

# State of Arizona ENERGY SECTOR RISK PROFILE

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

## ARIZONA STATE FACTS

### State Overview

Population: 6.63 million (2% total U.S.)  
 Housing Units: 2.89 million (2% total U.S.)  
 Business Establishments: 0.13 million (2% total U.S.)

### Annual Energy Consumption

Electric Power: 75.1 TWh (2% total U.S.)  
 Coal: 21,500 MSTN (2% total U.S.)  
 Natural Gas: 278 Bcf (1% total U.S.)  
 Motor Gasoline: 60,300 Mbarrels (2% total U.S.)  
 Distillate Fuel: 24,600 Mbarrels (2% total U.S.)

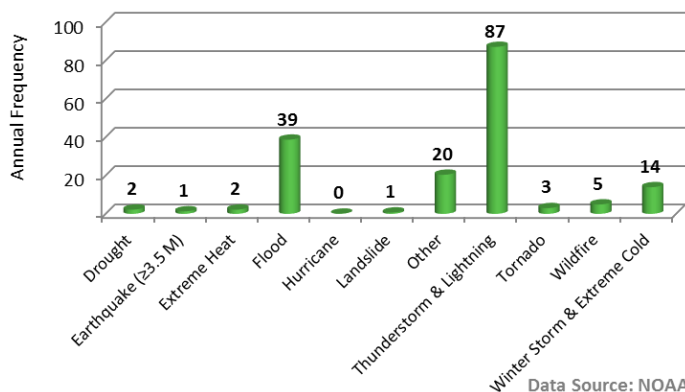
### Annual Energy Production

Electric Power Generation: 110.9 TWh (3% total U.S.)  
 Coal: 40.1 TWh, 36% [6.7 GW total capacity]  
 Petroleum: 0 TWh, <1% [0.1 GW total capacity]  
 Natural Gas: 30.3 TWh, 27% [16.4 GW total capacity]  
 Nuclear: 31.9 TWh, 29% [4.2 GW total capacity]  
 Hydro: 6.8 TWh, 6% [2.9 GW total capacity]  
 Other Renewable: 0.5 TWh, <1% [0.9 GW total capacity]

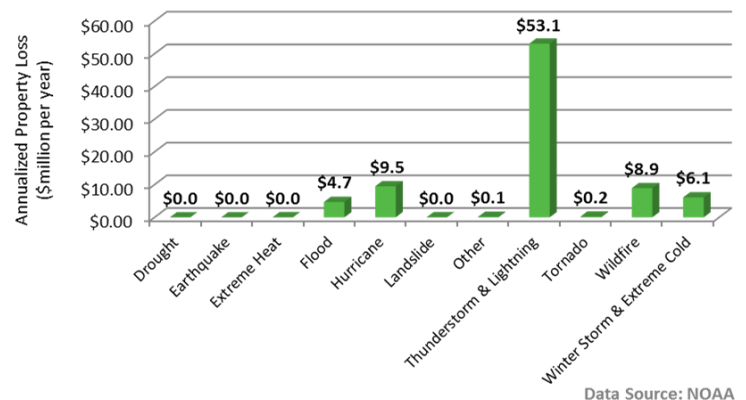
Coal: 7,500 MSTN (1% total U.S.)  
 Natural Gas: 0 Bcf (0% total U.S.)  
 Crude Oil: 100 Mbarrels (<1% total U.S.)  
 Ethanol: 1,000 Mbarrels (<1% total U.S.)

## NATURAL HAZARDS OVERVIEW

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



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



- › According to NOAA, the most common natural hazard in Arizona is Thunderstorm & Lightning, which occurs once every 4.2 days on the average during the months of March to October.
- › The second-most common natural hazard in Arizona is Flood, which occurs once every 9.4 days on the average.

- › As reported by NOAA, the natural hazard in Arizona that caused the greatest overall property loss during 1996 to 2014 is Thunderstorm & Lightning at \$53.1 million per year.
- › The natural hazard with the second-highest property loss in Arizona is Hurricane at \$9.5 million per year.

