Morris Resiliency Series Session 4:
Toward a Resilient Energy Infrastructure

Lise Trudeau, Emerging Technology Planning Director
Division of Energy Resources
Our mission is to protect the public interest, advocate for Minnesota consumers, ensure a strong, competitive and fair marketplace, strengthen the state’s economic future; and serve as a trusted public resource for consumers and businesses
MN Department of Commerce: Divisions

- Energy
- Financial Institutions
- Fraud
- Insurance Enforcement
- Telecom
- Licensing
- Weights & Measures
Division of Energy Resources

• Promote clean, reliable, and affordable energy for Minnesota businesses and homes
• Advocate on behalf of public interest in state and federal regulatory proceedings
• Maintain state emergency energy planning and recovery plans
• Oversee the Conservation Improvement Program, including Conservation Applied Research & Development
• Promote energy-efficient buildings and emerging energy technologies
• Administer the Home Energy Assistance and Weatherization Assistance Programs
There's no bad weather, just bad gear.

-Scandinavian saying
Chance favors the prepared mind.

-Louis Pasteur
Overview

• **2020 MN Quadrennial Energy Report**
  - Trends and factors in rapid power sector transformation
  - projections through 2034 based on utility resource plans

• **MN Solar Pathways study**
  - Planning for least-risk, best-value strategies to meet MN solar goals

• **MN Thermal Grid Study**
  - cost-effective, efficient heating using any source (industrial waste heat, geothermal, heat sink for excess wind power, etc.)
  - Supports load-flexibility and resilience
Quadrennial Energy Report 2020

- Pursuant 216C.18
- Produced every four years
- Outlines key developments in the energy sector
- Redesigned for easy access to important energy information
Power Sector Transition
Coal is dropping significantly; renewables are expanding quickly for power generated in Minnesota.

**Electricity Generated in Minnesota**

<table>
<thead>
<tr>
<th>2005</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>62%</td>
<td>29%</td>
</tr>
<tr>
<td>24%</td>
<td>20%</td>
</tr>
<tr>
<td>5%</td>
<td>25%</td>
</tr>
<tr>
<td>6%</td>
<td>26%</td>
</tr>
</tbody>
</table>

- **Renewable**
- **Natural Gas**
- **Coal**
- **Nuclear**

Source: U.S. EIA
Coal is dropping significantly; renewables are expanding quickly for power generation.
While wind dominates renewable electricity generation in Minnesota; solar is rising rapidly.

**MN Renewable Electricity Generation**

- **Wind, 21.4%**
- **Solar, 3.0%**
- **Biomass, 2.1%**
- **Hydro, 2.0%**

*source: U.S. EIA*
Figure 4. Minnesota’s GHG emissions from economic sectors, 2005-2018. The dark line in the column for the electricity generation sector represents the division between emissions from electricity generated in Minnesota (below the line) and emissions from net imports of electricity (above the line).
• State policies and market forces have resulted in a rapid decarbonization of Minnesota’s power sector.
• Minnesota is on path to a carbon intensity below the national average in 2020

source: U.S. EIA
Electric utilities are planning to transition to a 70% carbon free energy mix by 2034
Minnesota’s Electric Utilities

Cooperatives (by G&T)
- Great River Energy
- Dairyland Power Cooperative
- East River Electric Cooperative
- Minnkota Power Cooperative
- Independent Cooperatives

Municipals (by G&T)
- Central Municipal Power Agency and Services
- Minnesota Municipal Power Agency
- Missouri River Energy Services
- Northern Municipal Power Agency
- Southern Minnesota Municipal Power Agency
- Independent Municipals

Investor-Owned
- Minnesota Power
- Otter Tail Power
- Xcel Energy
Upper Midwest Electricity in Transition

Current Plans: 2020 – 2034*

* Per Xcel, GRE, Mn Power, and OTP Resource Plans and announced retirements, including energy generated outside Minnesota
Energy Sector – Current Commitments

- **Xcel Energy**: 80% carbon reduction by 2030 & 100% carbon-free electricity by 2050
- **Great River Energy**: 95% carbon free by 2023
- **Minnesota Power**: 50% renewable energy & 50% carbon reduction by 2021
- **SMMPA**: 80% carbon free in 2030
- **OTP**: 30% renewable energy & 40% carbon reduction by 2022
The Minnesota Solar Pathways team:

- Examined paths to reach MN’s solar electricity goal of 10% by 2030 (~6GW) and higher levels of solar and wind by 2050, and
- Worked with stakeholders to identify least-risk, best-value strategies for Minnesota.
U.S. Electric Power Regions
→ Modeling indicates that 100% wind and solar can be achievable at a levelized cost of energy comparable to natural gas generation, and 95% wind and solar can be possible at lower costs.

