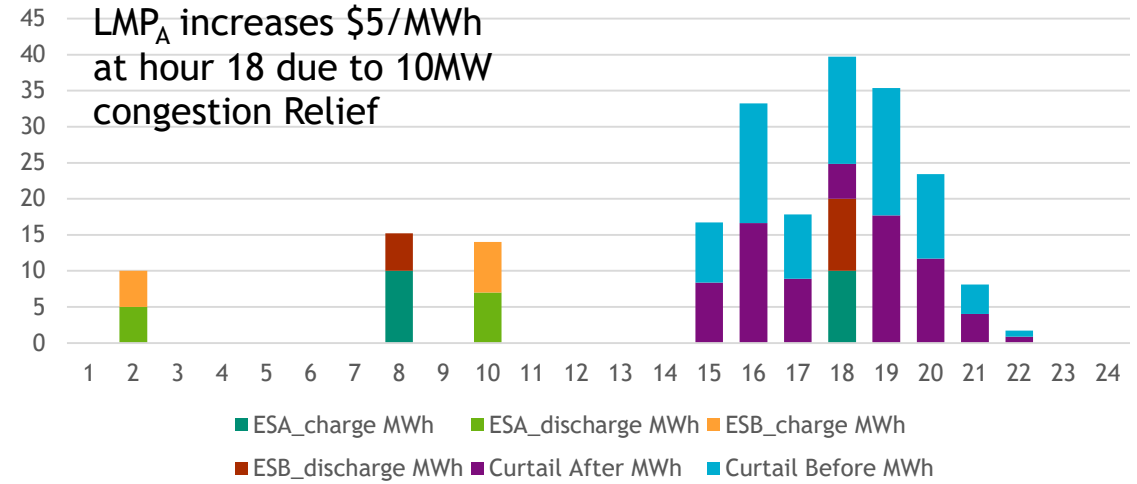




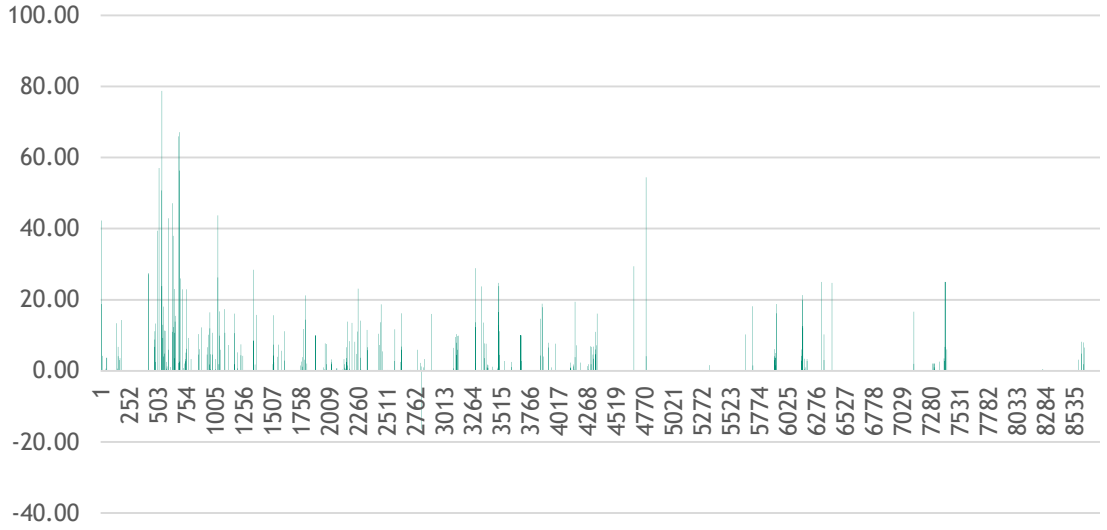
- Congestions make the marginal wind plant in region A curtail its output.
- Congestion component of LMP are negative indicating that if the congestions are relieved, more wind energy in region A can be sold to region B at higher LMPs
- In this case study:
  - Maximize the revenue for generators in region A by using storage as virtual transmission.
  - Compare with arbitrage benefit from wind curtailment.

CASE STUDY – RESULTS

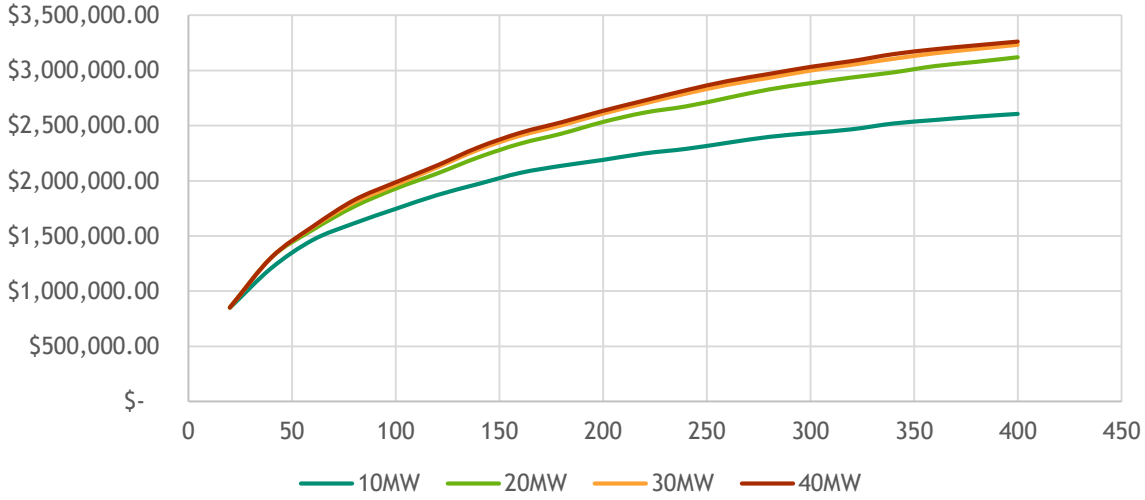
10MW/20Wh Case - Charge/discharge 24h Profile Example



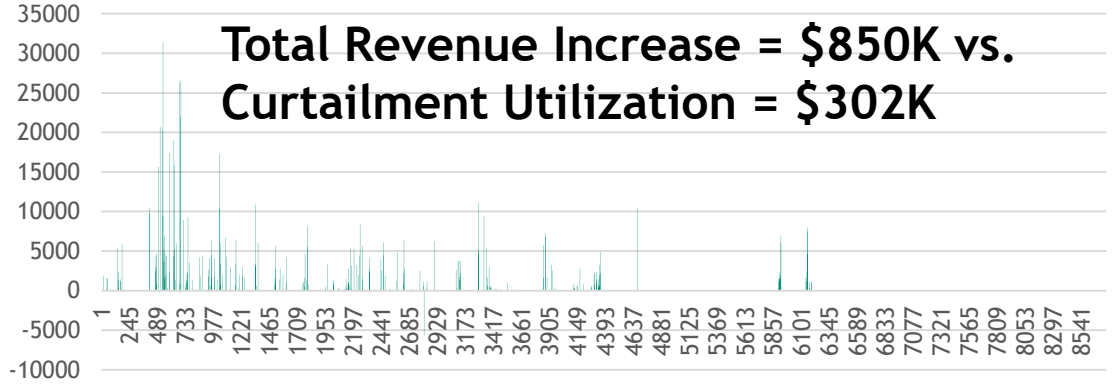
10MW/20Wh Case- LMP Improvement in $/MWh



Congestion Relieve Revenue $ vs. ESS size



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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