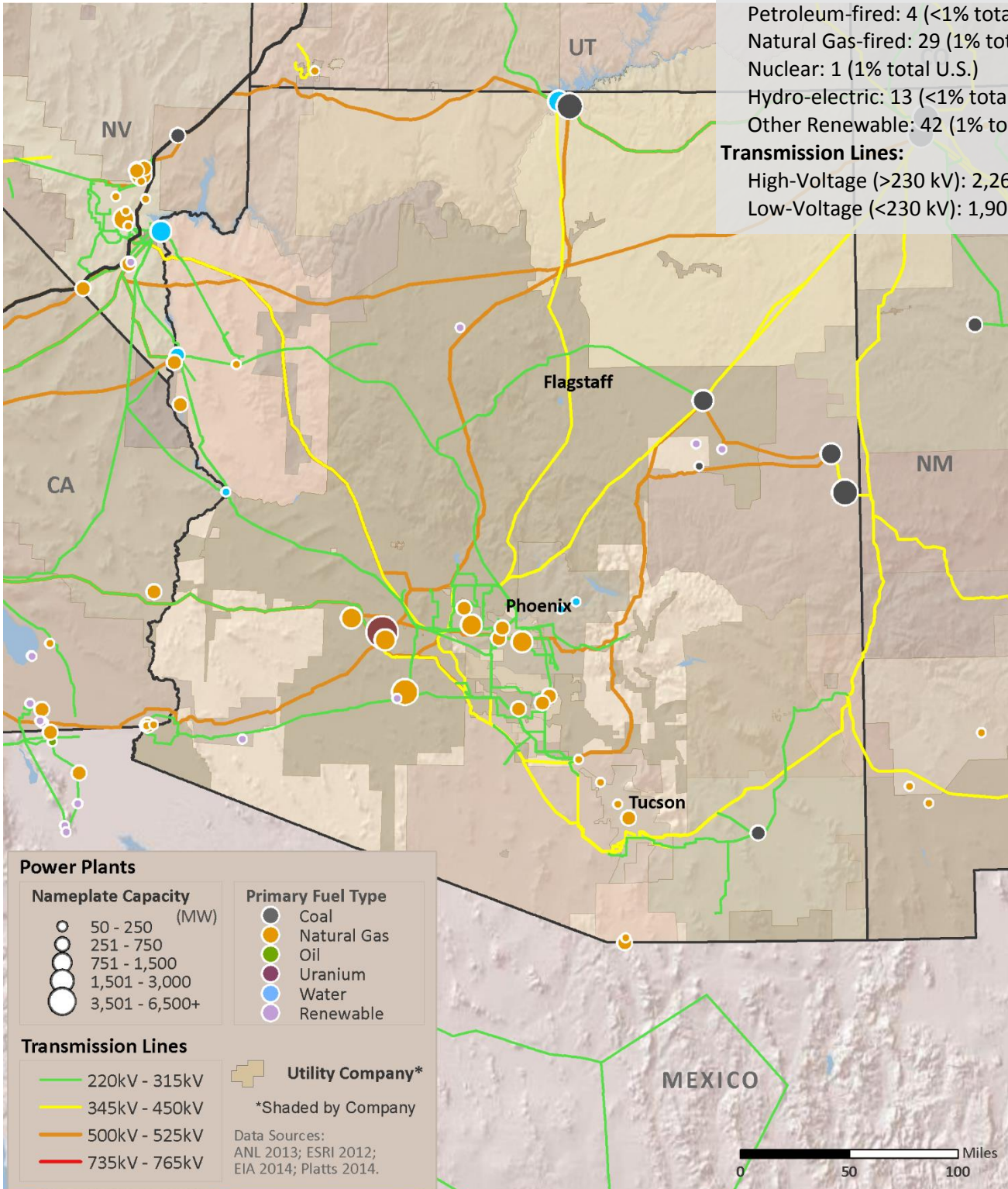
# ELECTRIC

**Electric Power Plants: 95 (1% total U.S.)**

- Coal-fired: 6 (1% total U.S.)
- Petroleum-fired: 4 (<1% total U.S.)
- Natural Gas-fired: 29 (1% total U.S.)
- Nuclear: 1 (1% total U.S.)
- Hydro-electric: 13 (<1% total U.S.)
- Other Renewable: 42 (1% total U.S.)

**Transmission Lines:**

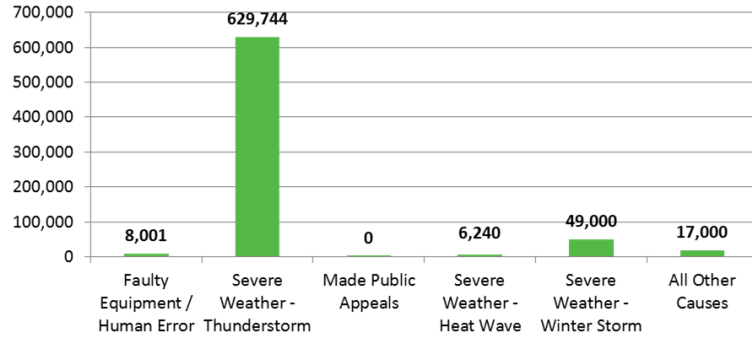
- High-Voltage (>230 kV): 2,268 Miles
- Low-Voltage (<230 kV): 1,906 Miles