→ Overbuilding solar and wind provides interesting opportunities to use excess generation, such as power to gas for transportation, and for use in the existing natural gas pipeline.
Projects awaiting grid interconnection are primarily solar, wind, and storage.
The Minnesota Solar Guide provides information and tools to support solar energy development in communities across the state.

The guide was created as part of MN Solar Pathways, a project funded by the U.S. Department of Energy’s Solar Energy Technologies Office to explore least-risk, best-value paths for Minnesota to achieve its solar energy goals.
mnsolarpathways.org
Mapping Thermal Grid Integration Opportunities
Estimated Minnesota Energy Consumption in 2018: 1,847 Trillion BTU

- **Solar**: 10.4
- **Nuclear**: 153.0
- **Hydro**: 9.6
- **Wind**: 97.5
- **Geothermal**: 1.1
- **Natural Gas**: 515
- **Coal**: 262
- **Biomass**: 105
- **Petroleum**: 583

**Electricity Generation**: 596
- **Net Electricity Imports**: 33.8
- **Residential**: 278
- **Commercial**: 220
- **Industrial**: 427
- **Transportation**: 464
- **Energy Services**: 661
- **Rejected Energy**: 1186

**Total Energy**: 1,847 Trillion BTU
Estimated Minnesota Carbon Dioxide Emissions in 2017: 88.4 Million Metric Tons

- Carbon Dioxide Emissions: 88.4
- Residential: 8.6
- Commercial: 6.6
- Industrial: 17.2
- Transportation: 30.8
- Electricity Generation: 25.2
- Natural Gas: 24.7
- Coal: 24.6
- Petroleum: 39.1
- Solar: 0
- Nuclear: 0
- Hydro: 0
- Wind: 0
- Geothermal: 0

Total:
- Residential: 8.6
- Commercial: 6.6
- Industrial: 17.2
- Transportation: 30.8
- Electricity Generation: 25.2
- Natural Gas: 24.7
- Coal: 24.6
- Petroleum: 39.1
- Solar: 0
- Nuclear: 0
- Hydro: 0
- Wind: 0
- Geothermal: 0
Emissions and energy use from buildings are increasing, but pathways exist to reduce building emissions.
Thermal Grids for Resiliency

- Cost-effective, efficient heating using any source
  - industrial waste heat,
  - geothermal,
  - heat sink for excess wind power

- Supports load-flexibility and resilience

- Infrastructure similar to Natural Gas distribution
Conservation programs work

$146 million boost to GDP from emissions reductions

48,000 local jobs added

$11 billion in new economic activity

Each dollar spent on CIP generates $3.75 in benefits to society

Extra $900 in the wallet of each Minnesotan
Governor’s Clean Energy Package: Energy Conservation and Optimization (ECO)

- ECO expands CIP to include load management and efficient fuel-switching, while protecting traditional energy efficiency, increasing CIP’s ability to offer additional efficient choices for customers and support local job opportunities.

- Projects supported by ECO are inherently local jobs in electrical, heating/cooling, ventilation, and insulation installation.

- ECO will provide residents and businesses more opportunities to save money on their energy bills and creating economic opportunities when needed most.
Communities are actively implementing climate and energy goals
Only a crisis - actual or perceived - produces real change. When that crisis occurs, the actions that are taken depend on the ideas that are lying around. That, I believe, is our basic function: to develop alternatives to existing policies, to keep them alive and available until the politically impossible becomes the politically inevitable.

- Milton Friedman
Questions?

Lise Trudeau, Emerging Technology Planning Director
Division of Energy Resources
This guide is available online at:

Or just Google Minnesota Microgrid Report
Electric System in Transition
2016-2020 Monthly Electricity Generation in Minnesota

source: U.S. EIA
Most of the emissions reductions in the electric power sector have come from utilities retiring coal-fired electricity generating facilities.

<table>
<thead>
<tr>
<th>Facility</th>
<th>Size (nameplate capacity, MW; rounded)</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hibbing Public Utilities Commission</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hibbing 3</td>
<td>10</td>
<td>Standby/backup: available for service but not normally used</td>
</tr>
<tr>
<td>Hibbing 5</td>
<td>20</td>
<td>Standby/backup: available for service but not normally used</td>
</tr>
<tr>
<td>Hibbing 6</td>
<td>6</td>
<td>Standby/backup: available for service but not normally used</td>
</tr>
<tr>
<td>Minnesota Power</td>
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</tr>
<tr>
<td>Boswell unit 3</td>
<td>365</td>
<td>Operating</td>
</tr>
<tr>
<td>Boswell unit 4</td>
<td>558</td>
<td>Operating</td>
</tr>
<tr>
<td>Taconite Harbor Energy Center unit 1</td>
<td>75</td>
<td>Standby/backup: available for service but not normally used</td>
</tr>
<tr>
<td>Taconite Harbor Energy Center unit 2</td>
<td>75</td>
<td>Standby/backup: available for service but not normally used</td>
</tr>
<tr>
<td>Otter Tail Power Company</td>
<td></td>
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</tr>
<tr>
<td>Hoot Lake 2</td>
<td>54</td>
<td>Operating, full retirement by 2021</td>
</tr>
<tr>
<td>Hoot Lake 3</td>
<td>75</td>
<td>Operating, full retirement by 2020</td>
</tr>
<tr>
<td>Xcel Energy</td>
<td></td>
<td></td>
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<tr>
<td>Sherburne County 1</td>
<td>680</td>
<td>Operating, full retirement by 2026</td>
</tr>
<tr>
<td>Sherburne County 2</td>
<td>682</td>
<td>Operating, full retirement by 2023</td>
</tr>
<tr>
<td>Sherburne County 3</td>
<td>876</td>
<td>Operating, proposed retirement by 2030</td>
</tr>
<tr>
<td>Allen S King</td>
<td>511</td>
<td>Operating, proposed retirement by 2028</td>
</tr>
</tbody>
</table>
Wind capacity has grown rapidly

