Optimizing the Propane Supply Chain in the State of Iowa

September 2016

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1 Executive Summary

The propane crisis of 2013-2014 presents significant concerns for Midwestern states. The State of Iowa is taking a scientific approach to addressing these challenges by developing a Propane Supply Chain Optimization Strategy.

The focus of the effort is to understand the root causes of issues that resulted in the propane shortage. Then, leveraging this knowledge, potential risks and opportunities are objectively analyzed to better manage Iowa's propane supply chain. The core goals of the effort are:

- To be better informed when demand for propane reaches critical levels and Iowa faces potential shortages; and
- To proactively define viable contingencies to better manage extreme fluctuations and disruptions in propane supply in the future.

Iowa's approach is to analyze the problem objectively using a Supply Chain Network Optimization methodology. It is a proven discipline, leveraged by large Fortune 500 companies and government agencies, to optimize complex global supply chains, improve profitability and increase operational efficiency.

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The effort is an extension of Iowa's Statewide Freight Transportation Network Optimization Strategy. Partnered with Quetica Consulting, the Iowa Department of Transportation (Iowa DOT) is using demand-based supply chain design and optimization techniques to effectively identify and prioritize investment opportunities for an optimized freight transportation network to lower costs for Iowa businesses.

This propane study, conducted in 2014-2015, employs these same techniques to evaluate short- and long-term optimization scenarios to better handle fluctuations in propane supply and demand, and the corresponding economic impact to Iowa businesses and consumers. .

1.1 What is the Need

In the winter of 2013-2014, residential and commercial users of propane in Iowa and other states were challenged by a severe propane shortage and sharp price increases driven by:

- An **agricultural shortage** for propane for crop drying with a late grain harvest in the fall;
- **Colder than normal winter temperatures**, as well as an abnormally early and long winter season, further stressed a depleted propane supply for heating use and increasing the cost to consumers;
- **Closing of the Cochin pipeline** for maintenance, a primary source of supply, for several weeks during peak 2013 demand with permanent reversal in 2014;
- **Rail disruptions and lack of truck capacity** limiting the ability to replenish inventories; and
- **Lower Midwest inventories** with an increase in propane exports and propane dehydrogenation demand.

Although these events seem like an anomaly, ongoing changes in the propane supply chain in Iowa and nationally present risks in the future. The demand for propane in Iowa was higher in 2013-2014 than recent years, but not at historic levels. Demand will continue to fluctuate. With changing infrastructure, globalization of the market and increasing price competition, there is no guarantee that propane supply will be available to meet all domestic residential and agricultural demand in Iowa in the future.

In Iowa, over 163,000 or 13.3 percent of households rely on propane as a heating source in winter months, with the percentage rising above 45% in some counties, where alternative heating sources like natural gas are less accessible[1]. Ensuring Iowa households have reliable heat during the winter months is a safety concern. But it is also an economic issue. Instability in the global propane market creates dramatic price fluctuations. A one dollar change in the average propane price per gallon would drive over $148 million in additional costs to Iowa residents in a typical year.

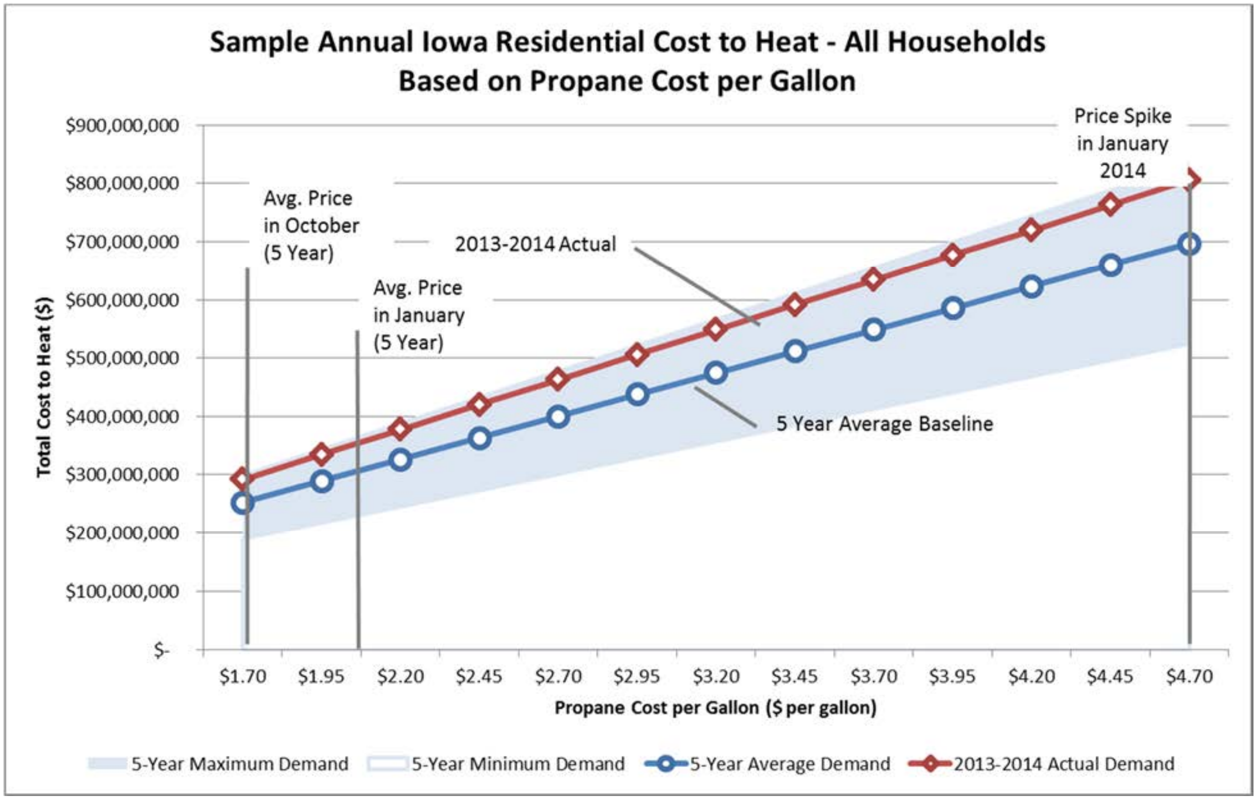

Figure 1 - Effect of changes in propane prices on Iowa residential users[2]

The potential economic impact is even greater in the Iowa agriculture community, where propane is used for corn drying, heating of livestock buildings and other uses. Iowa is the leading producer of corn in the U.S. with corn sales of $11.7 billion[3]. The impact of a one dollar change in the average price per gallon for propane would drive over $265 million in additional costs to the Iowa agriculture community in a typical year.

