

Rocky Mountain Region ENERGY SECTOR RISK PROFILE

This Energy Risk Profile examines the relative magnitude of the risks that the Rocky Mountain Region’s energy infrastructure routinely encounters in comparison with the probable impacts. The Rocky Mountain Region consists of the States of Colorado, Idaho, Montana, Utah and Wyoming. 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.

ROCKY MOUNTAIN REGION FACTS

Region Overview

Population: 11.4 million (4% total U.S.)
 Housing Units: 4.7 million (4% total U.S.)
 Business Establishments: 0.3 million (4% total U.S.)

Annual Energy Consumption

Electric Power: 130 TWh (4% total U.S.)
 Coal: 70,950 MSTN (8% total U.S.)
 Natural Gas: 1,500 Bcf (7% total U.S.)
 Motor Gasoline: 117,700 Mbarrels (4% total U.S.)
 Distillate Fuel: 69,400 Mbarrels (5% total U.S.)

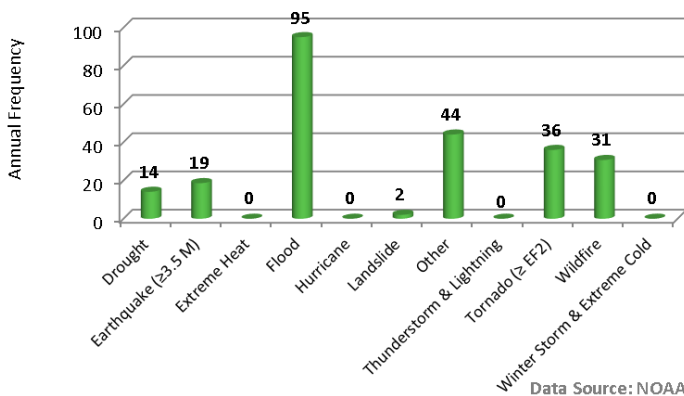
Annual Energy Production

Electric Power Generation: 185 TWh (5% total U.S.)
 Coal: 122.8 TWh, 66% [19.3 GW total capacity]
 Petroleum: 0.6 TWh, <1% [10.6 GW total capacity]
 Natural Gas: 20.0 TWh, 11% [0.2 GW total capacity]
 Nuclear: 0 TWh, 0% [0 GW total capacity]
 Hydro: 25.1 TWh, 14% [6.9 GW total capacity]
 Other Renewable: 16.4 TWh, 9% [5.8 GW total capacity]

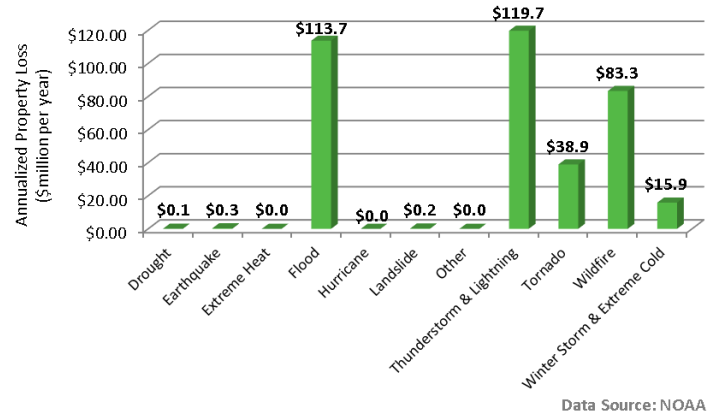
Coal: 483,700 MSTN (48% total U.S.)
 Natural Gas: 4,290 Bcf (18% total U.S.)
 Crude Oil: 163,800 Mbarrels (9% total U.S.)
 Ethanol: 4,300 Mbarrels (1% total U.S.)

NATURAL HAZARDS OVERVIEW

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



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



- According to NOAA, the most common natural hazard in the Rocky Mountain Region is Flood, which occurs once every 3.8 days on the average during the months of March to October.
- The second-most common natural hazard in the region is Other, which occurs once every 8.3 days on the average.

- As reported by NOAA, the natural hazard in the Rocky Mountain Region that caused the greatest overall property loss during 1996 to 2014 is Thunderstorm & Lightning at \$119.7 million per year.
- The natural hazard with the second-highest property loss in the region is Flood at \$113.7 million per year.

