State of Vermont
ENERGY SECTOR RISK PROFILE

This State Energy Risk Profile examines the relative magnitude of the risks that the State of Vermont’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.

VERMONT STATE FACTS

<table>
<thead>
<tr>
<th>State Overview</th>
<th>Annual Energy Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population: 0.63 million (&lt;1% total U.S.)</td>
<td>Electric Power Generation: 6.6 TWh (&lt;1% total U.S.)</td>
</tr>
<tr>
<td>Housing Units: 0.32 million (&lt;1% total U.S.)</td>
<td>Coal: 0 TWh, 0% [0 GW total capacity]</td>
</tr>
<tr>
<td>Business Establishments: 0.02 million (&lt;1% total U.S.)</td>
<td>Petroleum: 0 TWh, &lt;1% [0.1 GW total capacity]</td>
</tr>
<tr>
<td></td>
<td>Natural Gas: 0 TWh, 0% [0 GW total capacity]</td>
</tr>
<tr>
<td></td>
<td>Nuclear: 5.0 TWh, 76% [0.6 GW total capacity]</td>
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<tr>
<td></td>
<td>Hydro: 1.1 TWh, 17% [0.3 GW total capacity]</td>
</tr>
<tr>
<td></td>
<td>Other Renewable: 0.1 TWh, 2% [0.2 GW total capacity]</td>
</tr>
<tr>
<td></td>
<td>Coal: 0 MSTN (0% total U.S.)</td>
</tr>
<tr>
<td></td>
<td>Natural Gas: 0 Bcf (0% total U.S.)</td>
</tr>
<tr>
<td></td>
<td>Crude Oil: 0 Mbarrels (0% total U.S.)</td>
</tr>
<tr>
<td></td>
<td>Ethanol: 0 Mbarrels (0% total U.S.)</td>
</tr>
<tr>
<td>Annual Energy Consumption</td>
<td></td>
</tr>
<tr>
<td>Electric Power: 5.5 TWh (&lt;1% total U.S.)</td>
<td></td>
</tr>
<tr>
<td>Coal: 0 MSTN (0% total U.S.)</td>
<td></td>
</tr>
<tr>
<td>Natural Gas: 392 Bcf (2% total U.S.)</td>
<td></td>
</tr>
<tr>
<td>Motor Gasoline: 7,800 Mbarrels (&lt;1% total U.S.)</td>
<td></td>
</tr>
<tr>
<td>Distillate Fuel: 3,900 Mbarrels (&lt;1% total U.S.)</td>
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</tr>
</tbody>
</table>

NATURAL HAZARDS OVERVIEW

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

According to NOAA, the most common natural hazard in Vermont is Thunderstorm & Lightning, which occurs once every 12.6 days on the average during the months of March to October.

The second-most common natural hazard in Vermont is Winter Storm & Extreme Cold, which occurs once every 13.5 days on the average during the months of October to March.

Annualized Property Loss due to Natural Hazards in Vermont (1996–2014)

As reported by NOAA, the natural hazard in Vermont that caused the greatest overall property loss during 1996 to 2014 is Flood at $52.3 million per year.

The natural hazard with the second-highest property loss in Vermont is Winter Storm & Extreme Cold at $1.9 million per year.
Electric Power Plants: 67 (1% total U.S.)
- Coal-fired: 0 (0% total U.S.)
- Petroleum-fired: 10 (<1% total U.S.)
- Natural Gas-fired: 0 (0% total U.S.)
- Nuclear: 1 (1% total U.S.)
- Hydro-electric: 45 (2% total U.S.)
- Other Renewable: 11 (<1% total U.S.)

Transmission Lines:
- High-Voltage (>230 kV): 31 Miles
- Low-Voltage (<230 kV): 1,134 Miles
Electric Transmission

- According to NERC, the leading cause of electric transmission outages in Vermont is Faulty Equipment/Human Error.
- Vermont experienced 19 electric transmission outages from 1992 to 2009, affecting a total of 165,502 electric customers.
- Severe Weather - Ice Storm affected the largest number of electric customers as a result of electric transmission outages.


