State of Minnesota
ENERGY SECTOR RISK PROFILE

This State Energy Risk Profile examines the relative magnitude of the risks that the State of Minnesota’s energy infrastructure routinely encounters in comparison with the probable impacts. Natural and man-made hazards with the potential to cause disruption of the energy infrastructure are identified.

The Risk Profile highlights risk considerations relating to the electric, petroleum and natural gas infrastructures to become more aware of risks to these energy systems and assets.

MINNESOTA STATE FACTS

<table>
<thead>
<tr>
<th>State Overview</th>
<th>Annual Energy Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population: 5.42 million (2% total U.S.)</td>
<td>Electric Power Generation: 52.2 TWh (1% total U.S.)</td>
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<tr>
<td>Housing Units: 2.37 million (2% total U.S.)</td>
<td>Coal: 22.7 TWh, 44% [5.3 GW total capacity]</td>
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<tr>
<td>Business Establishments: 0.15 million (2% total U.S.)</td>
<td>Petroleum: 0 TWh, &lt;1% [0.9 GW total capacity]</td>
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<table>
<thead>
<tr>
<th>Annual Energy Consumption</th>
<th>Annual Energy Production</th>
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<tbody>
<tr>
<td>Electric Power: 68.0 TWh (2% total U.S.)</td>
<td>Natural Gas: 7.1 TWh, 14% [5.9 GW total capacity]</td>
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<tr>
<td>Coal: 13,400 MSTN (2% total U.S.)</td>
<td>Nuclear: 11.9 TWh, 23% [1.9 GW total capacity]</td>
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<tr>
<td>Natural Gas: 409 Bcf (2% total U.S.)</td>
<td>Hydro: 0.6 TWh, 1% [0.2 GW total capacity]</td>
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<tr>
<td>Motor Gasoline: 53,900 Mbarrels (2% total U.S.)</td>
<td>Other Renewable: 7.6 TWh, 15% [3.1 GW total capacity]</td>
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<tr>
<td>Distillate Fuel: 28,300 Mbarrels (2% total U.S.)</td>
<td>Coal: 0 MSTN (0% total U.S.)</td>
</tr>
<tr>
<td>Natural Gas: 0 Bcf (0% total U.S.)</td>
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<tr>
<td>Motor Gasoline: 53,900 Mbarrels (2% total U.S.)</td>
<td>Crude Oil: 0 Mbarrels (0% total U.S.)</td>
</tr>
<tr>
<td>Distillate Fuel: 28,300 Mbarrels (2% total U.S.)</td>
<td>Ethanol: 25,200 Mbarrels (8% total U.S.)</td>
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</table>

NATURAL HAZARDS OVERVIEW

Annual Frequency of Occurrence of Natural Hazards in Minnesota (1996–2014)

As reported by NOAA, the natural hazard in Minnesota that caused the greatest overall property loss during 1996 to 2014 is Thunderstorm & Lightning at $86.3 million per year.

The natural hazard with the second-highest property loss in Minnesota is Flood at $45.4 million per year.

According to NOAA, the most common natural hazard in Minnesota is Thunderstorm & Lightning, which occurs once every 3.9 days on the average during the months of March to October.

The second-most common natural hazard in Minnesota is Winter Storm & Extreme Cold, which occurs once every 9 days on the average during the months of October to March.
**ELECTRIC**

**Electric Power Plants:** 282 (2% total U.S.)
- Coal-fired: 18 (2% total U.S.)
- Petroleum-fired: 75 (3% total U.S.)
- Natural Gas-fired: 36 (1% total U.S.)
- Nuclear: 2 (2% total U.S.)
- Hydro-electric: 25 (1% total U.S.)
- Other Renewable: 126 (4% total U.S.)

**Transmission Lines:**
- High-Voltage (>230 kV): 3,019 Miles
- Low-Voltage (<230 kV): 11,945 Miles
Electric Transmission

- According to NERC, the leading cause of electric transmission outages in Minnesota is Faulty Equipment/Human Error.
- Minnesota experienced 23 electric transmission outages from 1992 to 2009, affecting a total of 16,123 electric customers.
- Faulty Equipment/Human Error affected the largest number of electric customers as a result of electric transmission outages.