The net impact is that stability of the propane supply chain has a significant impact on the Iowa economy via its impact on the agriculture community and Iowa residents. The total odorized propane industry also contributes over $568 million to the Iowa GDP annually[4].

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[1] (Iowa Economic Development Authority, 2015)

[2] Sources: (U.S. Energy Information Administration), (Oil Price Information Service (OPIS))

[3] (United States Department of Agriculture, 2012)

[4] (Warren Wilczewski, 2014)

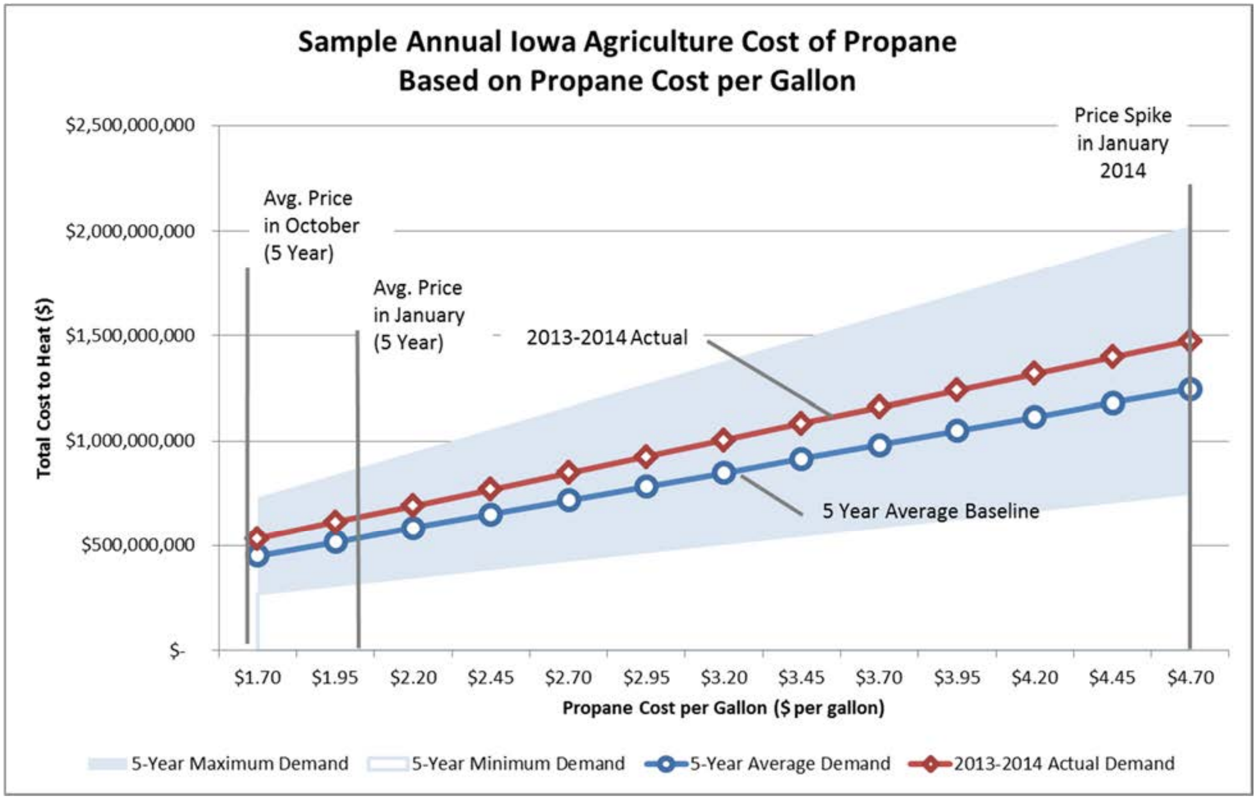

Figure 2 - Effect of changes in propane prices on Iowa agriculture users[5]

1.2 What is the Approach

Adapting and managing through these changes in the propane industry are supply chain issues. The challenge is getting propane to end users where and when it is needed at a reasonable cost.

The obstacles are constraints in the transportation network (e.g., pipeline and terminal capacity, truck and driver availability) and inventory management (e.g., storage in market centers, in bulk storage in Iowa and at Iowa end users). Since demand for propane is highly seasonal, bottlenecks occur during peak periods.

Managing through these constraints requires an understanding of the propane supply chain infrastructure, including:

- **Demand fluctuations** within Iowa for crop drying and heating;
- **Storage requirements** (e.g., capacity, reorder points);
- **Sourcing practices** (e.g., contracting, contingency supply); and
- **Transportation capacity** across modes (e.g., pipeline, truck).

The problem was analyzed objectively using a Supply Chain Network Optimization methodology (see Section 2.2), including:

- Analysis of **demand and capacity** across the propane supply chain;
- Identification of **constraints** in both the transportation network and inventory management;
- Creation of supply chain **optimization strategies**; and
- Development of a **business case** to support recommended strategies.

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[5] Sources: (U.S. Energy Information Administration), (Oil Price Information Service (OPIS))

A computer simulation model was setup to represent current and forecasted demand, transportation and inventory capacity, and quantitative performance measurements (e.g., costs, reorder points). Propane demand, capacity, forecasts, and performance data was collected, cleansed, analyzed, and aggregated into the computer model.

