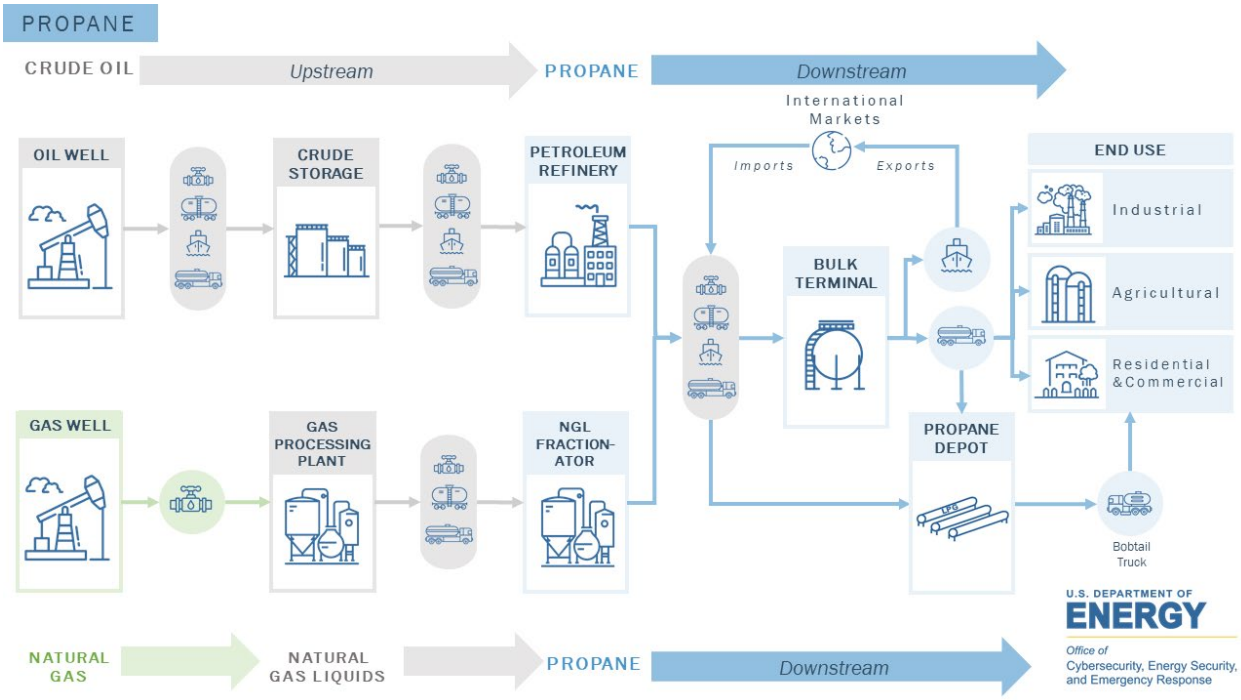
How It Works: Propane Supply Chain

Propane (also referred to as liquid petroleum gas, or LPG) is a petroleum-derived gas that is stored and transported in a compressed liquid form. Propane accounts for approximately 1% of total energy consumption in the United States and is primarily used for residential and commercial heating; for industrial purposes, including chemical and plastics manufacturing; and for agricultural applications, including grain drying and heating livestock and greenhouses in the winter. Smaller applications include cooking, power generation, and transportation. Approximately 6.0 million homes in the U.S.—mostly in the Midwest and Northeast—depend on propane as their primary heating fuel and a reliable supply of propane is critical for these homes during winter. [1]

Exhibit 1. Propane Supply Chain from Wellhead to End Users

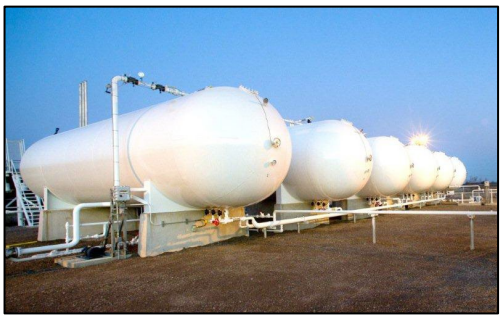


The propane supply chain is complex, with supply originating as a byproduct of both natural gas processing and crude oil refining. In 2021, approximately 80% of U.S. propane supply originated at natural gas processing plants where natural gas liquids (NGLs) are removed from the raw natural gas stream to create pipeline-quality gas. After removal at gas processing plants, the captured NGL mix is sent to NGL "fractionation" facilities where it is distilled into "purity" products, including propane, butane, and ethane. Consumer-grade propane (also known as HD-5) is the most widely sold and distributed grade of propane in the United States. HD-5 is typically composed of at least 90% propane with propylene, butane, and other gases composing the remaining 10%. Commercial grade propane and HD-10 propane, which are primarily used in industrial processes, have lower propane content compared to consumer grade propane.