- Faulty Equipment / Human Error
- Electrical System Separation – Islanding
- Severe Weather - Heat Wave
- Severe Weather - Thunderstorm
- Protection System Misoperation
- All Other Causes

Data Source: NERC

Electric Distribution

Electric-Utility Reported Power Outages by Month (2008–2013)

- Between 2008 and 2013, the greatest number of electric outages in Minnesota has occurred during the month of March.
- The leading cause of electric outages in Minnesota during 2008 to 2013 was Weather/Falling Trees.
- On average, the number of people affected annually by electric outages during 2008 to 2013 in Minnesota was 449,995.
- The average duration of electric outages in Minnesota during 2008 to 2013 was 2,770 minutes or 46.2 hours a year.


- Animal
- Faulty Equipment / Human Error
- Overdemand
- Planned
- Theft / Vandalism
- Unknown
- Vehicle Accident
- Weather / Falling Trees

Data Source: Eaton

Utility Outage Data (2008–2013)

- Total number of people affected by outages
- Total duration of outages (minutes)

Data Source: Eaton
PETROLEUM

Petroleum Infrastructure Overview
Refineries: 2 (1% total U.S.)
Terminals: 25 (1% total U.S.)
Crude Pipelines: 2,402 Miles (5% total U.S.)
Product Pipelines: 5,100 Miles (1% total U.S.)
Bio-Refineries (Ethanol): 22 (11% total U.S.)
Petroleum Transport

Top Events Affecting Petroleum Transport by Truck and Rail (1986–2014)

The leading event type affecting the transport of petroleum product by rail and truck in Minnesota during 1986 to 2014 was Incorrect Operation for rail transport and Miscellaneous/Unknown for truck transport, with an average 1.0 and 13.4 incidents per year, respectively.

Petroleum Refinery

The leading cause of petroleum refinery disruptions in Minnesota from 2003 to 2014 was Maintenance/Turnaround. Minnesota’s petroleum refineries experienced 63 major incidents from 2003 to 2014. The average production impact from disruptions of Minnesota’s refineries from 2003 to 2014 is 30.8 thousand barrels per day.


Average Production Impact (thousand barrels per day) from Petroleum Refinery Outages in Minnesota (2003–2014)
NATURAL GAS

Natural Gas Infrastructure Overview
- Gas Wells: 0 (0% total U.S.)
- Processing Plants: 0 (0% total U.S.)
- Storage Fields: 2 (<1% total U.S.)
- Interstate Pipelines: 7,500 Miles (1% total U.S.)
- Local Distribution Companies: 40 (2% total U.S.)
Natural Gas Transport

The leading event type affecting natural gas transmission and distribution pipelines in Minnesota during 1986 to 2014 was Outside Force for Transmission Pipelines and Outside Force for Distribution Pipelines, with an average 0.29 and 0.97 incidents per year (or one incident every 3.4 and 1 years), respectively.

Top Events Affecting Natural Gas Transmission and Distribution in Minnesota (1986–2014)

Data Source: DOT PHMSA
DATA SOURCES

Overview Information
- Census Bureau (2012) State and County QuickFacts [http://quickfacts.census.gov/qfd/download_data.html]

Production Numbers

Consumption Numbers

Electricity
- Platts (2014 Q2) Transmission Lines (Miles by Voltage Level)
- Platts (2014 Q2) Power Plants (Production and Capacity by Type)

Petroleum
- Argonne National Laboratory (2012) Petroleum Terminal Database
- Argonne National Laboratory (2014) Ethanol Plants
- NPMS (2011) Petroleum Product Pipeline (Miles of Interstate Pipeline)
- NPMS (2011) Crude Pipeline (Miles of Interstate Pipeline)

Natural Gas
- EIA (2013) Number of Producing Gas Wells [http://www.eia.gov/dnav/ng/ng_prod_wells_s1_a.htm]
- NPMS (2011) Natural Gas Pipeline (Miles of Interstate Pipeline)
- Platts (2014 Q2) Local Distribution Companies (LDCs)

Event Related

*The NERC disturbance reports are not published after 2009.

Notes
- Natural Hazard, Other, includes extreme weather events such as astronomical low tide, dense smoke, frost/freeze, and rip currents.
- Each incident type is an assembly of similar causes reported in the data source. Explanations for the indescribable incident types are below.
  - Outside Force refers to pipeline failures due to vehicular accident, sabotage, or vandalism.
  - Natural Forces refers to damage that occurs as a result of naturally occurring events (e.g., earth movements, flooding, high winds, etc.)
  - Miscellaneous/Unknown includes releases or failures resulting from any other cause not listed or of an unknowable nature.
  - Overdemand refers to outages that occur when the demand for electricity is greater than the supply, causing forced curtailment.
- Number (#) of Incidents – The number within each pie chart piece is the number of outages attributable to each cause.

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