# Electric Transmission

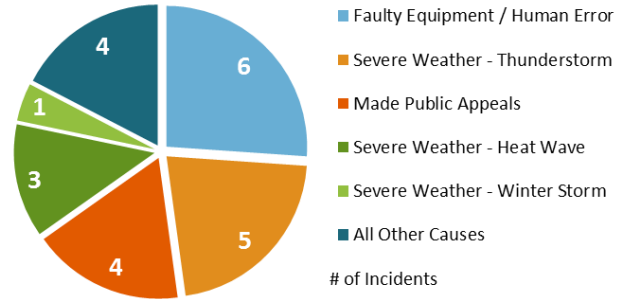
- › According to NERC, the leading cause of electric transmission outages in Arizona is **Faulty Equipment/Human Error**.
- › Arizona experienced **23 electric transmission outages** from 1992 to 2009, affecting a total of **709,985** electric customers.
- › **Severe Weather - Thunderstorm** affected 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)**



Data Source: NERC

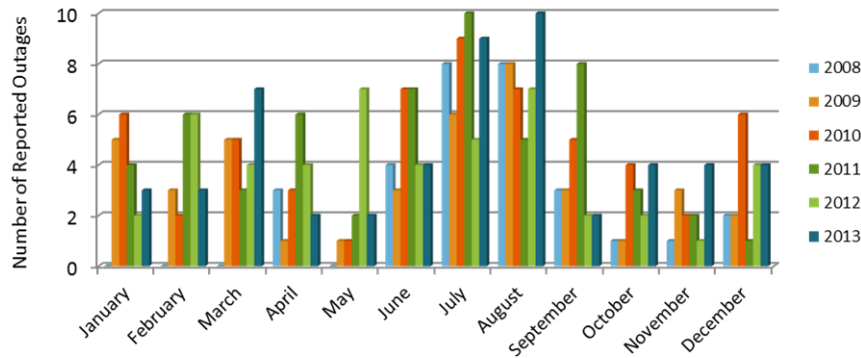
**Number of NERC-Reported Electric Transmission Outages by Cause (1992–2009)**



Data Source: NERC

# Electric Distribution

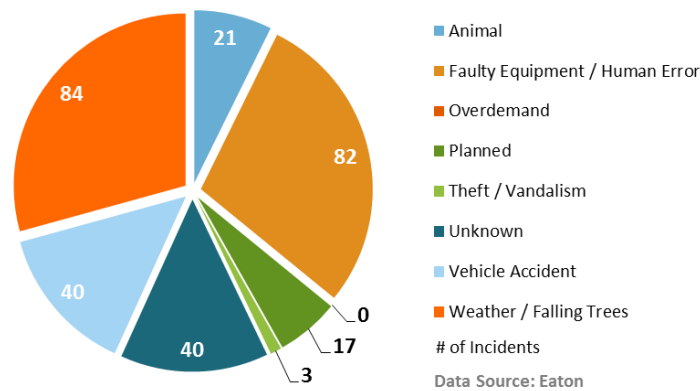
**Electric-Utility Reported Power Outages by Month (2008–2013)**



Data Source: Eaton

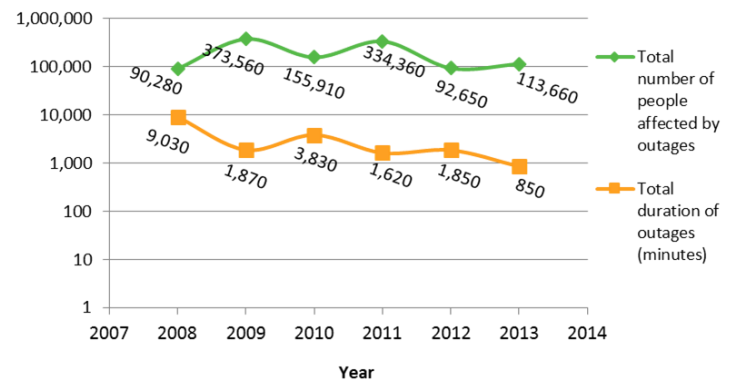
- › Between 2008 and 2013, the greatest number of electric outages in Arizona has occurred during the month of **July**.
- › The leading cause of electric outages in Arizona during 2008 to 2013 was **Weather/Falling Trees**.
- › On average, the number of people affected annually by electric outages during 2008 to 2013 in Arizona was **193,403**.
- › The average duration of electric outages in Arizona during 2008 to 2013 was **3,175 minutes or 52.9 hours a year**.