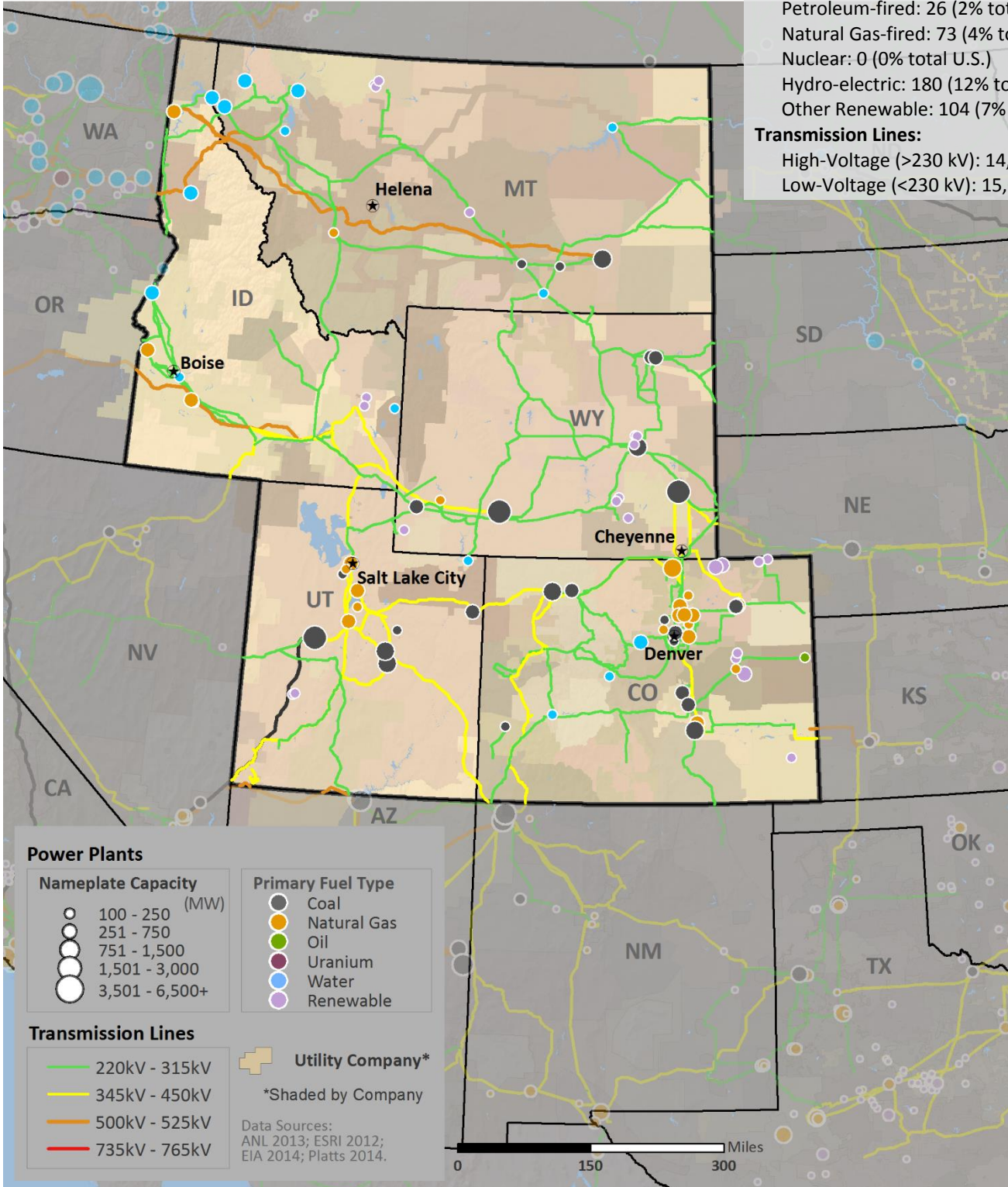
ELECTRIC

Electric Power Plants: 429 (8% total U.S.)

- Coal-fired: 46 (8% total U.S.)
- Petroleum-fired: 26 (2% total U.S.)
- Natural Gas-fired: 73 (4% total U.S.)
- Nuclear: 0 (0% total U.S.)
- Hydro-electric: 180 (12% total U.S.)
- Other Renewable: 104 (7% total U.S.)