A network design and optimization tool was utilized to run simulations and conduct what-if analysis to identify network constraints and evaluate alternatives. Qualitative measurements (e.g., safety, service considerations) were applied and return on investment analysis conducted to prioritize optimization strategies.

1.3 Key Findings and Recommendations

The core factors that affect the current state of Iowa's propane supply chain and its ability to meet demand for propane in Iowa in the future are as follows.

- **Propane is an open market commodity.** Propane is an openly-traded, energy commodity. Thus, the behavior of industry participants is largely driven by the goal of minimizing costs and associated price risks. This reality can run counter to end user demand and service level expectations associated with regulated utilities.
- **Sourcing practices are Iowa-centric.** Iowa has the benefit of extensive pipeline terminal access across multiple, major pipelines. With pipelines being the lowest cost transportation method from market hubs and regional production sites, Iowa pipeline terminals are the primary source for propane, driving an Iowa-centric sourcing approach, in order to deliver the lowest cost to Iowa end users.
- **Market infrastructure and dynamics are changing.** Historically, the Iowa propane industry was able to manage any seasonal peaks in demand with Canadian imports via the Cochin pipeline. But the permanent reversal of the Cochin in 2014, to achieve higher utilization by flowing diluent[6] year-round into Alberta, eliminates the flexibility to manage fluctuations in Iowa demand via this source.

  In addition, although shale development and growth in oil and natural gas production is growing domestic propane production, the opening of new export terminals and propane dehydrogenation (PDH) facilities at a faster pace is shifting supply movement to the Gulf region.

- **Pipeline is key constraint with current behavior.** Although the pipelines provide a strategic advantage to Iowa, they also represent a key supply chain constraint. Given current costs and infrastructure, the Iowa propane industry continues to receive its primary supply of propane via pipeline from the Mid-Continent Market Center in Conway, Kansas. However, during seasonal peaks, these pipelines run at maximum capacity and are unable to increase flow. If demand increases above capacity, the industry is no longer able to meet demand with current infrastructure and Iowa-centric sourcing practices.

  Neighboring states with higher dependency on the Cochin[7] are also leveraging Iowa pipeline terminals to compensate for the pipeline's closure. Rail infrastructure in the Midwest region does not deliver equivalent capacity, is more expensive and is less reliable than pipeline delivery. Out-of-state marketer usage of Iowa terminals is a new reality, further reducing pipeline capacity in practice and increasing wait times at terminals.

[6] See Section 5.2.1.

[7] The Cochin reversal affected propane service to North Dakota (Carrington terminal), Minnesota (Benson and Mankato terminals), Iowa (New Hampton Terminal) and Indiana (Milford terminal). States within the Midwest region expected to be most affected by the Cochin reversal include Illinois, Indiana, Iowa, Minnesota, North Dakota, South Dakota and Wisconsin.

- **Sourcing and infrastructure strategy needs to be expanded with changing market conditions.** In today's environment, the core issue is how to handle contingency supply needs not supported by the pipelines, during demand surges. Iowa has lower investments in inventory and other infrastructure than states without the same pipeline terminal access. Sourcing supply at alternative sites outside Iowa results in increases in transportation costs, and requires advance planning to secure inventory and transportation resources. Marketers have to modify sourcing, inventory and transportation practices to adjust to current market conditions, with price competitiveness remaining a major concern.

The propane industry in Iowa and other Midwestern states will continue to face volatility in propane supply and demand, driven by industry economics and these changing market dynamics. However, ensuring a consistent supply of propane remains critical to public safety, where it is a primary heating source, and to the economics of Iowa businesses, for grain drying and other agricultural and commercial uses.

The supply chain optimization analysis evaluates the ability of Iowa's propane supply chain to handle:
- Current demand with current infrastructure;
- Future increases in demand with current infrastructure; and
- The impact of changing and/or new infrastructure constraints.

Emphasis in this first phase of the study was on planning and identifying scenarios when changes in demand or constraints limit the ability to meet demand at a reasonable price. This information helps the State of Iowa identify potential disruptions in supply before reaching crisis levels.

The impact of fluctuations in supply and demand was modelled to identify contingencies and recommend optimization strategies. This analysis focuses on ensuring a consistent supply of propane to residential and agricultural users in Iowa, understanding the economic impact of supply chain changes, and works to avoid emergency declarations, where alternatives exist.

This report provides an overview of these supply chain analytics and provides insights into the relative impact of improvement opportunities and recommended actions, including:

Source: Stock Photography (Copyright - Shelly Yates Young)

- **Monitoring** market conditions and infrastructure changes (e.g., demand, inventory levels, pipeline disruptions, export capacity, price fluctuations);
- **Communicating and educating** on changes, risks and recommended actions (e.g., capacity limits, industry metrics for emergency declaration, price risks);
- **Incenting behavior** change (e.g., multiple driver shifts during peaks, early fills of end user storage within Iowa);
- **Incenting infrastructure** investments (e.g., right-sizing farm and residential storage, terminal load reservation/scheduling system); and
- Implementing a supporting **data strategy** (e.g., systemic monitoring, defining key metrics and measuring performance).

The next phase of the effort will shift to operational execution, working collaboratively with industry and end users to refine and implement high priority recommendations.

This objective approach provides a reusable framework for the State of Iowa to continually assess supply chain risks and prioritize optimization strategies that will have the highest impact to propane end users and industry participants.

2 Iowa's Propane Supply Chain

2.1 Supply Chain Overview

A supply chain consists of suppliers, plants, warehouses, and flows of products from origin to customers. Typically, 80 percent of a product's landed costs are locked in by the location of a company's facilities and the determination of product flows between them.