Number of NERC-Reported Electric Transmission Outages by Cause (1992–2009)

<table>
<thead>
<tr>
<th>Cause</th>
<th>Number of Outages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faulty Equipment / Human Error</td>
<td>163,000</td>
</tr>
<tr>
<td>Severe Weather - Heat Wave</td>
<td>3</td>
</tr>
<tr>
<td>Severe Weather - Ice Storm</td>
<td>1</td>
</tr>
<tr>
<td>Complete Electrical System Failure</td>
<td>1</td>
</tr>
<tr>
<td>Fuel Supply Deficiency</td>
<td>1</td>
</tr>
<tr>
<td>All Other Causes</td>
<td>11</td>
</tr>
</tbody>
</table>

Data Source: NERC

Electric Distribution

- Between 2008 and 2013, the greatest number of electric outages in Vermont has occurred during the month of December.
- The leading cause of electric outages in Vermont during 2008 to 2013 was Weather/Falling Trees.
- On average, the number of people affected annually by electric outages during 2008 to 2013 in Vermont was 69,732.
- The average duration of electric outages in Vermont during 2008 to 2013 was 2,012 minutes or 33.5 hours a year.

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

NOTE: # of Incidents – The number within each pie slice is the number of event incidents attributable to each cause.


- Animal: 10
- Faulty Equipment / Human Error: 46
- Overdemand: 16
- Planned: 0
- Theft / Vandalism: 7
- Unknown: 2
- Vehicle Accident: 2
- Weather / Falling Trees: 12

Utility Outage Data (2008–2013)

Data Source: Eaton
PETROLEUM

Petroleum Infrastructure Overview
- Refineries: 0 (0% total U.S.)
- Terminals: 3 (<1% total U.S.)
- Crude Pipelines: 126 Miles (<1% total U.S.)
- Product Pipelines: 60 Miles (<1% total U.S.)
- Bio-Refineries (Ethanol): 0 (0% total U.S.)
Petroleum Transport

- The leading event type affecting the transport of petroleum product by rail and truck in Vermont during 1986 to 2014 was Miscellaneous/Unknown for rail transport and Miscellaneous/Unknown for truck transport, with an average 0.1 and 1.3 incidents per year, respectively.

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

- The leading event type affecting crude oil pipelines in Vermont during 1986 to 2014 was Natural Forces, with an average 0.07 incidents per year (or one incident every 14.5 years). There are no product pipelines in the State of Vermont.

Top Events Affecting Crude Oil and Refined Product Pipelines in Vermont (1986–2014)

Data Source: DOT PHMSA
NATURAL GAS

Natural Gas Infrastructure Overview
Gas Wells: 0 (0% total U.S.)
Processing Plants: 0 (0% total U.S.)
Storage Fields: 0 (0% total U.S.)
Interstate Pipelines: 120 Miles (<1% total U.S.)
Local Distribution Companies: 3 (<1% total U.S.)
Natural Gas Transport

The leading event type affecting natural gas distribution pipelines in Vermont during 1986 to 2014 was **Natural Forces**, with an average **0.13 incidents** per year (or one incident every 7.7 years). There are no natural gas transmission pipelines in the State of Vermont.


<table>
<thead>
<tr>
<th>Event Type</th>
<th>Economic Loss</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrosion</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Equipment Failure</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Excavation Damage</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Incorrect Operation</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Material / Weld Failures</td>
<td>$10</td>
<td>$0</td>
</tr>
<tr>
<td>Miscellaneous / Unknown</td>
<td>$27</td>
<td>$0</td>
</tr>
<tr>
<td>Natural Forces</td>
<td>$648</td>
<td>0.13</td>
</tr>
<tr>
<td>Outside Force</td>
<td>$0</td>
<td>0.03</td>
</tr>
</tbody>
</table>

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.

FOR MORE INFORMATION CONTACT:
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Office of Electricity Delivery and Energy Reliability
U.S. Department of Energy
email: energyanalysis@hq.doe.gov

**Abbreviations**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Bcf</td>
<td>Billion Cubic Feet</td>
</tr>
<tr>
<td>GW</td>
<td>Gigawatt</td>
</tr>
<tr>
<td>kV</td>
<td>Kilovolt</td>
</tr>
<tr>
<td>Mbarrels</td>
<td>Thousand Barrels</td>
</tr>
<tr>
<td>Mmbpd</td>
<td>Thousand Barrels per Day</td>
</tr>
<tr>
<td>MMcf</td>
<td>Million Cubic Feet per Day</td>
</tr>
<tr>
<td>MSTN</td>
<td>Thousand Short Tons</td>
</tr>
<tr>
<td>TWh</td>
<td>Terawatt hours</td>
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</tbody>
</table>