Electricity in Transition: A Regulatory Perspective

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Topics

• Overview
• Generation Fleet Transition
• Renewables Integration
• Engaged Customers
• Distributed Energy Resources
• Looking Forward
Ensure safe, adequate, and reliable services at fair and reasonable rates, consistent with the state’s policies, for three critical industries:

- **Electricity**
  - 3 investor owned – ~70% of state annual electric energy sales

- **Natural gas**

- **Local telephone service** (limited rate regulation)

Need for and physical location of “large energy facilities”

Mediate consumer service issues
Integrated Resource Planning

**Resource Plan**
- Alternatives
- Forecast
- DSM
- Generic Size, Type, & Timing Approved
- Existing Generation
- Rate Increase Approved

**Certificate of Need**
- Alternatives
- Forecast
- Specific Facility Approved
- Environment & Socioeconomic

**Rate Case**
- Finance Adjustments
- Assign Costs
- Forecast Adjustments
- Rate Increase Approved
- Design Rates

**Energy Facility Permitting**
- Alternatives
- Public Participation
- Siting/Routing Approved & Constructed
- Environmental Review
Average price of electricity to consumers is a weighted average of total consumer revenue (energy, demand, fuel adj., riders, etc) and total sales across all sectors.
Affordable Electricity Costs
Average Residential Monthly Bill

Source: U.S. Energy Information Administration, EIA-861
Trends in MN Economic Growth, Electricity Use, and Emissions

Sources: U.S. Energy Information Administration
U.S. Bureau of Economic Analysis
Minnesota Generation Fleet Transition

Experience to date: 1990 - 2016

- 1990: 66% Natural Gas, 2% Renewables, 23% Coal, 0% Nuclear
- 2005: 62% Natural Gas, 6% Renewables, 45% Coal, 0% Nuclear
- 2016: 23% Natural Gas, 45% Renewables, 23% Coal, 0% Nuclear
Minnesota Electricity in Transition

Current Plans: 2016 - 2030

2016

- Nuclear: 23%
- Coal: 45%
- Natural Gas: 9%
- Renewables: 23%

2030*

- Nuclear: 21%
- Coal: 22%
- Natural Gas: 12%
- Renewables: 45%

* Based on MN IOU IRPs & announcements
## Minnesota Generation Fleet Transition

### Upcoming Challenge: 2020 - 2040

<table>
<thead>
<tr>
<th>Power Plant</th>
<th>Capacity (MW)</th>
<th>Announced Retirement or End of Economic Life</th>
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</thead>
<tbody>
<tr>
<td>MN Power, Coal</td>
<td>130</td>
<td>2018, Retirement</td>
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<td>Otter Tail, Coal</td>
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<td>2021, Retirement</td>
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<td>Xcel Energy, Coal</td>
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<td>2026, 2023, Retirement</td>
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<td>670, 2030, Operating license</td>
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<td>Prairie Island 1 &amp; 2</td>
<td>1100, 2033, 2034, Operating license</td>
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<td>2034, Economic life</td>
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<td>2035, 2036, Economic life</td>
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<tr>
<td>Xcel Energy, Coal</td>
<td>510</td>
<td>2037, Economic life</td>
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Wind and Solar Growth due to:

- Significantly improved technology;
- Plummeting costs and increasing value;
- Advancements in planning and operating with high levels of variable renewables;
- Customer preferences for renewables.

Wind Capacity as of January 2017

MN: 3,500 MW
Wind Price Trends

Rate Impacts

- RES Rate Impact Reports required by Minn. Stat. 216B.1691, Subd. 2e
- Commission developed rate impact methodology in 2015; future period reflects IRP timeframe post-Commission methodology
Solar Capacity
as of October 2017

Source: MN Department of Commerce
Solar Price Trends – Utility Scale

Sample includes 189 contracts totaling 11.7 GW$_{AC}$

Levelized PPA Price (Real 2016 $/MWh)