The supply chain for propane is comprised of the following high-level components[8]:

- **Production Facilities**. Propane, a liquefied petroleum (LP) gas, is produced as a by-product of crude oil and natural gas production activities. Propane, along with other LP gases like ethane and butane, are produced and separated at natural gas processing plants and crude oil refineries (U.S. Energy Information Administration).
- **Market Centers or Hubs.** Because propane is a by-product and not produced for immediate consumption, the large portion of propane production is shipped into regional market centers (or hubs) for underground storage. These market centers operate as wholesale commodity exchanges where propane is bought and sold. Propane remains in storage in a pressurized, liquid state[9] at these primary storage facilities[10], until delivery is requested.

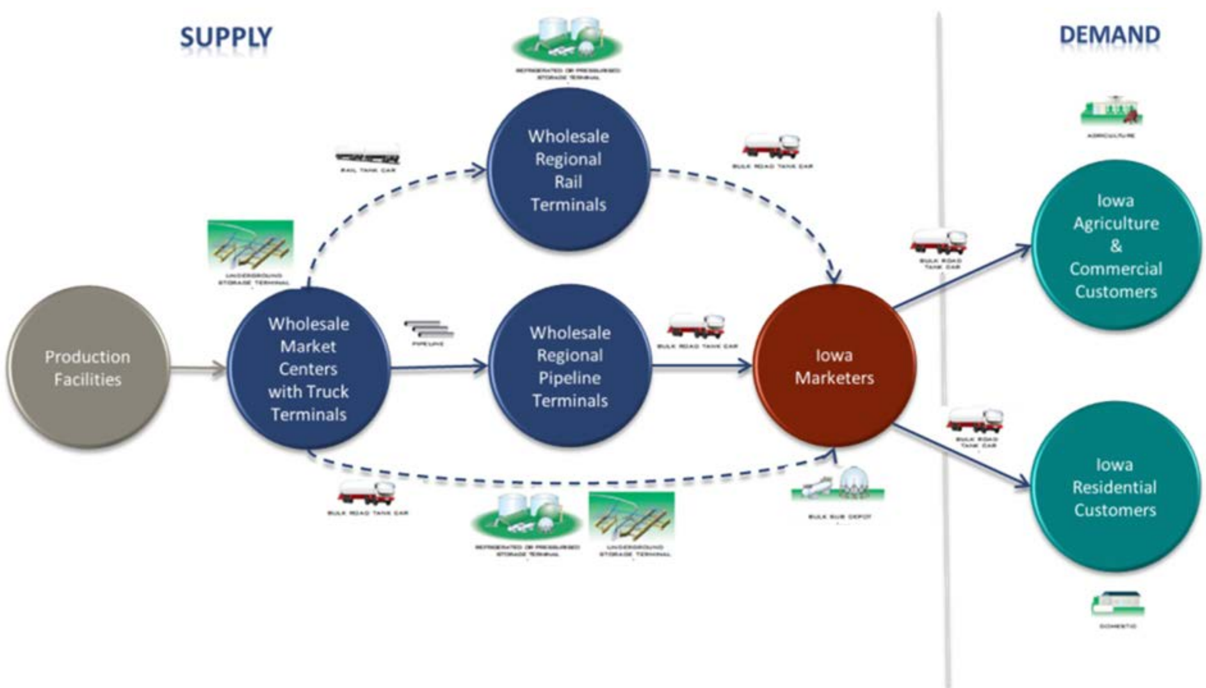

Figure 3 - Iowa Propane Supply Chain Components

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[8] The primary supply chain for propane is outlined in this section. Additional transportation modes, storage facilities, supply sources, etc. may be applicable on an exception basis or in other regions of the United States.

[9] Propane is 270 times more compact as a liquid than as a gas, making it economical to store and transport as a liquid. At atmospheric pressure and temperatures above -44 F, propane exists as a gas. When contained in an approved cylinder or tank, it exists as a liquid and vapor. The vapor is released from the container as a clean-burning fuel gas. (National Propane Gas Association)

[10] See Section 5.1.1 Primary Storage at Market Centers or Hubs

- **Transportation Terminals.** Regional marketers (or retailers) of propane buy propane from wholesalers, who will in turn facilitate delivery upon request, via pipeline, truck or rail from primary storage to a transportation terminal. Propane is loaded onto bulk, highway tanker trucks for transport to marketer secondary storage facilities[11].
- **Bulk Plants and Marketer Storage.** Marketers maintain local and regional inventories of propane in bulk plants and other above or below ground storage facilities for delivery to their end customers. Propane is then transported via smaller, local tanker trucks, referred to as "bobtails", for delivery to end user customers.
- **End User Facilities.** Residential, agricultural and commercial customers buy propane from marketers, who deliver and load it into end user (or tertiary) storage[12]. Propane is stored in aboveground or underground tanks at the end user site and consumed as needed for space heating, grain drying, fuel for farm equipment, etc. (see Section 3).

