

CapX2020



Delivering electricity you can rely on

CapX2050 Transmission Study Phase I

January 2020



The CapX2020 Utilities

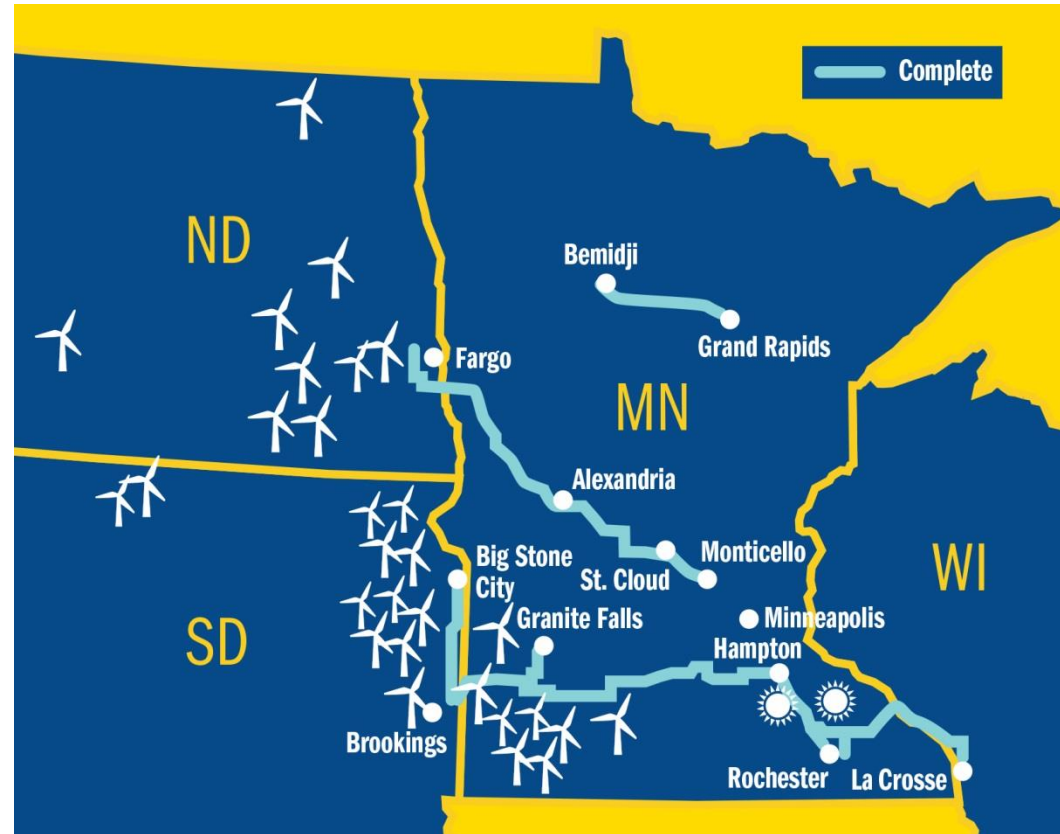
- Diverse group: cooperatives, municipals, investor-owned
- Many experienced transmission developers with financial strength
- Load-serving entities
- Aligned: Committed to customer needs and affordability
- National leaders in using renewable energy
- Industry leaders in reliability




Upper Midwest Transmission Expansion

Successful and proven collaboration

- CapX2020 is a joint initiative formed to upgrade and expand the electric grid to ensure continued reliable service for customers
- Between 2004 and 2017, over 800 miles of transmission completed resulting in:
 - Increased reliability
 - New generation outlet
 - Regional transmission support
- Benefits
 - \$1.6 billion in wages
 - Nearly 8,000 jobs
 - \$50 million in state tax revenue





Evolution of the use of the transmission system

Pre-MISO

- Transmission used primarily to transmit energy from a utility's generation resources to serve its load and provide for reserve sharing
- Predominantly dispatchable, central station generation (coal/natural gas/nuclear)

Today

- Transmission used to create market efficiencies across a 15 state footprint
- Generation dispatched to serve load based on least cost generation and transmission congestion
- Predominantly dispatchable generation, with growing non-dispatchable generation (wind/solar)

Future

- Transmission will be used to integrate more widely dispersed generation and to support greater levels of imports and exports
- Economics are resulting in the retirement of older dispatchable generation and replacement with non-dispatchable generation
- Fundamental changes are occurring that will impact transmission use and how grid reliability and stability are maintained



Anticipated future challenges

- Challenges are real, but manageable
- Ensuring an adequate supply of energy to meet customer demand *every hour will become more challenging with fewer dispatchable resources*
- With increased non-dispatchable generation, ensuring the electric system is stable to *reliably serve* customers
- *Variability of output* of new resources changes and complicates many facets of grid operation



Situations studied

Hypothetical simulation 2050

- Summer potential peak load with negligible wind
- Historic wind peak day
- Polar vortex with high load and low wind and solar

System stability

- Impacts of generation retirements in the metro area
- Appropriate amounts of grid support will need to be provided at specific locations where they will be effective


Impacts of generation retirements

- Evaluated impacts of retirements in various parts of the state
- Example: Fibrominn impact on local reliability



What we have learned

- To reliably serve all 8760 hours will require some dispatchable generation and/or long duration storage in conjunction with non-dispatchable resources
- New technology will be needed to support the electric grid
- Ability for system operators to meet real-time operational demands will be more challenging
- The integration of more non-dispatchable resources and retirement of more dispatchable generation will require more transmission infrastructure



Meeting customer demand every hour, not just peak demand, will be important

- Renewable generation resources are weather-dependent
- There will be periods during the year where renewable generation, alone, will be unable to meet customer demand
- At those times, simply having “more” renewable generation will not fill the gap



Advances in technology are part of solution set

- Flexible Alternating Current Transmission Systems (FACTS) - power electronics-based devices
- Advanced Inverter Technologies
- Storage breakthroughs to provide sufficient duration



Dispatchable resources will be required

- Non-dispatchable resources alone cannot meet consumer demand for all 8760 hours
- Abrupt changes in weather, including prolonged extreme conditions, sudden changes in consumer demand or disturbances on the transmission system (i.e., outages) will increasingly challenge the ability of the electrical grid to provide a continuous supply of energy
- To ensure reliable service to customers, sufficient dispatchable resources, including significant amounts of energy storage will be needed as traditional dispatchable resources are retired



More transmission will be needed in the future

- Holistic transmission planning needed in order to provide a reliable and affordable grid
- Minimizes the negative impacts that retirement of traditional dispatchable resources has on system stability and reliability
- Provides optionality for siting dispatchable and non-dispatchable resources across a broad footprint
- Enables the movement of energy between regions to ensure that energy needs are met for all hours of the year
- Assures reliability as distributed generation is added