Transmission Lines:

- High-Voltage (>230 kV): 14,370 Miles
- Low-Voltage (<230 kV): 15,080 Miles



Power Plants

Nameplate Capacity

- 100 - 250 (MW)
- 251 - 750
- 751 - 1,500
- 1,501 - 3,000
- 3,501 - 6,500+

Primary Fuel Type

- Coal
- Natural Gas
- Oil
- Uranium
- Water
- Renewable

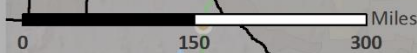
Transmission Lines

- 220kV - 315kV
- 345kV - 450kV
- 500kV - 525kV
- 735kV - 765kV

Utility Company*

*Shaded by Company

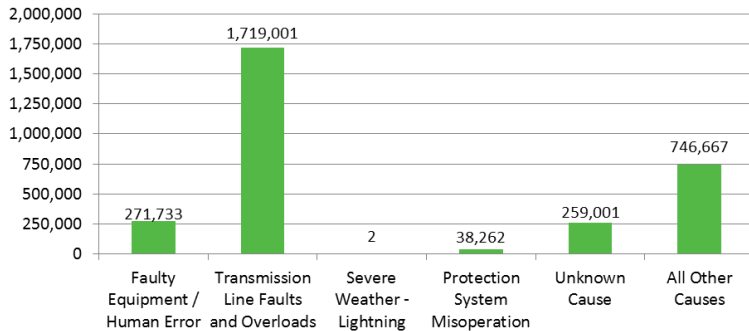
Data Sources:
ANL 2013; ESRI 2012;
EIA 2014; Platts 2014.



Electric Transmission

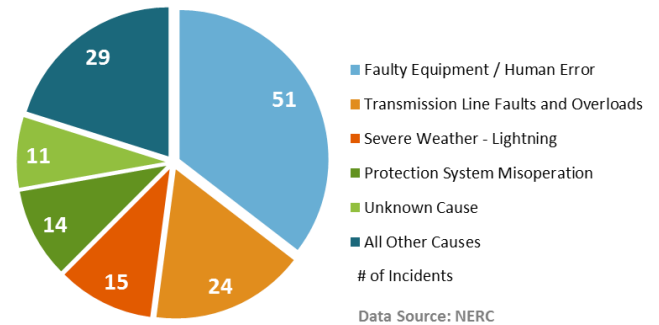
- › According to NERC, the leading cause of electric transmission outages in the Rocky Mountain Region is **Faulty Equipment/Human Error**.
- › The region experienced **144 electric transmission outages** from 1992 to 2009, affecting a total of **3 million** electric customers.
- › **Transmission Line Faults and Overloads** 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

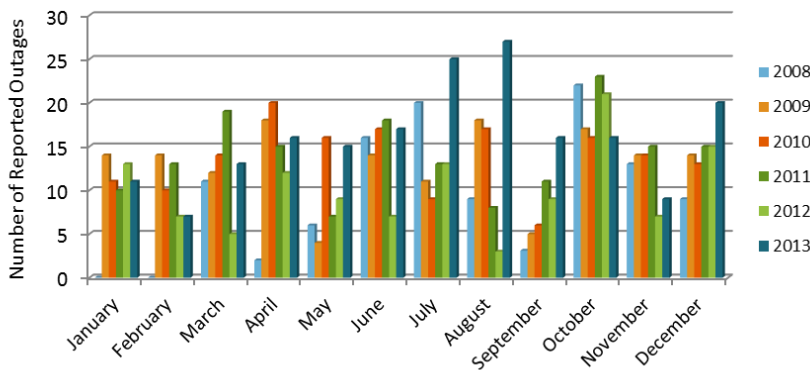
Number of NERC-Reported Electric Transmission Outages by Cause (1992–2009)



Data Source: NERC

Electric Distribution

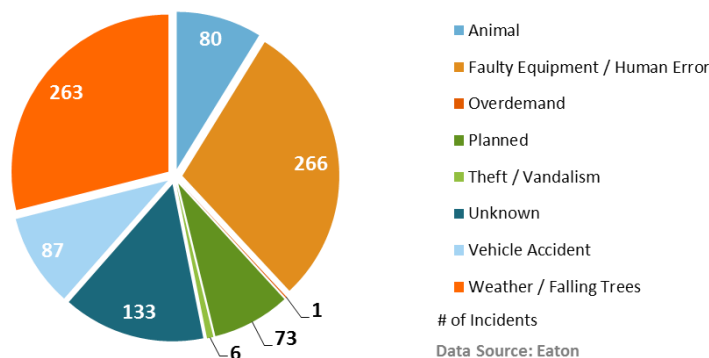
Electric Utility Reported Power Outages by Month (2008–2013)