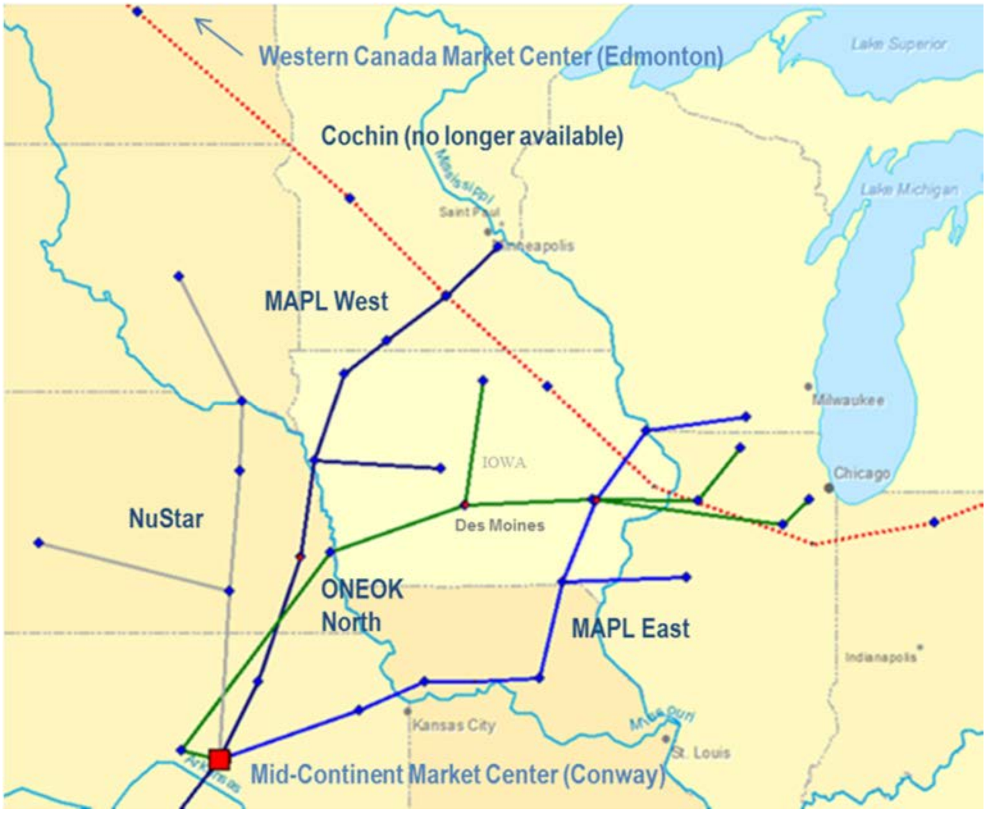

Figure 4 - Regional Propane Pipelines Servicing Iowa

As a state, Iowa is a consumer, not a producer, of propane. U.S. propane production is centered on oil and natural gas facilities in the Gulf region, as well as shale development zones around the country[13]. Thus, Iowa relies on inventories in the Mid-Continent Market Center in Conway, Kansas, as the primary source of wholesale propane in the region.

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[11] See Section 5.1.2 Secondary Storage at Marketers.

[12] See Section 5.1.3 Tertiary Storage at End Users.

[13] See Figure 22 - Map of North American Shale Plays

Propane moves from the market center in Kansas to terminals within Iowa via 3 main pipelines (Mid-American Pipeline (MAPL) East, Mid-American Pipeline (MAPL) West, and ONEOK North System)[14] that service the east, west and central portions of the State (see Figure 4). Until July 2014, propane was also imported into Iowa via the Cochin pipeline from the Western Canada Market Center for contingency supply needs, in order to meet seasonal propane demand surges (see Section 5.2.1).

Iowa marketers are local, regional or national in scope, but service propane end users from locations within Iowa or across the border in neighboring states. Most end users obtain propane from a marketer location within 50 miles of the consumption location (see Figure 5).

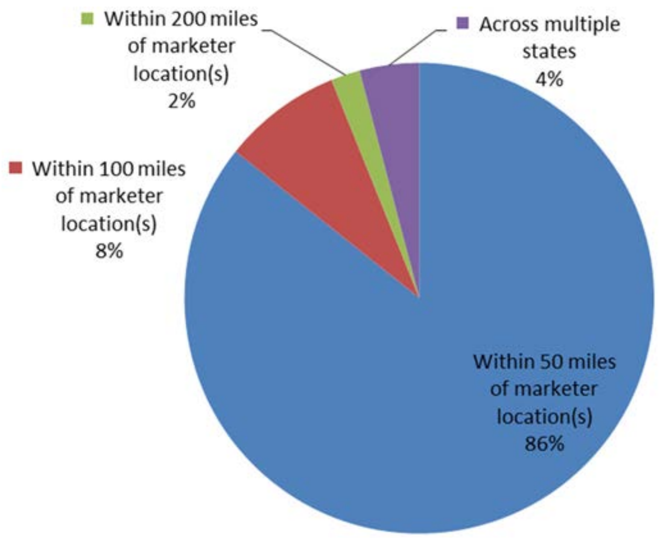

Figure 5 - Distance of Propane End User Customers from Iowa Marketer Location (Propane Supply Chain Survey of Iowa Marketers, 2014)

These elements comprise the core components of the Iowa propane supply chain and form the foundation of its supply chain optimization analysis.

2.2 Optimization Methodology

Supply chain network design and optimization is the discipline to strategically determine the optimal location and size of facilities, and the flow through the network, in order to deliver a company's products to its customers at minimized costs and within the required service level. Companies typically expect to reduce long-term transportation, warehousing, and other supply chain costs by 5 to 15 percent, while improving their service level and operational agility. The methodology is proven in the private sector to optimize complex global supply chain networks for large shippers, and is also an effective and efficient approach to optimize the publicly-owned elements of the freight transportation network.

The Iowa supply chain study leverages these same principles of demand-based supply chain network optimization to evaluate short- and long-term optimization scenarios to better handle fluctuations in propane supply and demand. Instead of optimizing the supply chain of an individual company, the study looks at the supply chain for propane as a whole, across all Iowa industry participants.

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[14] The NuStar East System also runs north from the Mid Continent Market Center, west of Iowa, through Nebraska and South Dakota.

The approach included four fundamental steps that included:

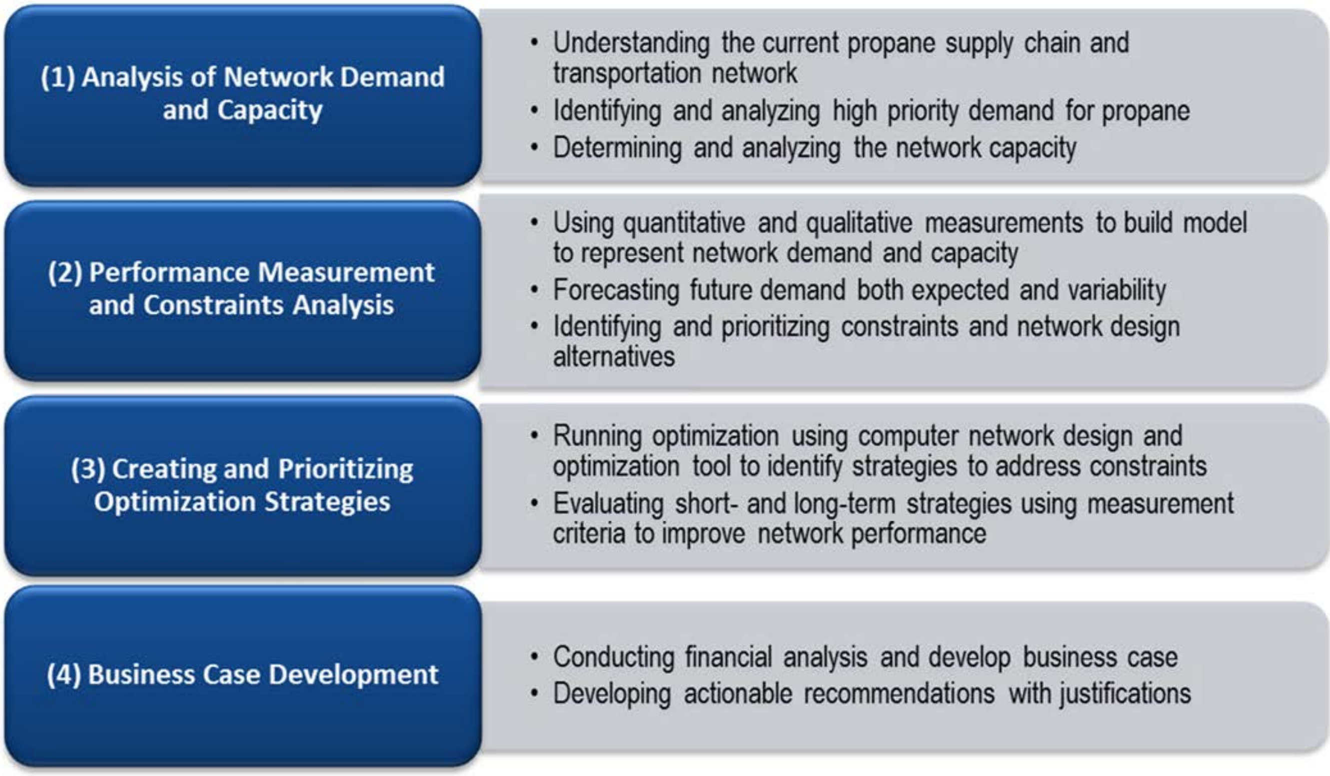

Figure 6 - Fundamental Steps of Supply Chain Network Optimization Analysis

The network optimization model[15] is designed to objectively analyze the optimal network structure, flows, and policies. An optimal network layout can be mathematically determined by looking at both physical and behavior attributes of the network:

Figure 7 - Core Components of Supply Chain Network Design

[15] See Figure 8 - Network Optimization Model Structure

Led by a project working group across Iowa state agencies[16], the process started with collecting data for the quantitative analysis, including:

- Demand by end user group: historical and future
- Sites and storage facilities: end users, marketers, hubs, terminals
- Product/pricing data by source

Data was sourced via a combination of primary and secondary research, including public data sources (see Section 9), as well as interviews and surveys with industry subject matter experts[17] on both the infrastructure and data essential to analyze the Iowa propane supply chain.

The next step was to translate industry practices into policies within the model, based on input from industry experts, to establish a baseline for analysis:

- Sourcing: Where do participants source propane? From single versus multiple sources; Pricing and contracting practices?
- Inventory: What storage is available? What level of inventory is maintained? When is it reviewed? Reordered?
- Transportation: What modes are used to move product from different origins to destinations? What are asset capacity, availability and costs by mode?

With a baseline model defined, the efforts shifted to analyzing scenarios based on what-if analysis to assess:

- The ability to handle current demand with current infrastructure and
- The ability to handle future increases in demand with current infrastructure.

Then the impact of new infrastructure, behavioral changes or best practices on ability to serve demand was modelled to proactively vet alternatives to best handle future demand fluctuations.

With this propane model, the goal was not to determine the "most" optimal solution. The supply chain is operated by multiple independent parties. As an open market commodity, supply and demand drives utilization of infrastructure. Instead, the core objective of the propane model is to understand the constraints within the network, by leveraging network optimization to model sensitivities of different parameters to determine their impact on the ability for the industry to meet demand. It assesses what is "feasible" with the supply chain network infrastructure; and identifies thresholds for when changes in demand or constraints will limit the ability to meet demand at a reasonable price. The targeted benefits, as an output of the model, are to:

- Provide a means to identify potential disruptions in propane supply before reaching crisis levels;
- Model the impact of fluctuations in supply and demand to identify contingencies, while minimizing cost to users;
- Ensure consistent supply of propane to residential and commercial users of propane in Iowa;
- Prioritize investments based on objective measurement criteria;
- Recommend specific and actionable optimization strategies; and
- Develop a reusable framework to support future analysis as market conditions change.

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[16] State agency participants in the Iowa Propane Supply Chain Optimization Strategy project included Iowa Governor's Office, Iowa Department of Transportation (Iowa DOT), Iowa Department of Agriculture and Land Stewardship (IDALS), Iowa Economic Development Authority (IEDA) and Iowa Utilities Board (IUB).

[17] External subject matter experts representing key propane industry stakeholders were leveraged throughout the project, including pipeline operators, wholesalers, transport companies (across modes) and marketers, as well as industry associations, regulatory authorities, educational and research groups.