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



Data Source: Eaton

**Utility Outage Data (2008–2013)**



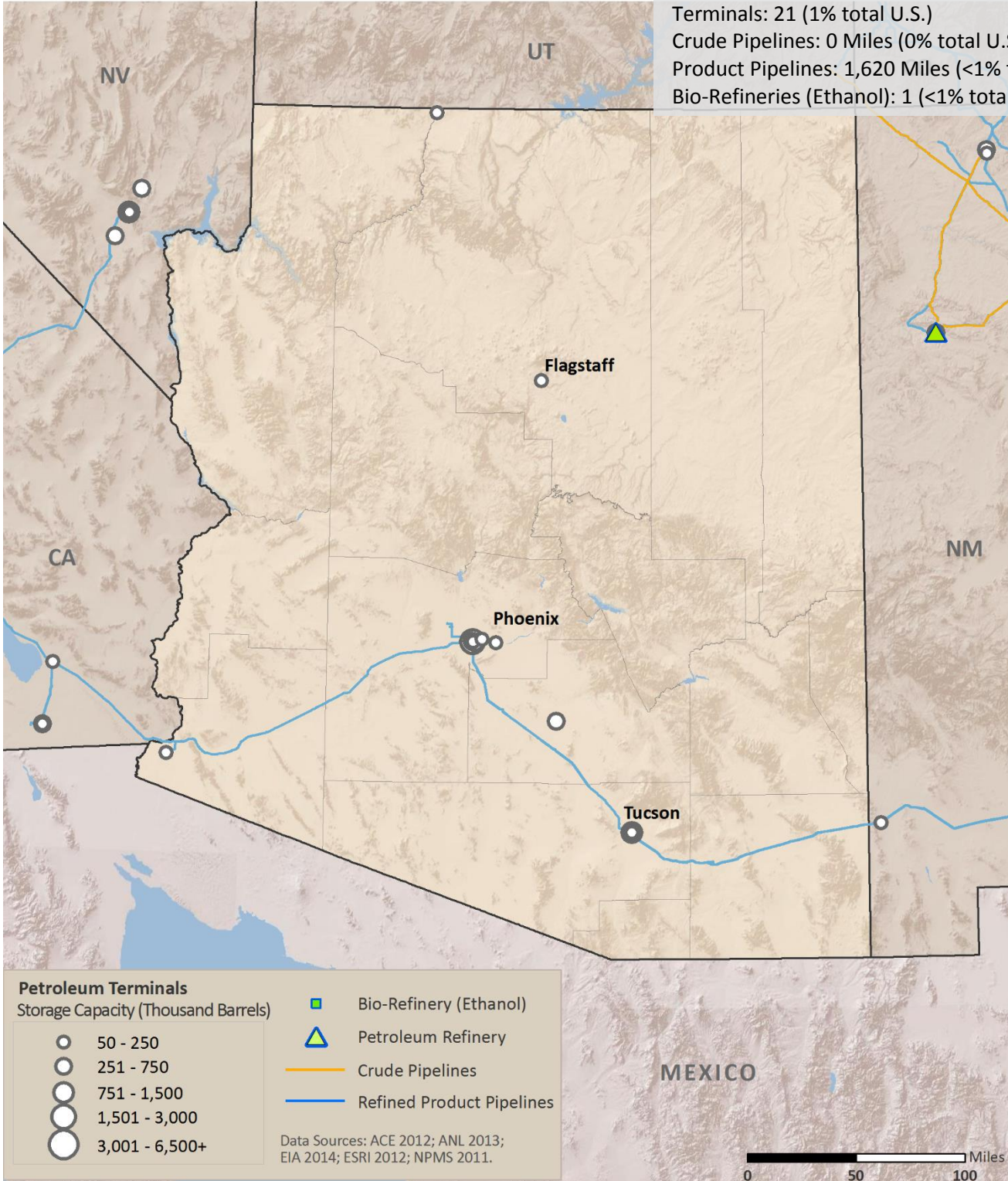
Data Source: Eaton

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

# PETROLEUM

### Petroleum Infrastructure Overview

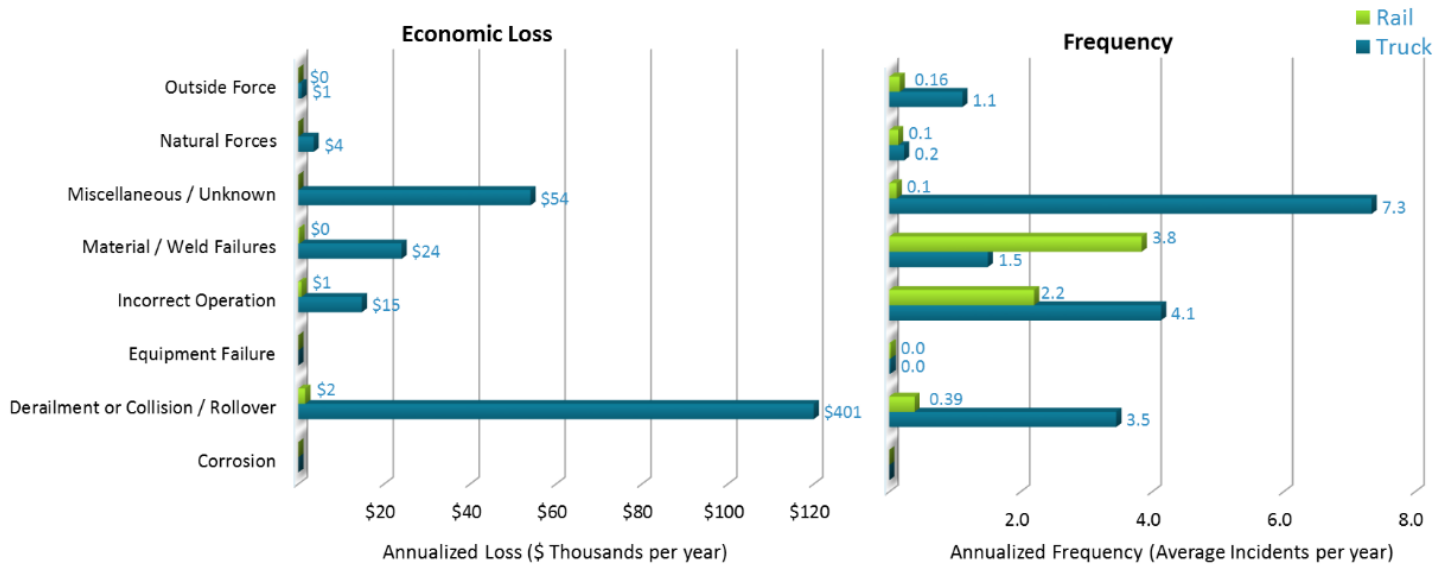
Refineries: 0 (0% total U.S.)  
 Terminals: 21 (1% total U.S.)  
 Crude Pipelines: 0 Miles (0% total U.S.)  
 Product Pipelines: 1,620 Miles (<1% total U.S.)  
