State of Virginia
ENERGY SECTOR RISK PROFILE

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

VIRGINIA STATE FACTS

State Overview
Population: 8.26 million (3% total U.S.)
Housing Units: 3.41 million (3% total U.S.)
Business Establishments: 0.19 million (3% total U.S.)

Annual Energy Consumption
Electric Power: 107.8 TWh (3% total U.S.)
Coal: 7,900 MSTN (1% total U.S.)
Natural Gas: 8 Bcf (<1% total U.S.)
Motor Gasoline: 84,800 Mbarrels (3% total U.S.)
Distillate Fuel: 31,500 Mbarrels (2% total U.S.)

Annual Energy Production
Electric Power Generation: 70.7 TWh (2% total U.S.)
Coal: 14.2 TWh, 20% [6.4 GW total capacity]
Petroleum: 0.4 TWh, <1% [2.8 GW total capacity]
Natural Gas: 25.0 TWh, 35% [9.1 GW total capacity]
Nuclear: 28.7 TWh, 41% [3.7 GW total capacity]
Hydro: 0.3 TWh, <1% [3.9 GW total capacity]
Other Renewable: 0 TWh, 0% [0.4 GW total capacity]

NATURAL HAZARDS OVERVIEW

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

- According to NOAA, the most common natural hazard in Virginia is Thunderstorm & Lightning, which occurs once every 3 days on the average during the months of March to October.
- The second-most common natural hazard in Virginia is Flood, which occurs once every 9 days on the average.

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

- As reported by NOAA, the natural hazard in Virginia that caused the greatest overall property loss during 1996 to 2014 is Hurricane at $37.6 million per year.
- The natural hazard with the second-highest property loss in Virginia is Flood at $27.0 million per year.
ENERGY SECTOR RISK PROFILE

State of Virginia

ELECTRIC

Electric Power Plants: 113 (1% total U.S.)
- Coal-fired: 22 (2% total U.S.)
- Petroleum-fired: 36 (2% total U.S.)
- Natural Gas-fired: 20 (1% total U.S.)
- Nuclear: 2 (2% total U.S.)
- Hydro-electric: 27 (1% total U.S.)
- Other Renewable: 6 (<1% total U.S.)

Transmission Lines:
- High-Voltage (>230 kV): 1,249 Miles
- Low-Voltage (<230 kV): 374 Miles
Electric Transmission

- According to NERC, the leading cause of electric transmission outages in Virginia is **Severe Weather - Thunderstorm**.
- Virginia experienced **33 electric transmission outages** from 1992 to 2009, affecting a total of **5,205,983** electric customers.
- **Natural Disaster - Hurricane/Tropical Storm** affected the largest number of electric customers as a result of electric transmission outages.

### Electric Customers Disrupted by 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>Severe Weather - Thunderstorm</td>
<td>2,583,316</td>
</tr>
<tr>
<td>Natural Disaster - Hurricane/Tropical Storm</td>
<td>37,000</td>
</tr>
<tr>
<td>Faulty Equipment / Human Error</td>
<td>909,000</td>
</tr>
<tr>
<td>Severe Weather - Ice Storm</td>
<td>909,001</td>
</tr>
<tr>
<td>Severe Weather - Winter Storm</td>
<td></td>
</tr>
<tr>
<td>All Other Causes</td>
<td></td>
</tr>
</tbody>
</table>

Data Source: NERC

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

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

![Pie Chart: Number of NERC-Reported Electric Transmission Outages by Cause (1992–2009)](chart.png)

**# of incidents**

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 Virginia has occurred during the month of **June**.

- The leading cause of electric outages in Virginia during 2008 to 2013 was **Weather/Falling Trees**.
- On average, the number of people affected annually by electric outages during 2008 to 2013 in Virginia was **731,620**.
- The average duration of electric outages in Virginia during 2008 to 2013 was **4,423 minutes** or **73.7 hours** a year.

### Causes of Electric-Utility Reported Outages (2008–2013)

- **Animal**: 168
- **Faulty Equipment / Human Error**: 125
- **Overdemand**: 55
- **Planned**: 52
- **Theft / Vandalism**: 36
- **Unknown**: 36
- **Vehicle Accident**: 25
- **Weather / Falling Trees**: 13
- **Other**: 1

Data Source: Eaton

### Utility Outage Data (2008–2013)

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

Data Source: Eaton

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

- Refineries: 0 (0% total U.S.)
- Terminals: 45 (2% total U.S.)
- Crude Pipelines: 0 Miles (0% total U.S.)
- Product Pipelines: 900 Miles (<1% total U.S.)
- Bio-Refineries (Ethanol): 1 (<1% total U.S.)
Petroleum Transport

The leading event type affecting the transport of petroleum product by rail and truck in Virginia during 1986 to 2014 was Incorrect Operation for rail transport and Miscellaneous/Unknown for truck transport, with an average 1.1 and 8.0 incidents per year, respectively.

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

The leading event type affecting petroleum product pipelines in Virginia during 1986 to 2014 was Outside Force, with an average 0.34 incidents per year (or one incident every 2.9 years). There are no crude oil pipelines in the State of Virginia.

Top Events Affecting Crude Oil and Refined Product Pipelines in Virginia (1986–2014)
**NATURAL GAS**

**Natural Gas Infrastructure Overview**
- Gas Wells: 7,864 (2% total U.S.)
- Processing Plants: 0 (0% total U.S.)
- Storage Fields: 3 (1% total U.S.)
- Interstate Pipelines: 2,880 Miles (1% total U.S.)
- Local Distribution Companies: 20 (1% total U.S.)

Data Sources: ANL 2013; EIA 2014; ESRI 2012; Platts 2014; NPMS 2011.
Natural Gas Transport

The leading event type affecting natural gas transmission and distribution pipelines in Virginia during 1986 to 2014 was **Outside Force** for Transmission Pipelines and **Outside Force** for Distribution Pipelines, with an average 0.16 (or one incident every 6.2 years) and 1.52 incidents per year, respectively.


- **Corrosion**: $199,000
- **Equipment Failure**: $34,000
- **Excavation Damage**: $42,000
- **Incorrect Operation**: $45,000
- **Material / Weld Failures**: $7,000
- **Miscellaneous / Unknown**: $38,000
- **Natural Forces**: $130,000
- **Outside Force**: $38,000

**Economic Loss** and **Frequency**

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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