Data Source: Eaton

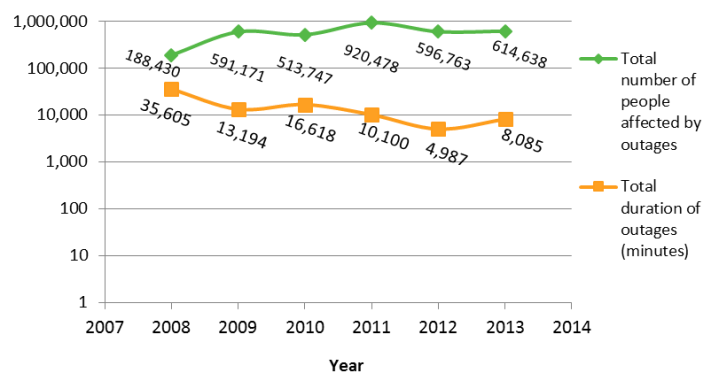
- › Between 2008 and 2013, the greatest number of electric outages in the Rocky Mountain Region has occurred during the month of **October**.
- › The leading cause of electric during 2008 to 2013 was **Faulty Equipment/Human Error**.
- › On average, the number of people affected annually by electric outages during 2008 to 2013 was **570,871**.
- › The average duration of electric outages in the region during 2008 to 2013 was **14,765 minutes or 246 hours a year**.

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



Data Source: Eaton

Utility Outage Data (2008–2013)



