State of California
ENERGY SECTOR RISK PROFILE

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

CALIFORNIA STATE FACTS

<table>
<thead>
<tr>
<th>State Overview</th>
<th>Annual Energy Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population: 38.33 million (12% total U.S.)</td>
<td>Electric Power: 259.5 TWh (7% total U.S.)</td>
</tr>
<tr>
<td>Housing Units: 13.79 million (10% total U.S.)</td>
<td>Coal: 1,900 MSTN (&lt;1% total U.S.)</td>
</tr>
<tr>
<td>Business Establishments: 0.86 million (12% total U.S.)</td>
<td>Natural Gas: 2,337 Bcf (10% total U.S.)</td>
</tr>
<tr>
<td></td>
<td>Motor Gasoline: 337,400 Mbarrels (11% total U.S.)</td>
</tr>
<tr>
<td></td>
<td>Distillate Fuel: 87,200 Mbarrels (6% total U.S.)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annual Energy Production</th>
<th>Annualized Property Loss due to Natural Hazards in California (1996–2014)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Power Generation: 199.5 TWh (5% total U.S.)</td>
<td>Drought $0.1, Earthquake $29.1, Flood $193, Hurricane $72.7, Landslide $6.9, Other $1.8, Thunderstorm &amp; Lightning $53.3, Tornado $10.7, Wildfire $164.1</td>
</tr>
<tr>
<td>Coal: 1.4 TWh, &lt;1% [0.4 GW total capacity]</td>
<td>Wildfire $101.7, Winter Storm &amp; Extreme Cold $164.1</td>
</tr>
<tr>
<td>Petroleum: 0.3 TWh, &lt;1% [0.5 GW total capacity]</td>
<td></td>
</tr>
<tr>
<td>Natural Gas: 119.7 TWh, 60% [45.6 GW total capacity]</td>
<td></td>
</tr>
<tr>
<td>Nuclear: 18.5 TWh, 9% [4.6 GW total capacity]</td>
<td></td>
</tr>
<tr>
<td>Hydro: 27.4 TWh, 14% [13.5 GW total capacity]</td>
<td></td>
</tr>
<tr>
<td>Other Renewable: 9.8 TWh, 5% [7.5 GW total capacity]</td>
<td></td>
</tr>
</tbody>
</table>

CALIFORNIA STATE FACTS

NATURAL HAZARDS OVERVIEW

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

- According to NOAA, the most common natural hazard in California 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 California is Earthquake (≥3.5 M), which occurs once every 3.9 days on the average.

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

- As reported by NOAA, the natural hazard in California that caused the greatest overall property loss during 1996 to 2014 is Wildfire at $164.1 million per year.
- The natural hazard with the second-highest property loss in California is Winter Storm & Extreme Cold at $101.7 million per year.
ELECTRIC

Electric Power Plants: 833 (7% total U.S.)
- Coal-fired: 7 (1% total U.S.)
- Petroleum-fired: 12 (1% total U.S.)
- Natural Gas-fired: 274 (8% total U.S.)
- Nuclear: 2 (2% total U.S.)
- Hydro-electric: 261 (9% total U.S.)
- Other Renewable: 277 (10% total U.S.)

Transmission Lines:
- High-Voltage (>230 kV): 4,428 Miles
- Low-Voltage (<230 kV): 10,320 Miles

Power Plants
Nameplate Capacity
- 50 - 250 MW
- 251 - 750 MW
- 751 - 1,500 MW
- 1,501 - 3,000 MW
- 3,501 - 6,500+ MW

Primary Fuel Type
- Coal
- Natural Gas
- Oil
- Uranium
- Water
- Renewable

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

Utility Company*
*Shaded by Company

Data Sources:
Electric Transmission

» According to NERC, the leading cause of electric transmission outages in California is Faulty Equipment/Human Error.
» California experienced 118 electric transmission outages from 1992 to 2009, affecting a total of 19,772,487 electric customers.
» Transmission Line Faults and Overloads affected the largest number of electric customers as a result of electric transmission outages.


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

Between 2008 and 2013, the greatest number of electric outages in California has occurred during the month of December.
» The leading cause of electric outages in California during 2008 to 2013 was Faulty Equipment/Human Error.
» On average, the number of people affected annually by electric outages during 2008 to 2013 in California was 3,810,855.
» The average duration of electric outages in California during 2008 to 2013 was 36,025 minutes or 600.4 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: 20 (14% total U.S.)
- Terminals: 130 (7% total U.S.)
- Crude Pipelines: 3,072 Miles (6% total U.S.)
- Product Pipelines: 71,280 Miles (11% total U.S.)
- Bio-Refineries (Ethanol): 6 (3% 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 California during 1986 to 2014 was Incorrect Operation for rail transport and Miscellaneous/Unknown for truck transport, with an average 8.2 and 21.8 incidents per year, respectively.

Petroleum Refinery

The leading cause of petroleum refinery disruptions in California from 2003 to 2014 was Operational Upset or Process Problem. California’s petroleum refineries experienced 1,331 major incidents from 2003 to 2014. The average production impact from disruptions of California’s refineries from 2003 to 2014 is 18 thousand barrels per day.


Table:

<table>
<thead>
<tr>
<th>Category</th>
<th># of Incidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance/Turnaround</td>
<td>350</td>
</tr>
<tr>
<td>Equipment Failure or Damage</td>
<td>259</td>
</tr>
<tr>
<td>Operational Upset or Process</td>
<td>276</td>
</tr>
<tr>
<td>Loss of Containment/Flaring</td>
<td>335</td>
</tr>
<tr>
<td>All Other Causes</td>
<td>111</td>
</tr>
</tbody>
</table>

Data Source: DOE OE

Average Production Impact (thousand barrels per day) from Petroleum Refinery Outages in California (2003–2014)

Data Source: DOE OE

Produced by Department of Energy (DOE), Office of Electricity Delivery & Energy Reliability (OE)
NATURAL GAS

Natural Gas Infrastructure Overview
Gas Wells: 1,346 (<1% total U.S.)
Processing Plants: 24 (5% total U.S.)
Storage Fields: 14 (3% total U.S.)
Interstate Pipelines: 28,080 Miles (6% total U.S.)
Local Distribution Companies: 12 (1% total U.S.)
Natural Gas Transport

- The leading event type affecting natural gas transmission and distribution pipelines in California during 1986 to 2014 was **Excavation Damage** for Transmission Pipelines and **Outside Force** for Distribution Pipelines, with an average 1.29 and 6.19 incidents per year, respectively.


- **Economic Loss**
  - Corrosion: $211k, $364k
  - Equipment Failure: $93k, $98k
  - Excavation Damage: $595k, $176k
  - Incorrect Operation: $151k, $98k
  - Material / Weld Failures: $83k
  - Miscellaneous / Unknown: $386k
  - Natural Forces: $424k, $2,313k
  - Outside Force: $473k, $6,375k

- **Frequency**
  - Transmission: 0.35, 0.19, 0.06
  - Distribution: 1.13, 1.3, 1.3

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 California from 2005 to 2014 is **Fuel Supply Problem**.
- California’s natural gas processing plants experienced 1 disruption from 2005 to 2014.
- The average production impact from disruptions of California’s natural gas processing plants from 2005 to 2014 is 350 million cubic feet per day (MMcfd).

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

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.
  - Underdemand 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:**

Alice Lippert
Senior Technical Advisor
Office of Electricity Delivery and Energy Reliability
U.S. Department of Energy
email: energyanalysis@hq.doe.gov