Minnesota's Wind Capacity
as of December 2020 (Source: MN Department of Commerce)

Cumulative (MW)

- 4,310 MW
- Actual
- Projected
Minnesota’s solar generating capacity has grown rapidly since 2015.
## Levelized Cost of Energy Comparison

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Renewable Energy</th>
<th>Conventional</th>
<th>Levelized Cost ($/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar PV-Rooftop Residential</td>
<td></td>
<td></td>
<td>$150 ($227)</td>
</tr>
<tr>
<td>Solar PV-Rooftop C&amp;I</td>
<td></td>
<td></td>
<td>$74 ($179)</td>
</tr>
<tr>
<td>Solar PV-Community</td>
<td></td>
<td></td>
<td>$63 ($94)</td>
</tr>
<tr>
<td>Solar PV-Crystalline Utility Scale(1)</td>
<td></td>
<td></td>
<td>$31 ($42)</td>
</tr>
<tr>
<td>Solar PV-Thin Film Utility Scale(1)</td>
<td></td>
<td></td>
<td>$29 ($38)</td>
</tr>
<tr>
<td>Solar Thermal Tower with Storage</td>
<td></td>
<td></td>
<td>$126 ($156)</td>
</tr>
<tr>
<td>Geothermal</td>
<td></td>
<td></td>
<td>$59 ($101)</td>
</tr>
<tr>
<td>Wind</td>
<td></td>
<td></td>
<td>$26 ($54)</td>
</tr>
<tr>
<td>Gas Peaking(3)</td>
<td></td>
<td></td>
<td>$41 ($65)</td>
</tr>
<tr>
<td>Nuclear(4)</td>
<td></td>
<td></td>
<td>$29 ($129)</td>
</tr>
<tr>
<td>Coal(5)</td>
<td></td>
<td></td>
<td>$41 ($65)</td>
</tr>
<tr>
<td>Gas Combined Cycle(3)</td>
<td></td>
<td></td>
<td>$28 ($44)</td>
</tr>
</tbody>
</table>

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Lazard’s Survey of Electricity Prices by Source
<table>
<thead>
<tr>
<th>City</th>
<th>Climate Goals</th>
<th>Renewable Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Marais</td>
<td><strong>Climate Action Plan (2019):</strong> Carbon Neutral by 2040</td>
<td>Achieve energy resilience</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>100% renewable</strong> for city operations</td>
</tr>
<tr>
<td>Northfield</td>
<td><strong>Climate Action Plan (2019):</strong> Carbon free by 2040</td>
<td><strong>10% in-boundary</strong> renewable electricity (20 MW)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Carbon-free electricity</strong> by 2030</td>
</tr>
<tr>
<td>Rochester</td>
<td><strong>Energy Action Plan (2017):</strong> Supports state goal to reduce GHG emissions 80% by 2050</td>
<td>Mayoral proclamation:</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>100% renewable</strong> electricity by 2031</td>
</tr>
<tr>
<td>St. Louis Park</td>
<td><strong>Climate Action Plan (2018):</strong> Carbon neutral, community-wide by 2040</td>
<td><strong>100% renewable</strong> electricity by 2030</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>10% in-boundary</strong> (37 MW)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>City ops currently at 100% renewable</td>
</tr>
<tr>
<td>St. Paul</td>
<td><strong>Climate Action and Resilience Plan (2019 draft):</strong> Reduce emissions 50% by 2030, carbon neutral by 2050, community-wide</td>
<td><strong>10% in-boundary</strong> renewable electricity (200 MW)</td>
</tr>
<tr>
<td>Minneapolis</td>
<td><strong>Climate Action Plan (2013):</strong> 80% reduction in emissions from 2005 by 2050, community-wide</td>
<td><strong>100% renewable</strong> electricity by 2030 community-wide</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>100% renewable</strong> electricity for city ops by 2022</td>
</tr>
</tbody>
</table>

Source: Great Plains Institute