[1] U.S. Census. 2021: American Community Survey 5-Year Estimates. B25040 House Heating Fuel.

Although propane is a gas at ambient temperature and pressure, it is stored and transported in a pressurized liquid state to improve its portability. Propane storage tanks are typically spherical or cylindrical, evenly distributing the pressure of the compressed propane across the tank walls to maintain tank stability. Propane is shipped from NGL fractionators and petroleum refineries to propane storage terminals in consuming markets via pressurized pipelines, railcars, marine vessels, and trucks. The propane is stored at these terminals before being loaded onto pressurized tanker trucks for transport to smaller secondary storage facilities (also called propane depots or bulk plants) operated by propane distributors that have contracts to supply individual homes and businesses. Some distributor storage facilities may also receive product directly by pipeline, rail, or marine vessel. Propane is transported to customer storage tanks on smaller tanker trucks referred to as "bobtail trucks." Residential customer tanks are typically filled ahead of the winter heating season, but often need to be refilled at least once during the winter in cold weather areas.

LPG "Bullet" Tanks

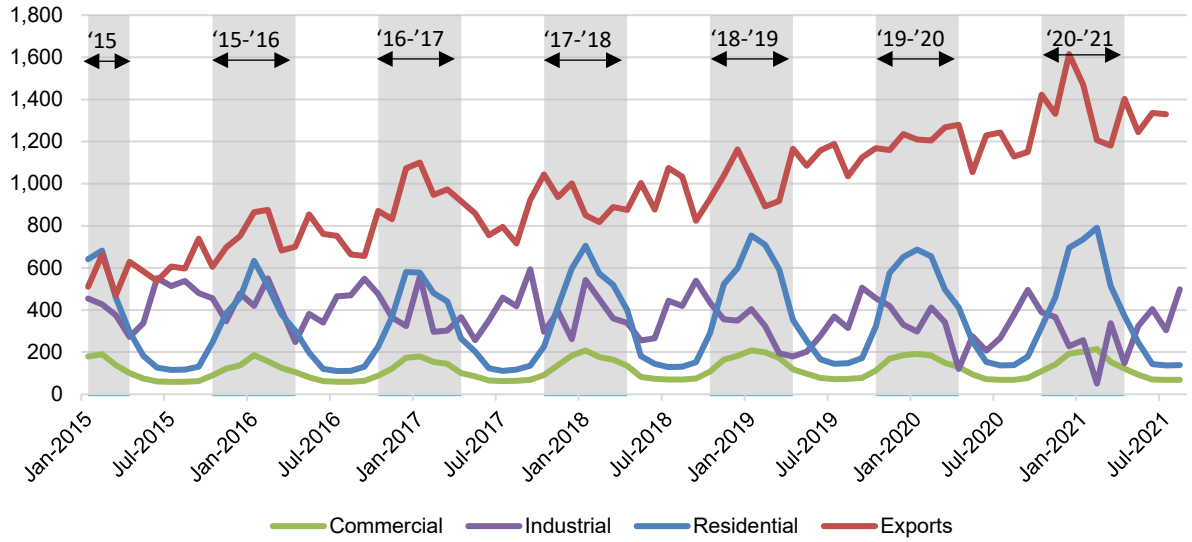


Source: TransTech Energy

Demand

U.S. propane demand is highly seasonal, with Winter peak demand roughly two to three times higher than summer demand. Residential and commercial demands typically peak in January or February, a function of the coldest temperatures (see Exhibit 2). Much of this consumption is concentrated in the Midwest and New England, typically in areas that lack access to piped natural gas (see Exhibit 3).