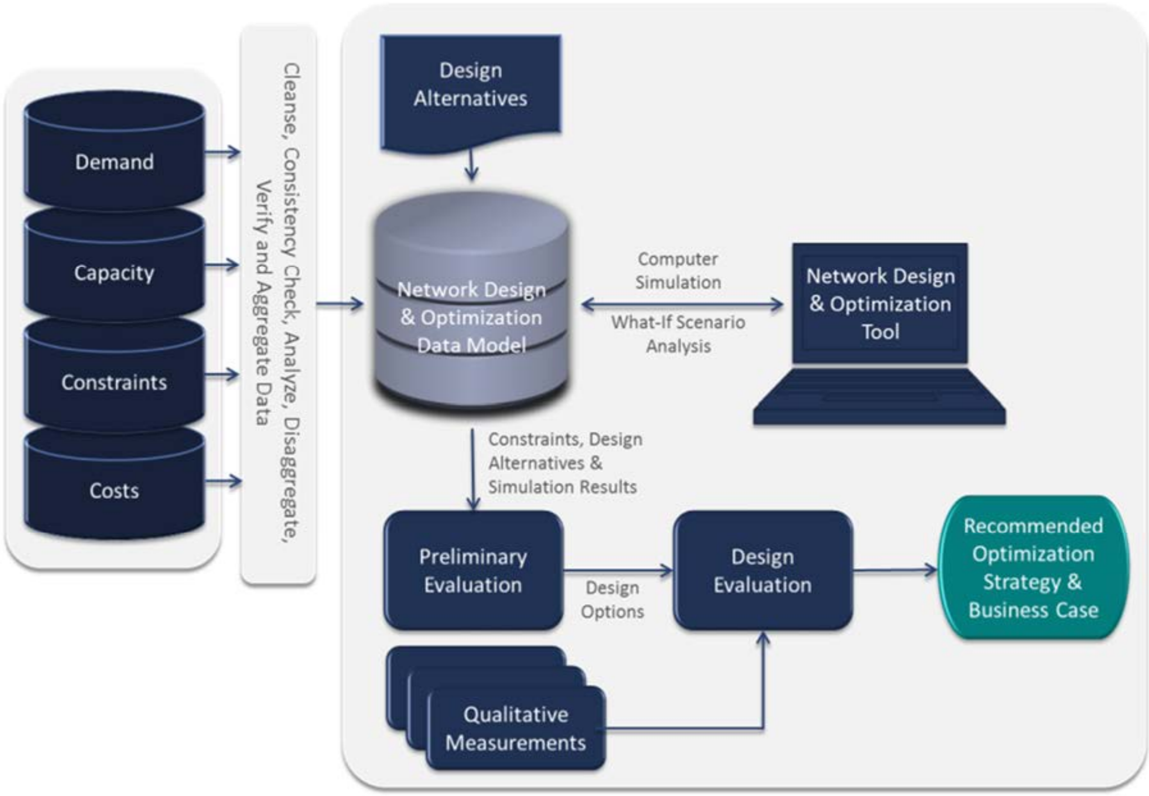

Figure 8 - Network Optimization Model Structure

The next sections of this report will outline the results of this analysis.

3 Understanding the Demand for Propane in Iowa

Propane is used for a variety of different purposes and varies by end user group. The primary end users of propane within Iowa are:

(1) Residential Users

Residential users utilize propane for space heating, as well as other applications such as water heating, cooking and clothes drying.

(2) Agriculture

Agricultural applications include grain drying, space heating for farm buildings (e.g., livestock), and as fuel to run farm equipment, as well as irrigation pumps.

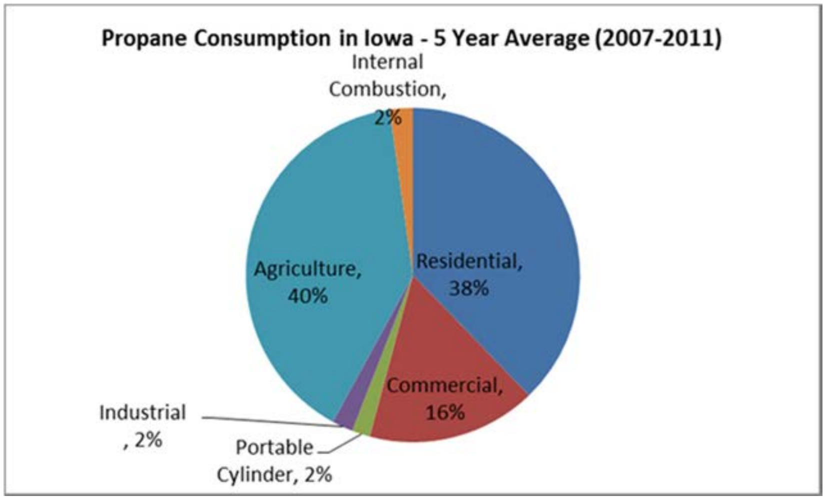

Figure 9 - Propane Consumption in Iowa by Sector, 2007 to 2011

(3) Other Commercial and Industrial Sectors

Propane also has commercial (e.g., heating and fuel source for institutional buildings) and industrial applications (e.g., soldering, cutting, heat treating, and fork-lift fuel).

There is also demand for portable propane cylinders, used as a fuel for gas barbeques, portable stoves, etc.

Propane can also be used to run internal combustion engines, as an alternative fuel to gasoline or ethanol.

The level of demand is affected by both short-term and long-term factors[18]. Short-term factors have an immediate or near term impact (often 30 days or less) on the level of propane consumed within a particular season.

- **Weather** – Weather has an impact on both residential and agricultural demand. Cold weather determines space heating requirements and, combined with moisture content, has an impact on the need for propane for corn drying.
- **Pricing** – As prices increase and thus the economics of using propane as an energy source changes, end users may conserve or use less propane, and/or look at alternative fuel or supply sources.

Factors that can have a longer term impact on the demand for propane include:

- **Economy** – Economic factors, such as Gross Domestic Product (GDP) growth or housing starts, affect the overall size of the residential and other end user markets.
- **Technology** – Changes in technology to add new applications for propane or increase energy efficiency can increase or decrease the demand for propane.
- **Energy Market Trends** – Market shifts between energy sources (e.g., conversion to natural gas) and/or changes in the relative cost of fuel can lead to product consumption changes and switching.
- **Industrial Trends** – Growth in industrial sectors, like the petrochemical industry's use in the production of plastics and other products, can lead to increases or decreases in consumption based on industrial trends.