 Bio-Refineries (Ethanol): 1 (<1% total U.S.)



# Petroleum Transport

The leading event type affecting the **transport of petroleum product by rail and truck** in Arizona during 1986 to 2014 was **Material/Weld Failures** for rail transport and **Miscellaneous/Unknown** for truck transport, with an average **3.8 and 7.3 incidents** per year, respectively.

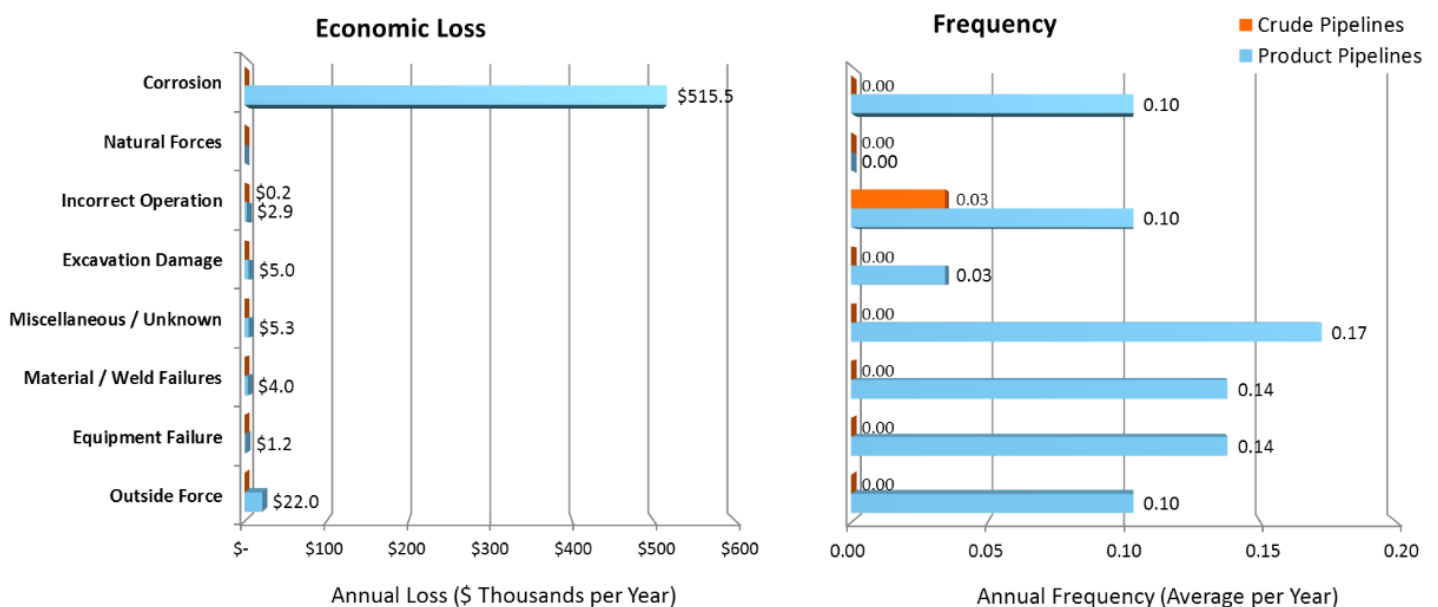
Top Events Affecting Petroleum Transport by Truck and Rail (1986–2014)



