State of Pennsylvania
ENERGY SECTOR RISK PROFILE

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

PENNSYLVANIA STATE FACTS

<table>
<thead>
<tr>
<th>State Overview</th>
<th>Annual Energy Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population: 12.77 million (4% total U.S.)</td>
<td>Electric Power Generation: 223.4 TWh (6% total U.S.)</td>
</tr>
<tr>
<td>Housing Units: 5.57 million (4% total U.S.)</td>
<td>Coal: 87.1 TWh, 39% [18.9 GW total capacity]</td>
</tr>
<tr>
<td>Business Establishments: 0.30 million (4% total U.S.)</td>
<td>Petroleum: 0.3 TWh, &lt;1% [3 GW total capacity]</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Annual Energy Consumption</th>
<th>Annual Energy Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Power: 144.7 TWh (4% total U.S.)</td>
<td>Coal: 87.1 TWh, 39% [18.9 GW total capacity]</td>
</tr>
<tr>
<td>Coal: 43,400 MSTN (5% total U.S.)</td>
<td>Petroleum: 0.3 TWh, &lt;1% [3 GW total capacity]</td>
</tr>
<tr>
<td>Natural Gas: 919 Bcf (4% total U.S.)</td>
<td>Natural Gas: 53.1 TWh, 24% [13.3 GW total capacity]</td>
</tr>
<tr>
<td>Motor Gasoline: 85,400 Mbarrels (3% total U.S.)</td>
<td>Nuclear: 75.2 TWh, 34% [10 GW total capacity]</td>
</tr>
<tr>
<td>Distillate Fuel: 59,000 Mbarrels (4% total U.S.)</td>
<td>Hydro: 1.8 TWh, &lt;1% [2.3 GW total capacity]</td>
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<tr>
<td></td>
<td>Other Renewable: 2.1 TWh, &lt;1% [1.5 GW total capacity]</td>
</tr>
<tr>
<td></td>
<td>Coal: 55,500 MSTN (5% total U.S.)</td>
</tr>
<tr>
<td></td>
<td>Natural Gas: 2,260 Bcf (9% total U.S.)</td>
</tr>
<tr>
<td></td>
<td>Crude Oil: 4,300 Mbarrels (&lt;1% total U.S.)</td>
</tr>
<tr>
<td></td>
<td>Ethanol: 2,500 Mbarrels (1% total U.S.)</td>
</tr>
</tbody>
</table>

NATURAL HAZARDS OVERVIEW

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

- According to NOAA, the most common natural hazard in Pennsylvania is Thunderstorm & Lightning, which occurs once every 3.4 days on the average during the months of March to October.
- The second-most common natural hazard in Pennsylvania is Winter Storm & Extreme Cold, which occurs once every 7 days on the average during the months of October to March.

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

- As reported by NOAA, the natural hazard in Pennsylvania that caused the greatest overall property loss during 1996 to 2014 is Flood at $91.6 million per year.
- The natural hazard with the second-highest property loss in Pennsylvania is Drought at $24.1 million per year.
Electric Power Plants: 182 (1% total U.S.)
- Coal-fired: 36 (3% total U.S.)
- Petroleum-fired: 38 (2% total U.S.)
- Natural Gas-fired: 37 (1% total U.S.)
- Nuclear: 5 (4% total U.S.)
- Hydro-electric: 19 (1% total U.S.)
- Other Renewable: 47 (2% total U.S.)

Transmission Lines:
- High-Voltage (>230 kV): 1,046 Miles
- Low-Voltage (<230 kV): 350 Miles
Electric Transmission

- According to NERC, the leading cause of electric transmission outages in Pennsylvania is Faulty Equipment/Human Error.
- Pennsylvania experienced 34 electric transmission outages from 1992 to 2009, affecting a total of 2,270,811 electric customers.
- Severe Weather - High Winds 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)

- Faulty Equipment / Human Error
- Severe Weather - High Winds
- Severe Weather - Thunderstorm
- Natural Disaster - Hurricane / Tropical Storm
- Severe Weather - Winter Storm
- All Other Causes

Severe Weather - High Winds affected the largest number of electric customers as a result of electric transmission outages.

