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 (3% 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]
- Hydros: 0.3 TWh, <1% [3.9 GW total capacity]
- Other Renewable: 0 TWh, 0% [0.4 GW total capacity]

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

- Drought: $18.4 million/year
- Earthquake: $0.1 million/year
- Extreme Heat: $0.0 million/year
- Flood: $27.0 million/year
- Hurricane: $37.6 million/year
- Lead Poisoning: $0.0 million/year
- Other: $0.0 million/year
- Tornado: $11.4 million/year
- Wildfire: $0.4 million/year
- Winter Storm & Extreme Cold: $3.1 million/year

Data Source: NOAA

- 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.
- 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.
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.


![Bar chart showing the number of electric transmission outages by cause with Severe Weather - Thunderstorm at 2,583,316, Natural Disaster - Hurricane/Tropical Storm at 37,000, Faulty Equipment / Human Error at 709,000, Severe Weather - Ice at 249,927, and Severe Weather - Winter Storm at 909,001.]

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

![Pie chart showing the number of incidents with Severe Weather - Thunderstorm at 9, Natural Disaster - Hurricane/Tropical Storm at 10, Faulty Equipment / Human Error at 3, Severe Weather - Ice at 4, Severe Weather - Winter Storm at 4, All Other Causes at 3, and # of incidents at 100.]

Electric Distribution

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

![Bar chart showing the number of electric outages by month with the greatest number occurring in June.]


![Pie chart showing the number of incidents with Animal at 168, Faulty Equipment / Human Error at 125, Overload at 55, Planned at 52, Theft / Vandalism at 36, Unknown at 13, Vehicle Accident at 0, and Weather / Falling Trees at 1.]

**Utility Outage Data (2008–2013)**

![Graph showing the total number of people affected by outages and the total duration of outages in minutes.]

- 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**.

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

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.)

Produced by Department of Energy (DOE), Office of Electricity Delivery & Energy Reliability (OE)
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**
- **Equipment Failure**
- **Excavation Damage**
- **Incorrect Operation**
- **Material / Weld Failures**
- **Miscellaneous / Unknown**
- **Natural Forces**
- **Outside Force**

**Economic Loss**

- **Corrosion**: $199
- **Equipment Failure**: $9
- **Excavation Damage**: $42
- **Incorrect Operation**: $45
- **Material / Weld Failures**: $7
- **Miscellaneous / Unknown**: $38
- **Natural Forces**: $130
- **Outside Force**: $28

**Frequency**

- **Transmission**
- **Distribution**

Data Source: DOT PHMSA
**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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