Exhibit 2. U.S. Propane Consumption by End Use (thousand barrels/day)

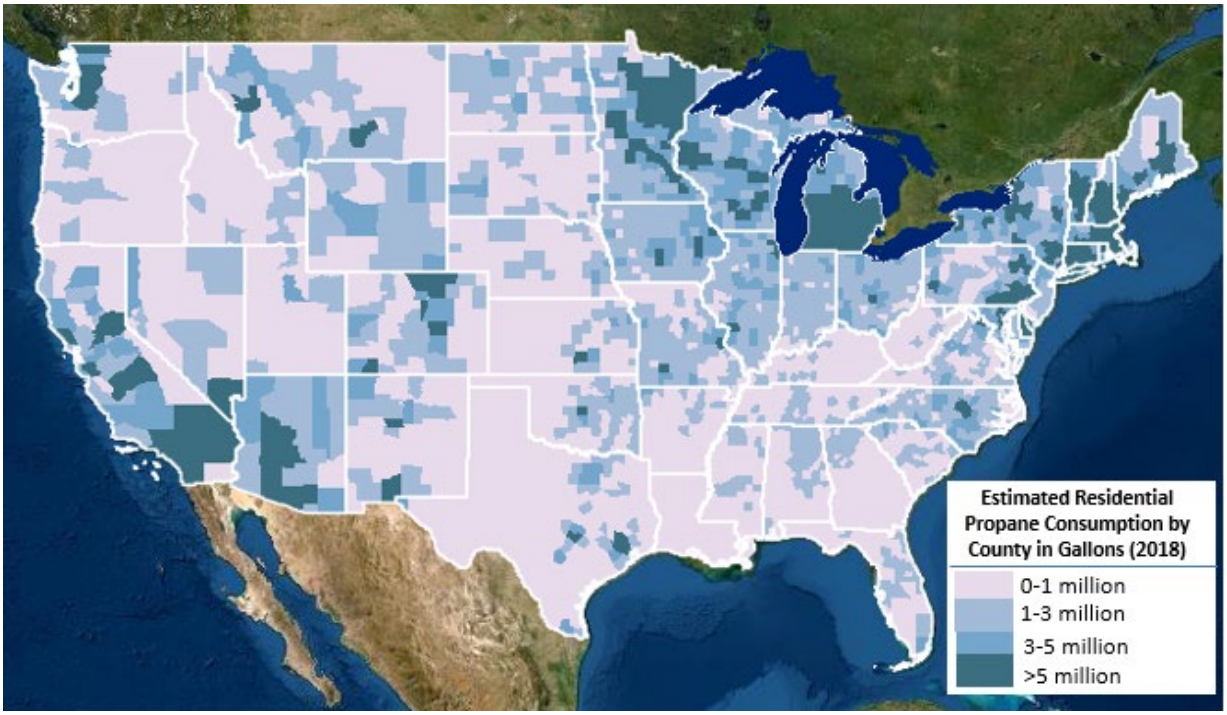


Source: EIA Monthly Energy Review Tables 3.7

Industrial demand (which includes agriculture) typically peaks in early Fall due to the use of propane-fired heaters for commercial grain drying. Propane demand for grain drying can fluctuate from year to year based on the moisture content of harvested grain, the timing of the harvest, the wholesale

price of corn, and the cost of propane. Agricultural propane demand can also spike during periods of extreme cold when propane-fired heaters are used to keep livestock warm. Propane demand from petrochemical producers typically peaks in Spring and Summer as lower prices incentivize propane use versus other feedstocks.

Exhibit 3. Estimated Residential Consumption of Propane by County, 2018



Source: DOE estimation of consumption based on U.S. Census 2018 and PERC Annual Retail Propane Sales Report 2018. Mapped in HSIN.

Major Propane Infrastructure in the U.S.

Much of the propane supply in the United States flows through two major propane fractionation and storage hubs: one located in Mont Belvieu, Texas (near the Houston Ship Channel) and one located in Conway, Kansas. These two sites were selected due to the presence of salt formations ideal for the development of underground propane storage caverns. Interstate pipelines transport propane from these hubs to end user markets primarily across the Midwest and along the East Coast (see Exhibit 4). In recent years, Northeast propane supply has increasingly originated at fractionators in the Marcellus and Utica shale plays in Pennsylvania and Ohio, moving to end markets by both pipeline and rail. In 2022, imports accounted for around 5% of annual U.S. propane supply and around 14% of annual U.S. propane consumption, with imports primarily delivered via railcar from Canada to states along the border. In the Midwest region (PADD 2), imports accounted for roughly one-third of propane consumption in 2021.[2]