Electric Distribution

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

- Between 2008 and 2013, the greatest number of electric outages in Pennsylvania has occurred during the month of July.
- The leading cause of electric outages in Pennsylvania during 2008 to 2013 was Weather/Falling Trees.
- On average, the number of people affected annually by electric outages during 2008 to 2013 in Pennsylvania was 837,355.
- The average duration of electric outages in Pennsylvania during 2008 to 2013 was 8,922 minutes or 148.7 hours a year.


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

**Petroleum Infrastructure Overview**
- Refineries: 4 (3% total U.S.)
- Terminals: 73 (4% total U.S.)
- Crude Pipelines: 26 Miles (<1% total U.S.)
- Product Pipelines: 4,140 Miles (1% total U.S.)
- Bio-Refineries (Ethanol): 0 (0% 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 Pennsylvania during 1986 to 2014 was Incorrect Operation for rail transport and Miscellaneous/Unknown for truck transport, with an average 1.4 and 28.2 incidents per year, respectively.

Petroleum Refinery

The leading cause of petroleum refinery disruptions in Pennsylvania from 2003 to 2014 was Equipment Failure or Damage. Pennsylvania’s petroleum refineries experienced 289 major incidents from 2003 to 2014. The average production impact from disruptions of Pennsylvania’s refineries from 2003 to 2014 is 41.3 thousand barrels per day.
**NATURAL GAS**

**Natural Gas Infrastructure Overview**
- Gas Wells: 57,068 (12% total U.S.)
- Processing Plants: 10 (2% total U.S.)
- Storage Fields: 54 (12% total U.S.)
- Interstate Pipelines: 8,820 Miles (2% total U.S.)
- Local Distribution Companies: 36 (2% total U.S.)

[Map of Pennsylvania showing natural gas infrastructure]
Natural Gas Transport

The leading event type affecting natural gas transmission and distribution pipelines in Pennsylvania during 1986 to 2014 was **Corrosion** for Transmission Pipelines and **Outside Force** for Distribution Pipelines, with an average 0.61 (or one incident every 1.6 years) and 2.19 incidents per year, respectively.

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

<table>
<thead>
<tr>
<th>Event Type</th>
<th>Economic Loss</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission Pipelines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrosion</td>
<td>$218,448</td>
<td>0.61</td>
</tr>
<tr>
<td>Equipment Failure</td>
<td>$63,0</td>
<td>0.32</td>
</tr>
<tr>
<td>Excavation Damage</td>
<td>$8,470</td>
<td>0.03</td>
</tr>
<tr>
<td>Incorrect Operation</td>
<td>$17,171</td>
<td>0.03</td>
</tr>
<tr>
<td>Material / Weld Failures</td>
<td>$6,73,1,029</td>
<td>0.06</td>
</tr>
<tr>
<td>Miscellaneous / Unknown</td>
<td>$3,62</td>
<td>0.42</td>
</tr>
<tr>
<td>Natural Forces</td>
<td>$3,285</td>
<td>0.45</td>
</tr>
<tr>
<td>Outside Force</td>
<td>$2,835</td>
<td>1.58</td>
</tr>
<tr>
<td>Distribution Pipelines</td>
<td></td>
<td>2.19</td>
</tr>
</tbody>
</table>

Data Source: DOT PHMSA

Natural Gas Processing

According to data derived from DOE’s Energy Assurance Daily, the leading cause of natural gas processing plant disruptions in Pennsylvania from 2005 to 2014 is **Cause Not Specified**.

Pennsylvania’s natural gas processing plants experienced 2 disruptions from 2005 to 2014.

The average production impact from disruptions of Pennsylvania’s natural gas processing plants from 2005 to 2014 is 355 million cubic feet per day (MMcfd).


- **Cause Not Specified**: 1 incident
- **Weather or Natural Disaster**: 1 incident

Data Source: DOE OE

### Average Production Impact (MMcfd) from Natural Gas Processing Plant Disruptions in Pennsylvania (2005–2014)

- **Cause Not Specified**: 355 MMcfd
- **Weather or Natural Disaster**: 355 MMcfd
- **Faring**: 0
- **Plant Conversion**: 0
- **N.A.**: 0

Data Source: DOE OE
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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