Data Source: DOT PHMSA

The leading event type affecting **crude oil pipeline and petroleum product pipelines** in Arizona during 1986 to 2014 was **Incorrect Operation** for crude oil pipelines and **Miscellaneous/Unknown** for product pipelines, with an average **0.03 and 0.17 incidents** per year (or one incident every 29 and 5.8 years), respectively.

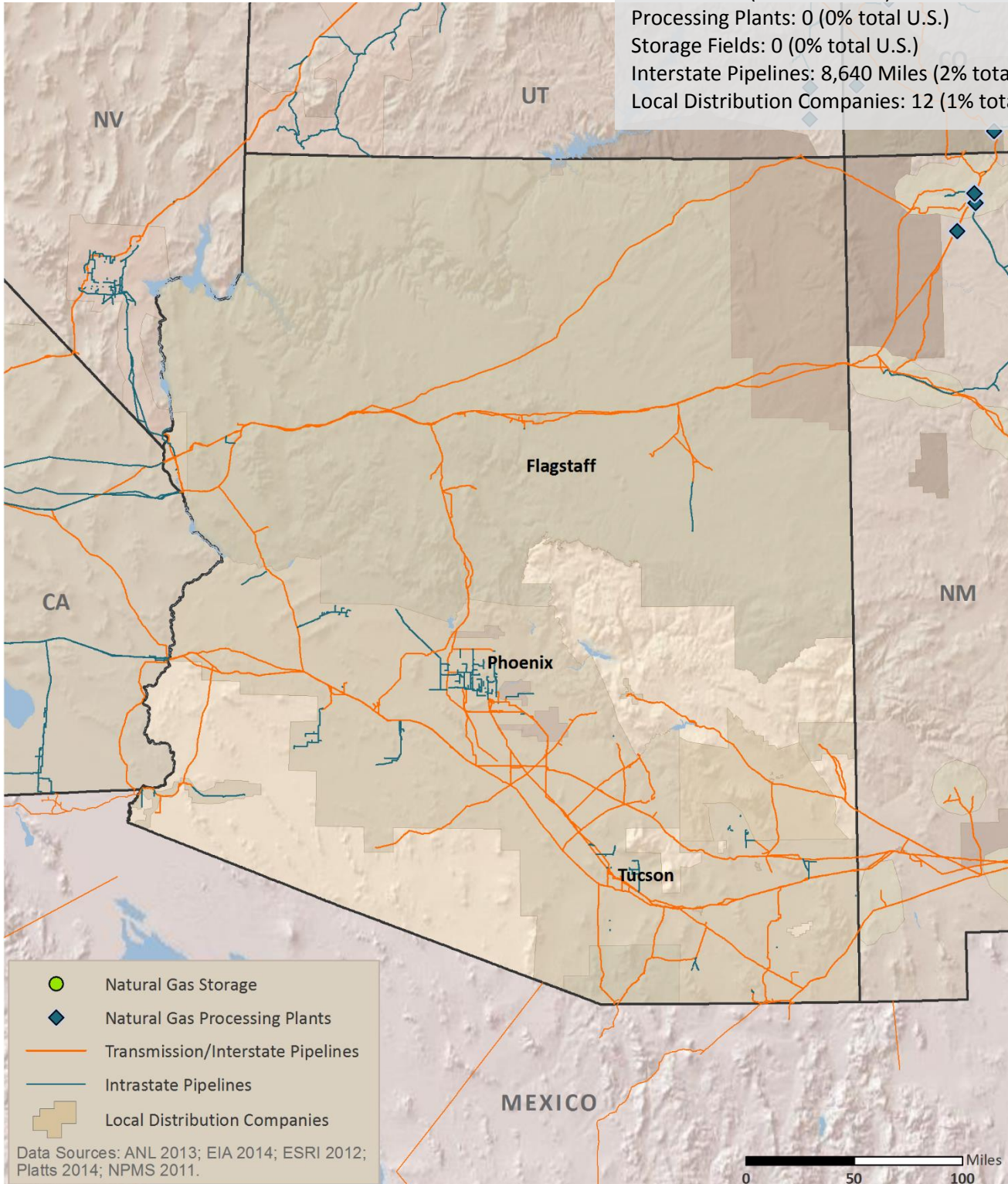
Top Events Affecting Crude Oil and Refined Product Pipelines in Arizona (1986–2014)