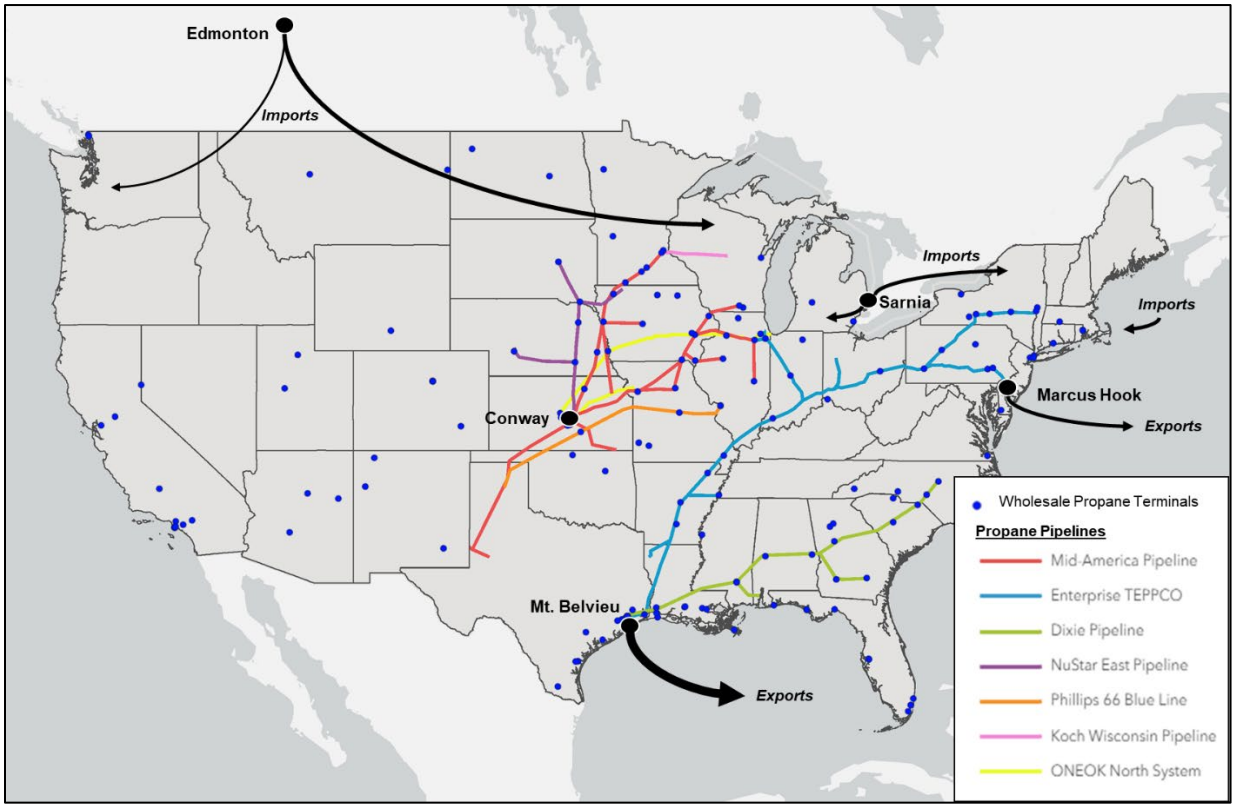
Due to the seasonal nature of demands, propane pipelines and railcars typically run below capacity in the Spring and Summer, and at or near capacity during Winter peak demand periods. Because supply infrastructure capacity is limited, regional and local storage facilities play an important role in balancing supply and demand between the seasons; stocks typically build during the low demand

[2] EIA. Petroleum & Other Liquids. Supply and Disposition. Propane. Annual 2021. https://www.eia.gov/dnav/pet/pet_sum_snd_a_EPLLPA_mbblpd_a_cur.htm

Spring and Summer months (from April to September-) and draw down as agricultural and heating demands increase during the Fall and Winter months (from October to March).

With the growth in U.S. oil and gas production in recent years, the U.S. produces significantly more propane than it consumes domestically, and U.S. exports of propane exports are nearly equal in magnitude to domestic consumption. Exports are mainly loaded on marine vessels in the Gulf Coast (primarily at the Mont Belvieu hub) but significant exports from the East Coast began in the 2010s with the startup of the Marcus Hook export facility near Philadelphia, which draws supply from the nearby Marcellus Shale region.

Exhibit 4. Propane Pipeline Systems and Propane Import/Export Flows



Source: DOE analysis of EIA data

Threats to the Propane Supply Chain

Local or regional propane shortages can develop during periods of persistent cold weather, particularly in mid-to-late Winter. Customer tanks are typically filled before the start of the Winter heating season and tank volumes may approach or fall below refill thresholds (usually around 30%) by January or February. An extended period of extreme cold weather during these months can trigger refill orders for a large number of customers over a short period of time. This sudden surge in demand can strain the capacity of the supply chain, including delivery trucks, distribution terminals, pipelines, and railcars. Although national and regional inventories of propane are often sufficient to meet demands during these periods, the supply chain may struggle to move propane from major storage hubs (such as Conway, Kansas) to where it is needed fast enough to meet consumer demands. Agricultural propane demands in the fall can also contribute to the conditions that cause Winter propane shortages as high grain drying during late and wet harvest seasons can draw down

propane inventories, making it difficult for suppliers and distributors to restock local inventories before the height of home heating season.

