This State Energy Risk Profile examines the relative magnitude of the risks that the state of Tennessee’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. Certain natural and adversarial threats, such as cybersecurity, electromagnetic pulse, geomagnetic disturbance, pandemics, or impacts caused by infrastructure interdependencies, are ill-suited to location-based probabilistic risk assessment as they may not adhere to geographic boundaries, have limited occurrence, or have limited historic data. Cybersecurity and other threats not included in these profiles are ever present and should be included in state energy security planning. A complete list of data sources and national level comparisons can be found in the Data Sources document.

Tennessee Risks and Hazards Overview

• The natural hazard that caused the greatest overall property loss between 2009 and 2019 was Flooding at $481 million per year (leading cause nationwide at $12 billion per year).
• Tennessee had 163 Major Disaster Declarations, 0 Emergency Declarations, and 6 Fire Management Assistance Declarations for 11 events between 2013 and 2019.
• Tennessee registered 15% fewer Heating Degree Days and 22% greater Cooling Degree Days than average in 2019.
• There is 1 Fusion Center located in Nashville.

Annualized Frequency of and Property Damage Due to Natural Hazards, 2009 – 2019

<table>
<thead>
<tr>
<th>HAZARD FREQUENCY – Annualized</th>
<th>PROPERTY DAMAGE – Annualized ($Million per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drought</td>
<td>6</td>
</tr>
<tr>
<td>Earthquake (≥ 3.5 M)</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Extreme Heat</td>
<td>5</td>
</tr>
<tr>
<td>Flood</td>
<td>42</td>
</tr>
<tr>
<td>Hurricane</td>
<td>0</td>
</tr>
<tr>
<td>Landslide</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Thunderstorm &amp; Lightning</td>
<td>123</td>
</tr>
<tr>
<td>Tornado</td>
<td>15</td>
</tr>
<tr>
<td>Wildfire</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Winter Storm &amp; Extreme Cold</td>
<td>27</td>
</tr>
</tbody>
</table>

Data Sources: NOAA and USGS
State of Tennessee | ENERGY SECTOR RISK PROFILE

ELECTRIC

Produced by Department of Energy (DOE), Office of Cybersecurity, Energy Security, and Emergency Response (CESER)

MARCH 2021 PAGE 2

Power Plants
Installed Capacity (Megawatts)
- 50 - 250 MW
- 251 - 750 MW
- 751 - 1,500 MW
- 1,501 - 3,000 MW
- 3,501 - 6,500+ MW

Primary Generation Source
- Coal
- Hydro
- Natural Gas
- Nuclear
- Oil
- Renewable

Transmission Lines (Kilovolts)
- 220 - 315 kV
- 345 - 450 kV
- 500 - 525 kV
- 735 - 765 kV
- 1,000 kV (DC)

Utility Company*
*Shaded by Company

Data Sources: ANL 2019; ESRI 2019; EIA 2019; Platts 2019.
Electric Infrastructure

- Tennessee has 83 electric utilities:
  - 0 Investor owned
  - 21 Cooperative
  - 61 Municipal
  - 1 Other utility
- Plant retirements scheduled by 2025: 1 electric generating unit totaling 889 MW of installed capacity.

Electric Customers and Consumption by Sector, 2018

<table>
<thead>
<tr>
<th>Sector</th>
<th>Customers</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>85%</td>
<td>43%</td>
</tr>
<tr>
<td>Commercial</td>
<td>15%</td>
<td>36%</td>
</tr>
<tr>
<td>Industrial</td>
<td>&lt;1%</td>
<td>21%</td>
</tr>
<tr>
<td>Transportation</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

