

APPENDIX A: ENERGY SUBSECTOR- OIL AND NATURAL GAS (ONG)

Define/Describe CI: Energy infrastructure consists of three main systems — electricity, oil, and natural gas. For the purposes of this paper, it is assumed that electric systems associated with the electrical power industry are inoperable, thus only oil and natural gas systems will be discussed. ONG is critical to produce electricity, heat buildings and residences, and power vehicles and equipment. Petroleum fuels and natural gas are critical to a number of sectors, especially transportation, and are required for all sectors' backup power generators during power outages.¹ Oil and natural gas systems generally include production (mining and extraction), refining, storage, and distribution systems (pipelines and fuel terminals, railways, trucking, and marine vessels).

ONG infrastructure is geographically dispersed, often crossing multiple jurisdictional boundaries. ONG assets and systems can be owned by private, Federal, State, or local entities that serve the public. Systems may also be owned, operated, and used by specific energy consumers.² There are five major crude oil pipeline networks, comprising about 46,000 pipeline miles³, that supply refineries with crude oil. There are five refineries that produce over 500,000 barrels of refined petroleum a day. The U.S. and Canada share a linked pipeline and refinery infrastructure, along with more than 140 refineries that can process around 20 million barrels of oil every day. In total, there are about 190,000 miles of petroleum pipelines throughout the U.S. and about 2.4 million miles of natural gas pipelines.⁴

Natural gas is used to generate 43% of all U.S. electricity.⁵ Natural gas is also used by 60% of U.S. households for space heating, water heating, and cooking.⁶ It is also used for process heat in industrial applications. The U.S. has about 1,700 midstream natural gas pipeline compressor stations with a total of 5,000-7,000 compressors.⁷ In addition, the U.S. has between 13,000-15,000 smaller upstream compressors and 2,000-3,000 compressors (all sizes) in downstream fuel & gas and LNG applications. Pressure is necessary to send the oil and gas through the pipelines. Compressor stations create this pressure to keep the product flowing. Protecting the compressor stations is essential for national security, especially the natural gas compressors.

¹ <https://www.cisa.gov/topics/critical-infrastructure-security-and-resilience/resilience-services/infrastructure-dependency-primer/learn/energy>

² Ibid

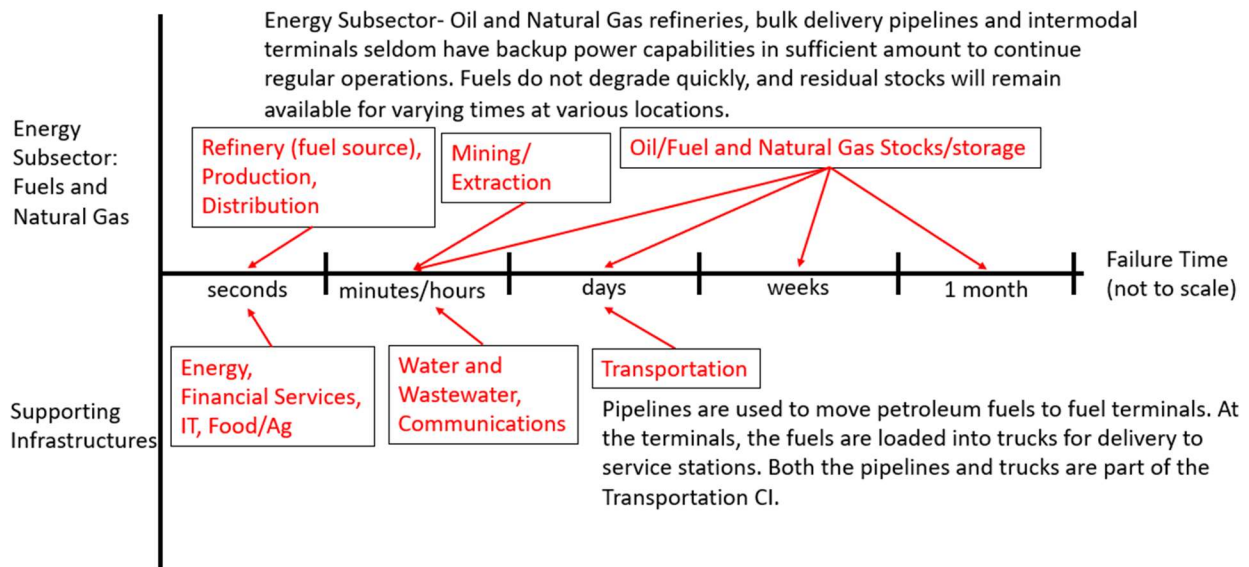
³ <https://www.visualcapitalist.com/interactive-map-crude-oil-pipelines-and-refineries-of-the-u-s-and-canada/>

⁴ <https://www.api.org/oil-and-natural-gas/wells-to-consumer/transporting-oil-natural-gas/pipeline/where-are-the-pipelines>