Data Source: DOT PHMSA

# NATURAL GAS

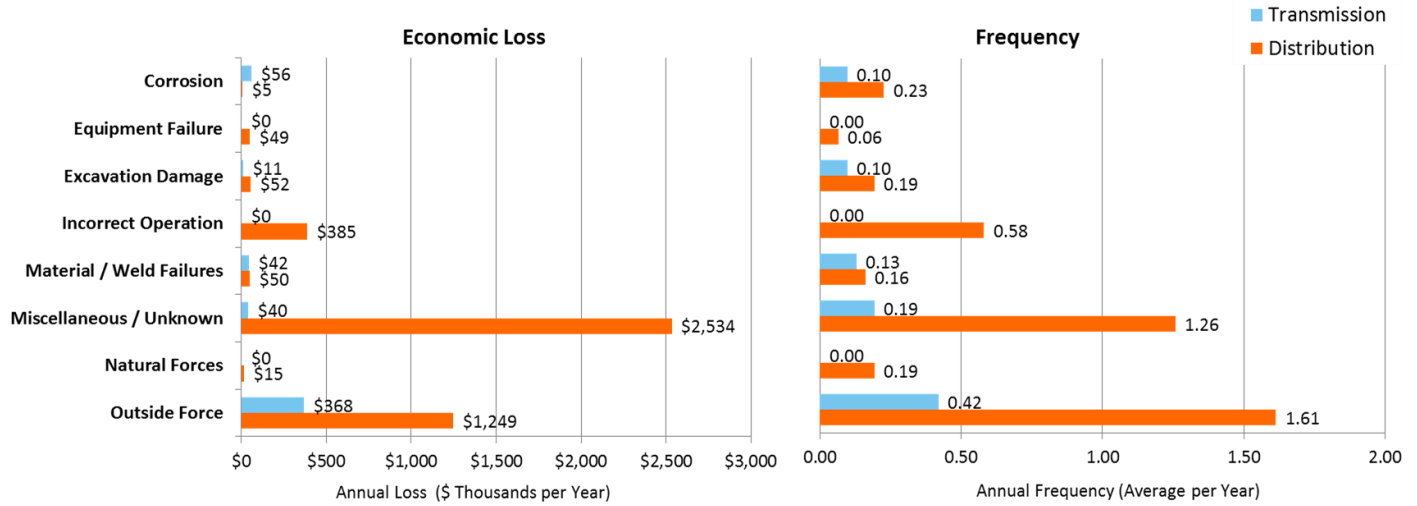
**Natural Gas Infrastructure Overview**  
Gas Wells: 5 (<1% total U.S.)  
Processing Plants: 0 (0% total U.S.)  
Storage Fields: 0 (0% total U.S.)  
Interstate Pipelines: 8,640 Miles (2% total U.S.)  
Local Distribution Companies: 12 (1% total U.S.)



# Natural Gas Transport

› The leading event type affecting natural gas transmission and distribution pipelines in Arizona during 1986 to 2014 was **Outside Force** for Transmission Pipelines and **Outside Force** for Distribution Pipelines, with an average **0.42 (or one incident every 2.4 years)** and **1.61 incidents** per year, respectively.