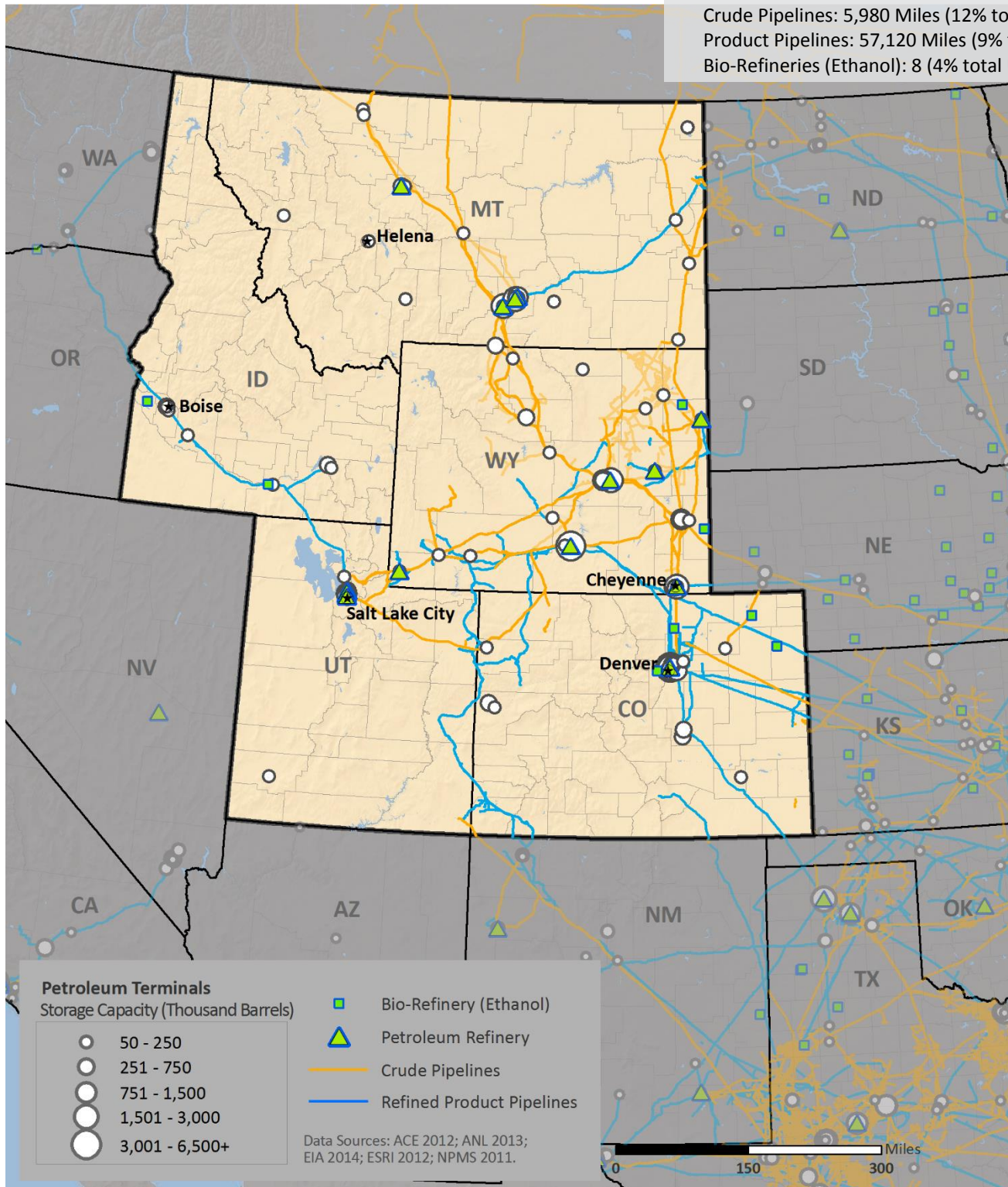
Data Source: Eaton

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

PETROLEUM

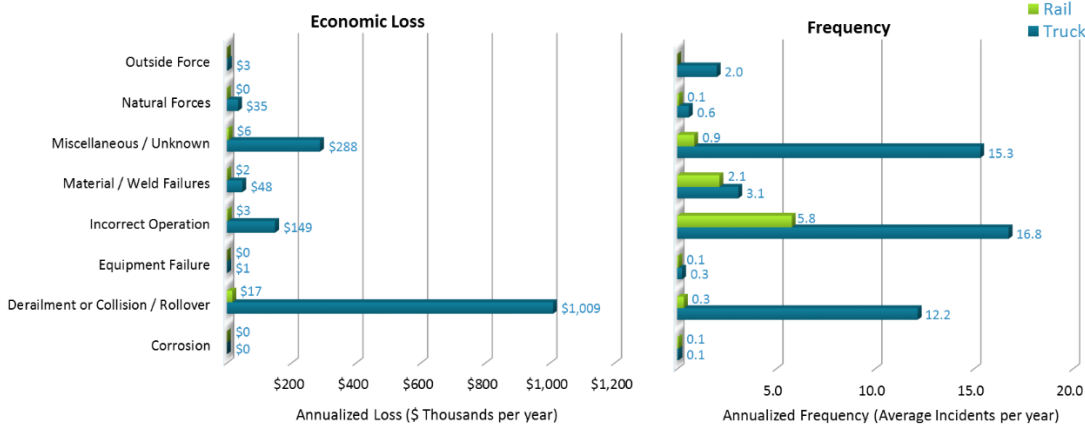
Petroleum Infrastructure Overview

Refineries: 17 (12% total U.S.)
 Terminals: 87 (4% total U.S.)
 Crude Pipelines: 5,980 Miles (12% total U.S.)
 Product Pipelines: 57,120 Miles (9% total U.S.)
 Bio-Refineries (Ethanol): 8 (4% total U.S.)



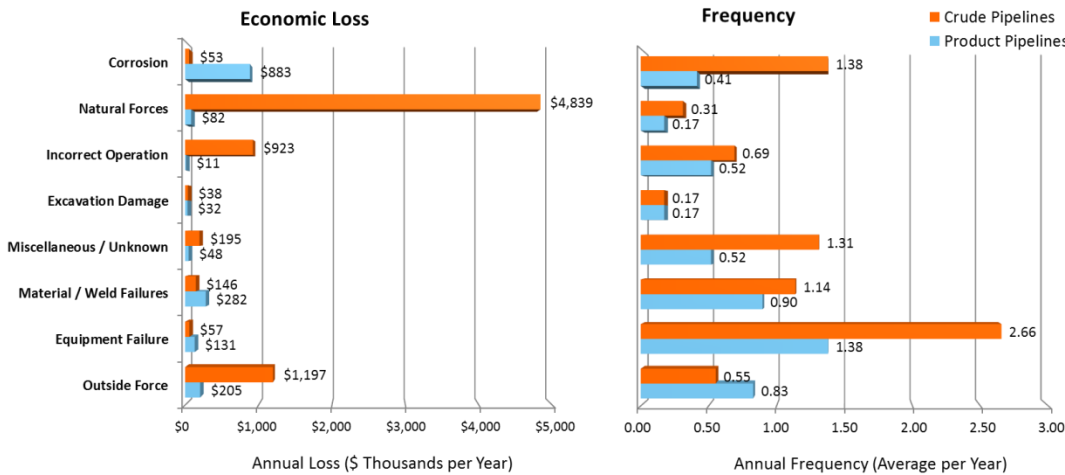
Petroleum Transport

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 during 1986 to 2014 was **Incorrect Operation** for rail transport and **Incorrect Operation** for truck transport, with an average **5.8 and 16.8 incidents** per year, respectively.