Supply chain issues during periods of high demand may be further compounded if Winter storms, unplanned infrastructure outages, or other factors reduce the supply chain's capacity to move fuels to end users. Various issues along the supply chain are discussed below:

- **Pipelines:** Pipelines that are mostly dedicated to propane service typically run at or near maximum capacity during the Winter months, so there is often limited ability to increase propane supply during periods of high demand, or to make up for missed deliveries following pipeline outages or slowdowns. Meanwhile, multi-product, common carrier pipelines that ship propane alongside other petroleum products cannot offer priority service to propane shippers during propane shortages without a waiver of tariff rules that require the pipelines to offer fair and equitable access to pipeline space.

- **Rail:** Rail is less reliable than pipeline for propane transport, particularly during Winter storms when snow, ice, and severe cold can slow or disrupt rail shipments. During periods of extreme cold (below negative -13º F), railways slow train speeds and shorten trains due issues affecting train air brake systems. This can significantly reduce the rail system's overall shipping capacity for all commodities, including propane.[3] Harsh weather can also increase the propensity for broken rails and switches, signal outages, locomotive failures, and rail car defects. Even when weather is not an issue, increasing rail shipments to address shortages is difficult because shipments must be initiated weeks in advance of the expected delivery date.

- **Terminals:** During demand spikes, propane distribution capacity may be limited by terminal constraints, including the availability of stored product at terminals and the speed at which trucks can be loaded. These constraints can temporarily cause lines of trucks to format terminals. Lines may also form at terminals during local shortages as trucks wait for new pipeline or rail shipments to arrive at the terminal. During supply shortages, suppliers that sell propane at terminals may stop making non-contract "spot" sales to preserve available inventory to meet supply obligations for contract customers. If available inventory is not sufficient to meet all demands from contract customers, suppliers may allocate customers to some percentage of their normal purchase volumes. Propane bulk terminals and distributor storage sites are also vulnerable to power outages during Winter storms or other events because terminal equipment, including pumps, meters, and safety equipment, require electric power for operation.

- **Trucking:** During peak demand periods, propane deliveries may be constrained by the number of available propane trucks and qualified drivers, and federal and state regulations that limit the amount of time that drivers can work before mandatory breaks (i.e., hours of service regulations). During supply shortages, suppliers may truck product into the region from further terminals, requiring more time on the road. This not only reduces the number of trips that can be completed, but also increases traffic and wait times at terminals that have available supply, further reducing the number of possible trips. Winter weather, including

[3] Canadian Pacific. White Paper: Railroading in the Canadian Winter. https://www.cpr.ca/en/about-cp-site/Documents/CP-2018-19-WhitePaper.pdf

snow and ice accumulation on roadways, can impact truck speeds and block access to customers sites.

Propane Shortage Response Measures

During propane shortages, the Federal Government and state governments primarily utilize waivers to ease regulations to facilitate the faster transportation of propane by truck, ship, and pipeline into the area experiencing the shortage.

Federal and State Hours-of-Service (HOS) Waivers: Federal HOS waivers allow propane truck drivers to work longer hours to move propane into areas experiencing shortages without taking mandatory breaks as required by Federal Motor Carrier Safety Regulations (FMCSR). During regionwide shortages, the Federal Motor Carrier Safety Administration (FMSCA) may issue regional FMCSR waivers applying to multiple states. FMCSR waivers apply to interstate commerce. States may need to separately waive state-level regulations for intrastate truck movements. See Energy Waiver Library for more information.

Prioritization of Pipeline Shipments: Under the Interstate Commerce Act, the Federal Energy Regulatory Commission (FERC) has the authority to order priority shipments on regulated interstate pipelines during emergency circumstances. For example, during the Midwest propane shortage in February 2014, the FERC—at the request of the National Propane Gas Association (NPGA)—ordered the Enterprise TEPPCO Pipeline to prioritize propane shipments from the Gulf Coast into the Midwest for one week. This helped address the shortage by directing additional supply to the affected regions. See Energy Waiver Library for more information.