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



Data Source: DOT PHMSA



# DATA SOURCES

## Overview Information

- › NOAA (2014) Storms Events Database [[www.ncdc.noaa.gov/data-access/severe-weather](http://www.ncdc.noaa.gov/data-access/severe-weather)]
- › Census Bureau (2012) State and County QuickFacts [[http://quickfacts.census.gov/qfd/download\\_data.html](http://quickfacts.census.gov/qfd/download_data.html)]

## Production Numbers

- › EIA (2012) Table P1 Energy Production Estimates in Physical Units [[http://www.eia.gov/state/seds/sep\\_prod/pdf/P1.pdf](http://www.eia.gov/state/seds/sep_prod/pdf/P1.pdf)]
- › EIA (2013) Natural Gas Gross Withdrawals and Production [[http://www.eia.gov/dnav/ng/ng\\_prod\\_sum\\_a\\_EPG0\\_VGM\\_mmcfc\\_a.htm](http://www.eia.gov/dnav/ng/ng_prod_sum_a_EPG0_VGM_mmcfc_a.htm)]
- › EIA (2012) Electric Power Annual, Table 3.6. Net Generation by State, by Sector, 2012 and 2011 (Thousand Megawatt hours) [<http://www.eia.gov/electricity/annual/pdf/epa.pdf>]
- › EIA (2012) Electric Power Annual, Existing Nameplate and Net Summer Capacity by Energy Source, Producer Type and State (EIA-860) [<http://www.eia.gov/electricity/data/state/>]

## Consumption Numbers

- › EIA (2012) Electric Power Annual, Fossil Fuel Consumption for Electricity Generation by Year, Industry Type and State (EIA-906, EIA-920, and EIA-923) [<http://www.eia.gov/electricity/data/state/>]
- › EIA (2013) Prime Supplier Sales Volumes [[http://www.eia.gov/dnav/pet/pet\\_cons\\_prim\\_dcu\\_nus\\_m.htm](http://www.eia.gov/dnav/pet/pet_cons_prim_dcu_nus_m.htm)]
- › EIA (2012) Adjusted Sales of Fuel Oil and Kerosene [<http://www.eia.gov/petroleum/data.cfm#consumption>]
- › EIA (2012) Annual Coal Consumption [<http://www.eia.gov/coal/data.cfm>]

## Electricity

- › EIA (2013) Form-860 Power Plants [<http://www.eia.gov/electricity/data/eia860/>]
- › 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
- › EIA (2013) Petroleum Refinery Capacity Report [<http://www.eia.gov/petroleum/refinerycapacity/>]
- › NPMS (2011) Petroleum Product Pipeline (Miles of Interstate Pipeline)
- › NPMS (2011) Crude Pipeline (Miles of Interstate Pipeline)

## Natural Gas

- › EIA (2013) Form-767 Natural Gas Processing Plants [[http://www.eia.gov/cfapps/ngqs/ngqs.cfm?f\\_report=RP9](http://www.eia.gov/cfapps/ngqs/ngqs.cfm?f_report=RP9)]
- › EIA (2013) Number of Producing Gas Wells [[http://www.eia.gov/dnav/ng/ng\\_prod\\_wells\\_s1\\_a.htm](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

- › DOE OE (2014) Form 417 Electric Disturbance Events [[http://www.oe.netl.doe.gov/OE417\\_annual\\_summary.aspx](http://www.oe.netl.doe.gov/OE417_annual_summary.aspx)]
- › DOE OE (2014) Energy Assurance Daily (EAD) [<http://www.oe.netl.doe.gov/ead.aspx>]
- › Eaton (2014) Blackout and Power Outage Tracker [[http://powerquality.eaton.com/blackouttracker/default.asp?id=&key=&Quest\\_user\\_id=&leadg\\_Q\\_QRequired=&site=&menu=&cx=3&x=16&y=11](http://powerquality.eaton.com/blackouttracker/default.asp?id=&key=&Quest_user_id=&leadg_Q_QRequired=&site=&menu=&cx=3&x=16&y=11)]
- › DOT PHMSA (2013) Hazardous Material Incident System (HMIS) [<https://hazmatonline.phmsa.dot.gov/IncidentReportsSearch/search.aspx>]
- › NERC (2009) Disturbance Analysis Working Group [<http://www.nerc.com/pa/rmm/ea/Pages/EA-Program.aspx>]\*  
\*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.

**Bcf** – Billion Cubic Feet

**GW** – Gigawatt

**kV** – Kilovolt

**Mbarrels** – Thousand Barrels

**Mbpd** – Thousand Barrels per Day

**MMcfd** – Million Cubic Feet per Day

**MSTN** – Thousand Short Tons

**TWh** – Terawatt hours

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