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

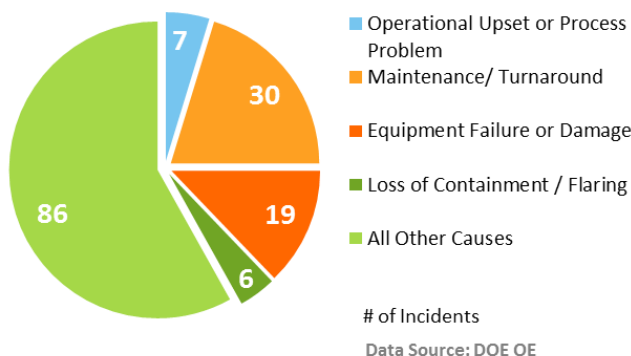


The leading event type affecting crude oil pipeline and petroleum product pipelines during 1986 to 2014 was **Equipment Failure** for crude oil pipelines and **Equipment Failure** for product pipelines, with an average **2.66 and 1.38 incidents** per year, respectively.

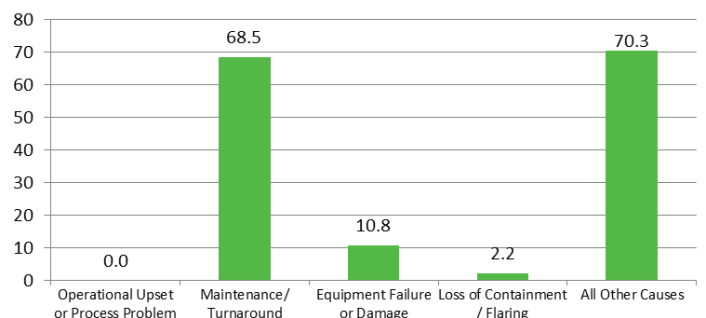
Petroleum Refinery

The leading cause of petroleum refinery disruptions in the Rocky Mountain Region from 2003 to 2014 was **Other Causes**. The region's petroleum refineries experienced **148 major incidents** from 2003 to 2014. The weighted average production impact from all disruptions at the refineries within the region from 2003 to 2014 is **56.2 thousand barrels per day**.

Top-Five Causes of Petroleum Refinery Disruptions (2003–2014)