Data Source: EIA

Electric Utility-Reported Outages by Cause, 2008 – 2017

<table>
<thead>
<tr>
<th>Year</th>
<th>Animal</th>
<th>Faulty Equipment / Human Error</th>
<th>Overdemand</th>
<th>Theft / Vandalism</th>
<th>Planned</th>
<th>Unknown</th>
<th>Vehicle Accident</th>
<th>Weather / Falling Trees</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>9%</td>
<td>50%</td>
<td>1%</td>
<td>11%</td>
<td>7%</td>
<td>13%</td>
<td>11%</td>
<td>22%</td>
</tr>
<tr>
<td>2009</td>
<td>11%</td>
<td>130%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>2010</td>
<td>7%</td>
<td>22%</td>
<td>1%</td>
<td>13%</td>
<td>9%</td>
<td>2%</td>
<td>9%</td>
<td>37%</td>
</tr>
<tr>
<td>2011</td>
<td>9%</td>
<td>22%</td>
<td>1%</td>
<td>11%</td>
<td>7%</td>
<td>13%</td>
<td>11%</td>
<td>22%</td>
</tr>
<tr>
<td>2012</td>
<td>9%</td>
<td>22%</td>
<td>1%</td>
<td>13%</td>
<td>7%</td>
<td>13%</td>
<td>11%</td>
<td>22%</td>
</tr>
<tr>
<td>2013</td>
<td>9%</td>
<td>22%</td>
<td>1%</td>
<td>13%</td>
<td>7%</td>
<td>13%</td>
<td>11%</td>
<td>22%</td>
</tr>
<tr>
<td>2014</td>
<td>9%</td>
<td>22%</td>
<td>1%</td>
<td>13%</td>
<td>7%</td>
<td>13%</td>
<td>11%</td>
<td>22%</td>
</tr>
<tr>
<td>2015</td>
<td>9%</td>
<td>22%</td>
<td>1%</td>
<td>13%</td>
<td>7%</td>
<td>13%</td>
<td>11%</td>
<td>22%</td>
</tr>
<tr>
<td>2016</td>
<td>9%</td>
<td>22%</td>
<td>1%</td>
<td>13%</td>
<td>7%</td>
<td>13%</td>
<td>11%</td>
<td>22%</td>
</tr>
</tbody>
</table>

Note: This chart uses a logarithmic scale to display a very wide range of values.
Data Source: Eaton

In 2018, the average Tennessee electric customer experienced 1.8 service interruptions that lasted an average of 3.3 hours.

In Tennessee, between 2008 and 2017:
- The greatest number of electric outages occurred in May (9th for outages nationwide)
- The leading cause of electric outages was Weather or Falling Trees (leading cause nationwide)
- Electric outages affected 252,400 customers on average
Natural Gas Transport

Top Events Affecting Natural Gas Transmission and Distribution, 1984 – 2019

- As of 2018, Tennessee had:
  - 4,937 miles of natural gas transmission pipelines
  - 40,327 miles of natural gas distribution pipelines

- 74% of Tennessee’s natural gas transmission system and 21% of the distribution system were constructed prior to 1970 or in an unknown year.

- Between 1984 and 2019, Tennessee’s natural gas supply was most impacted by:
  - **Natural Forces** when transported by transmission pipelines (2nd leading cause nationwide at $25.17M per year)
  - **Miscellaneous or Unknown** events when transported by distribution pipelines (2nd leading cause nationwide at $67.89M per year)

**Natural Gas Processing and Liquefied Natural Gas**

Natural Gas Customers and Consumption by Sector, 2018

- Tennessee has 1 natural gas processing facility with a total capacity of 25 MMcf/d.
- Tennessee has 4 liquefied natural gas (LNG) facilities with a total storage capacity of 1,276,000 barrels.
Petroleum Refineries

- Tennessee has 1 petroleum refinery with a total operable capacity of 180 Mb/d.
- Between 2009 and 2019, the leading causes of petroleum refinery disruptions in Tennessee were:
  - General Outages, Repairs, and/or Closures (3rd leading cause nationwide)
  - Maintenance (2nd leading cause nationwide)

Causes and Frequency of Petroleum Refinery Disruptions, 2009 – 2019

- As of 2018, Tennessee had:
  - 395 miles of crude oil pipelines
  - 869 miles of refined product pipelines
  - 0 miles of biofuels pipelines
- 65% of Tennessee’s petroleum pipeline systems were constructed prior to 1970 or in an unknown year.
- Between 1986 and 2019, Tennessee’s petroleum supply was most impacted by:
  - Miscellaneous or Unknown events when transported by truck (3rd leading cause nationwide at $52.87M per year)
  - Incorrect Operations when transported by rail (4th leading cause nationwide at $2.02M per year)
  - Material Failures when transported by crude pipelines (leading cause nationwide at $41.36M per year)
  - Incorrect Operations when transported by product pipelines (7th leading cause nationwide at $3.62M per year)
- Disruptions in other states may impact supply.