⁵ <https://www.eia.gov/energyexplained/electricity/electricity-in-the-us.php>

⁶ <https://www.eia.gov/energyexplained/natural-gas/use-of-natural-gas.php>

⁷ <https://netl.doe.gov/sites/default/files/netl-file/Brun.pdf>



Failure timeline: Refineries are expected to behave similarly to Chemical Plants and will generally fail in their primary mission (producing fuel) within seconds of a power outage.⁸ Intermodal transfer systems and transportation infrastructure failures may cause immediate sector failure, or they may cause failure over time based on residual capabilities (e.g., some intermodal transfer locations have significant bulk fuel storage capabilities). Refinery operations contingency plans focus on shutting down, not continued operations. These procedures are not always tested and sometimes they fail causing harmful toxic chemical release.⁹ Petroleum fuels and natural gas have a lengthy shelf life and can last months.

Describe CI Interdependencies (first order interdependencies that, if failing, will cause (at varying times) this energy subsector to fail.

- Communications, Energy, Financial Services, and IT are required for the administration of all CI. This includes (and is not limited to) financial transactions for supplies/raw materials, pay for employees, supply chain efforts, and the ability to effectively coordinate and execute operations. Food/Ag and Water are required to maintain the human element of each CI.
- Chemical: Chemicals are required for the refinery process (e.g., catalysts and lubricants for machines). On-hand stocks will shape refinery failure times due to lack of chemicals.
- Energy: Energy is required to operate extraction facilities, refineries and the bulk fuel distribution system.

⁸ EPA, Chemical Accidents from Electric Power Outages, Sept 2001 (updated 2023), p 2, <https://www.epa.gov/sites/default/files/2013-11/documents/power.pdf>

⁹ EPA, Chemical Accidents from Electric Power Outages, Sept 2001 (updated 2023), p 1-2, <https://www.epa.gov/sites/default/files/2013-11/documents/power.pdf>

- Information Technology (IT): IT is required in refineries, pipelines, bulk storage facilities, and transfer stations. (e.g., SCADA data systems).
- Transportation: Transportation is required to move fuel products. Pipelines and fuel terminals, railways, trucking, and marine vessels are part of the transportation sector.
- Water and Wastewater (WW): Production water is required for extraction and refinery operations.

Bin into local or regional or National entities. Refineries and pipelines and other fuel delivery systems rely on product from all over the country if not overseas. Pipelines extend locally and also cross-country in many places. Pipelines terminate at local storage distribution sites for local delivery or transfer to other modes of transport such as truck, rail, or ship/barge.

Impact of this CI with no power. (to CI and to society) Electricity is a necessity throughout the natural gas supply chain, including at production, pipeline, processing, and distribution facilities. Reliability of supply, transportation constraints, and the integrity of existing infrastructure are some of the issues surrounding the electricity and natural gas interdependencies.¹⁰ Other CI failure times due to fuel and natural gas energy subsector failure will range from minutes to over a month, depending on the amount of fuel stocks.

Without power the fuel and natural gas subsector fails causing the “lifeline” CIs to rely on “on-hand” stocks. It can be expected that an unpredictable amount of residual line pressure will remain in pipelines, particularly in natural gas pipelines, where approximately 90% of pump stations still run on natural gas instead of electricity.¹¹ Refineries and intermodal transfer stations that do not execute their shutdown procedures correctly may discharge toxic fuels causing widespread illness and fires. A no-power scenario would have a gradual impact on the availability of fuel and natural gas as on-hand stocks are depleted. For example, a lack of petroleum products would impact society within hours, while a lack of lubricants would impact machinery over a period of weeks.

Conclusion

- **Summary:** Assessment: As an enterprise, the oil and natural gas subsector will fail in seconds. Several of the interdependencies that this sector relies upon will fail within seconds. The lack of oil and natural gas will cause ever-increasing impact in other CI as stocks dwindle. Stockpiles, including the natural gas pressurized by natural gas-fueled pipeline pumps, may remain locally viable for days or weeks. For the remaining natural gas still inside pressurized pipelines, it will no longer receive input from wells, thus its duration will be brief and difficult to calculate as usage will be difficult to predict in a BSE.

¹⁰ DHS, Energy Sector Specific Plan, 215, p 27

¹¹ <https://www.cmu.edu/tepper/news/stories/2023/april/gas-pipelines-electric-outages.html>

- **Point towards broad solutions:** Analysis (including exercises) is required to determine the type and amounts of oil and natural gas that critical infrastructures need to keep on-hand for a BSE. On-hand stocks should be increased to allow for a period of continued CI functionality in a BSE. Critical mining, extraction sources, refineries, pipelines, bulk storage facilities, intermodal transfer stations, and fuel transportation assets should be identified and plans for continued operation should be established. A corresponding effort for the entire oil and natural gas subsector supply chain should be undertaken. All natural gas pumping/compression stations should use natural gas as their primary energy source.