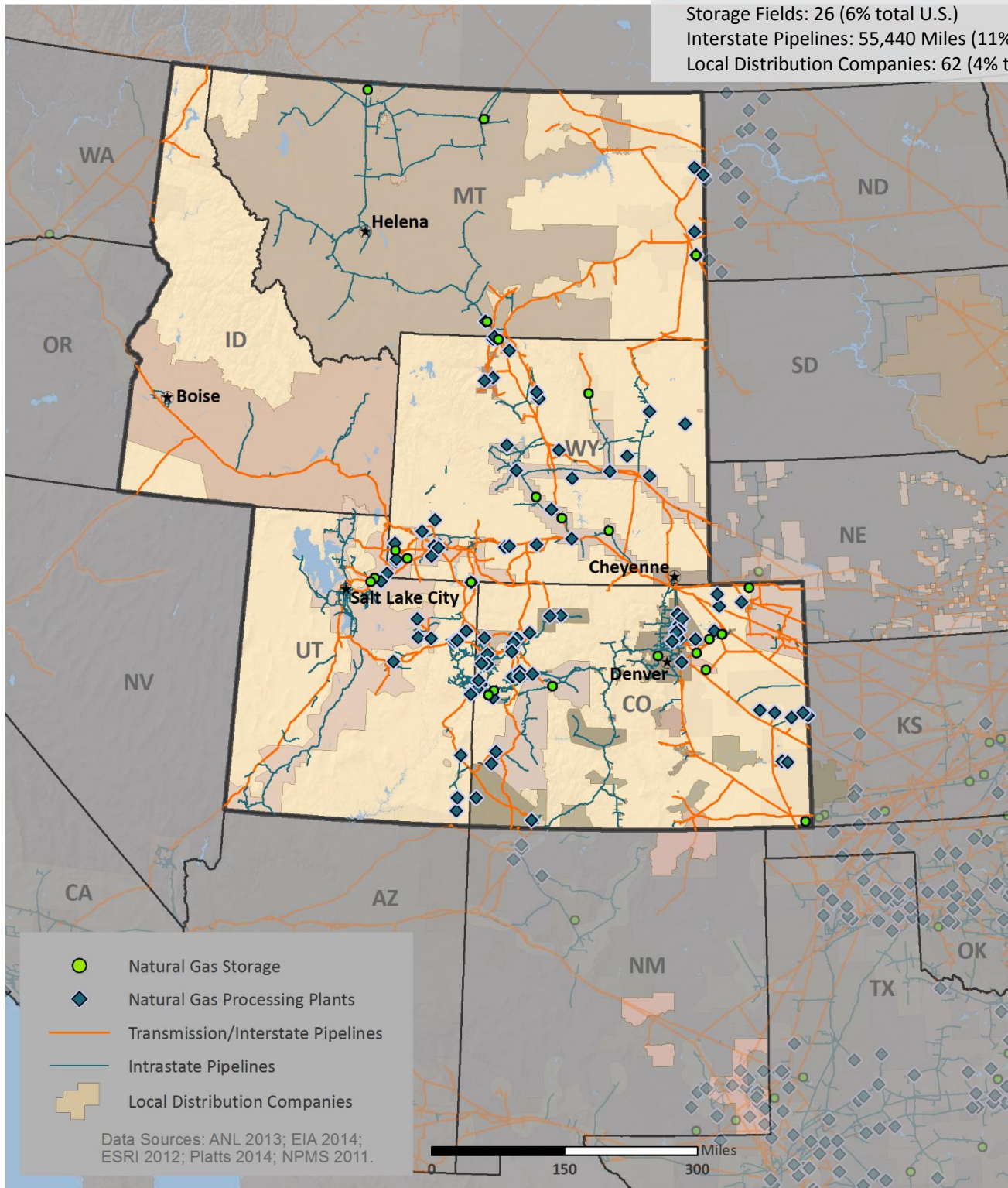
Average Production Impacts by Disruption Type (thousand barrels per day) at Petroleum Refineries (2003–2014)



NATURAL GAS

Natural Gas Infrastructure Overview

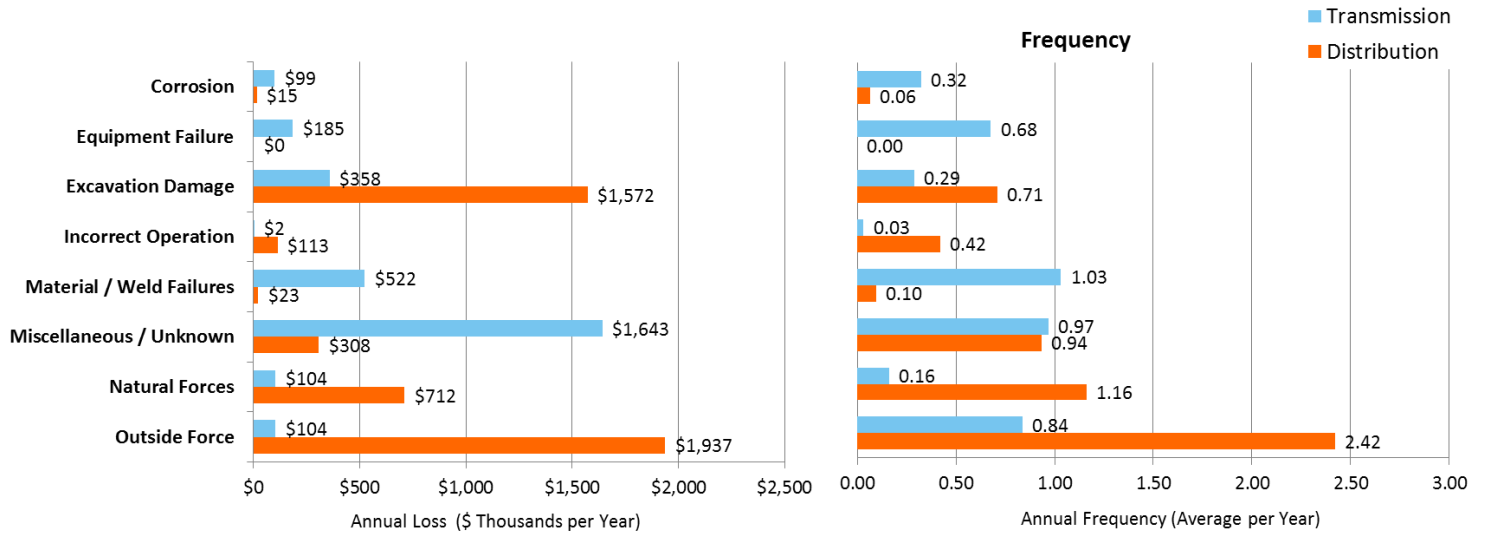
Gas Wells: 68,210 (14% total U.S.)
Processing Plants: 101 (20% total U.S.)
Storage Fields: 26 (6% total U.S.)
Interstate Pipelines: 55,440 Miles (11% total U.S.)
Local Distribution Companies: 62 (4% total U.S.)