- California
- Southwest
- Texas
- Southeast
- Midwest
- Hawaii

Sample includes 189 contracts totaling 11.7 GW$_{AC}$

Grid integration of large amounts of wind generation in Minnesota and the upper Midwest began in the early 2000s:

- Initial work focused on *interconnection*

- Minnesota utilities & MISO developed regional transmission plans


Today, the regional grid is planned and operated differently.
Reliability Study

- By Minnesota utilities and transmission companies; MISO
- With independent technical review

Increase Minnesota wind and solar generation

- 40% and 50% of annual electric energy

Three core and interrelated analyses:

- Developed a conceptual transmission plan;
- Evaluated hour by hour operational performance of the power system for full year; and
- Evaluated transient stability and system strength.
MRITS Study Operational Performance Analysis
Identification of Challenging Hours

% wind and solar generation (non-synchronous)
Key Findings:

- Wind and solar resources increased to 40% for Minnesota
  - The power system can be successfully operated for all hours of the year;
  - Requires some upgrades to existing transmission lines;
  - No fundamental system-wide dynamic stability or voltage regulation issues.

- Wind and solar resources increased to 50% for Minnesota and increased to 25% in other Midwest states
  - The power system can be successfully operated for all hours of the year;
  - Requires significant upgrades and expansions to the transmission system.
Regional Grid Integration of Variable Renewables

- Reducing Wind and Solar integration impacts
  - Large, liquid, fast markets;
  - Large balancing area with a strong grid; and
  - Forecasting wind generation day-ahead

- Midwest experience integrating wind
  - Variability is mitigated by geographic diversity;
  - Wind contributes to resource adequacy;
  - Market rules have evolved to require fuller wind participation.

- Wind and solar generators are power plants
  - Are Dispatched; Ride through disturbances; Provide reactive power; Capable of fast and accurate ramping and active power control.
Grid Balancing and Flexibility

Source: Harnessing Variable Renewables. IEA.
Existing resources are capable of operating flexibly to manage renewable integration

Robust regional grid and markets enable new and diverse technologies

Engaged Customers

Customers are becoming increasingly involved in where their electricity comes from and in how they use it.

Examples include:

- Green Tariffs
- Corporate sustainability
- Community goals
- Distributed Solar
- Demand Response
Distributed Energy Resources

Supply and demand-side resources that can be used throughout an electric distribution system to meet energy and reliability needs of customers

Includes:

• Efficiency

• Distributed Generation

• Distributed Flexibility and Storage

• Distributed Intelligence
End-Use Electrification Technologies...Assessing Technical, Economic and Achievable Potential

- Cars and light trucks
- Space heating
- Cool / Light / Appl. / Elec.
- Industry process
- Heavy-duty trucks
- Buildings other
- Industry boilers
- Constr. / Ag. / Min.
- Aviation
- Bus / Transit / Rail
- Industry other
- Maritime
- Military

Electric Vehicles
- Heat Pumps
- Induction Melting, Infrared Drying
- Batteries for Long-Haul Trucking
- Heat Pump Water Heaters, Electric Range, Clothes Dryers

More Limited Opportunities

Quad BTUs

Electricity Coal Petroleum Natural Gas Bioenergy
MN PUC Modernization Dockets

Interconnection Standards
- Interconnection Process (2018)
- Technical Standards (2019)

Distribution Grid
- Distribution Planning (2018)
- Grid Upgrades - AMI/ADMS

Rate Design
- More granular pricing
- TOU/Critical Peak Pricing

Performance Considerations
- Xcel Multi-Year Rate Case
- Metrics/Incentives
Evolveing Electric Grid

Minnesota’s electric grid is reliable, affordable, increasingly clean

The grid is at a time of significant change, as:

• Large infrastructure ages
• Consumer demands evolve
• New technology costs fall

Tomorrow’s integrated grid will optimize and extract value throughout the system:

• will be more distributed and flexible;
• will operate resiliently against natural disaster and attacks;
• will be cleaner, reliable, and affordable.

The regional transmission grid and markets will continue to be vital.
Thank you!

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