Natural Gas Transport

- › The leading event type affecting natural gas transmission and distribution pipelines in the Rocky Mountain Region during 1986 to 2014 was **Material/Weld Failures** for Transmission Pipelines and **Outside Force** for Distribution Pipelines, with an average **1.03 and 2.42 incidents per year**, respectively.

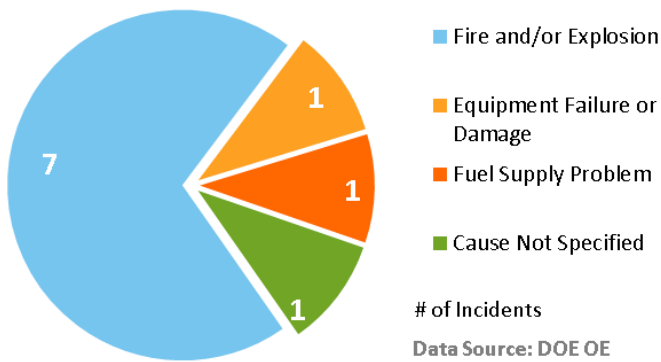
Top Events Affecting Natural Gas Transmission and Distribution (1986–2014)



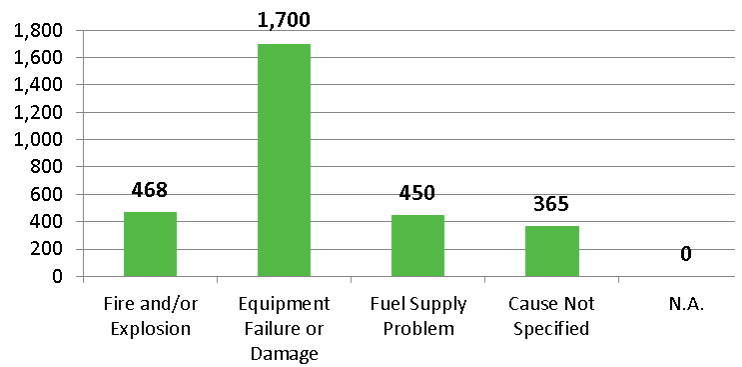
Natural Gas Processing

- › According to data derived from DOE's Energy Assurance Daily, the leading cause of natural gas processing plant disruptions in the Rocky Mountain Region from 2005 to 2014 is **Fire and/or Explosion**.
- › The region's natural gas processing plants experienced **10 disruptions** from 2005 to 2014.
- › The weighted average production impact from all disruptions at the natural gas processing plants within the region from 2005 to 2014 is **579 million cubic feet per day** (MMcfd).

Top-Four Causes of Natural Gas Processing Plant Disruptions (2005–2014)



Average Production Impact by Disruption Type (MMcfd) at Natural Gas Processing Plants (2005–2014)



DATA SOURCES

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

Overview Information

- › NOAA (2014) Storms Events Database [www.ncdc.noaa.gov/data-access/severe-weather]
- › Census Bureau (2012) State and County QuickFacts [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]
- › EIA (2013) Natural Gas Gross Withdrawals and Production [http://www.eia.gov/dnav/ng/ng_prod_sum_a_EPG0_VGM_mmcfd_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]
- › 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]
- › 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

- › DOE OE (2014) Form 417 Electric Disturbance Events [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]
- › 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.

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