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[18] (Wilczewski, 2012)

In a network modelling context, demand represents the requests from end users for propane up through the supply chain. Understanding the demand for propane within Iowa is critical to analyze both the ability for the supply chain to support that demand in the future, as well as how its economics will affect the behavior of market participants.

The supply chain analysis starts by evaluating the typical or business-as-usual (BAU) demand for propane within Iowa. However, based on the demand factors noted above, the demand can vary greatly season-to-season, as well as month-to-month within a particular year. To account for these variances, the average monthly demand over a 5-year period[19] is used to define the baseline demand for propane within the supply chain optimization model. It then defines different demand scenarios based on historical fluctuations from the average, future forecasts and theoretical extremes or variances from the average.

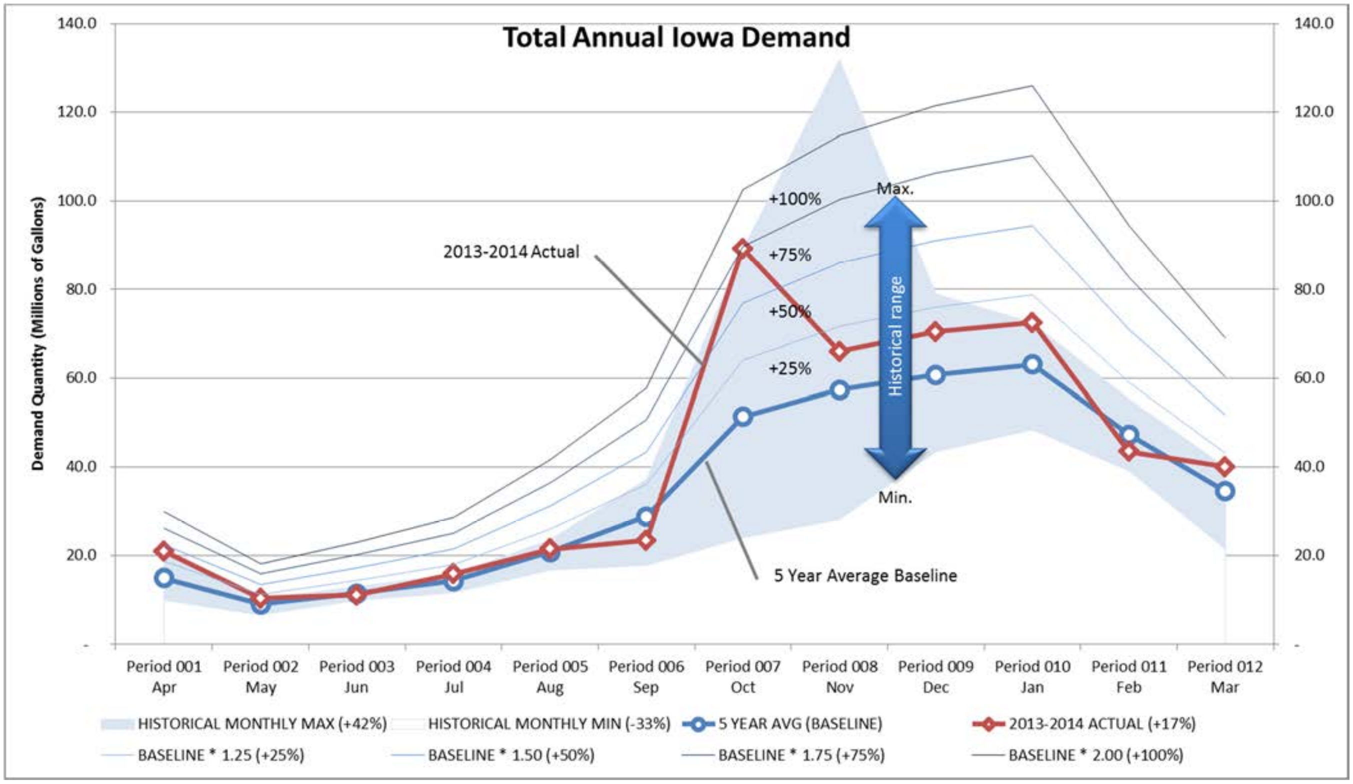

Figure 10 - Total Demand for Propane within Iowa by Month (2008 to 2014) (U.S. Energy Information Administration)

Figure 10 illustrates these year-over-year variances in demand levels, as well as emphasizes the seasonal nature of propane. This seasonality is one of the key challenges faced by the propane industry in Iowa in meeting demand. It results in underutilization of supply chain assets in the propane "summer" season (defined as April to September), while demand levels reach or exceed supply chain capacity in the "winter" season (defined as October through March). Winter represents the peak period for propane, when demand can surge based on weather and market conditions. The shaded area of the graph shows the wide variations in demand above and below the 5-year average.

The red chart line identifies the actual demand in the winter of 2013-2014. Although the demand for propane from October 2013 to January 2014 was above the 5-year average, the demand was not outside historical levels. So what happened in 2013-2014 that put the ability to service demand at risk? There were a variety of factors that

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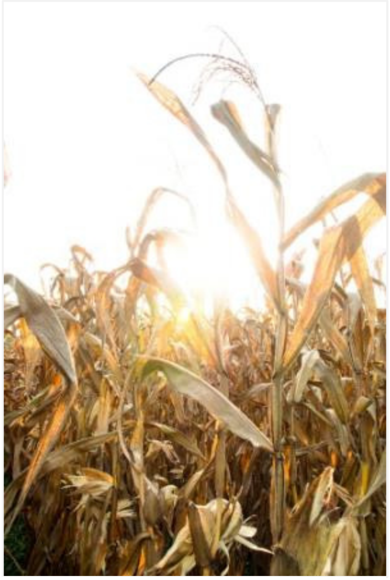
[19] Five-year average demand is based on Energy Information Administration (EIA) data for Prime Supplier Sales within Iowa from April 2009 to March 2014 (U.S. Energy Information Administration). Average monthly demand is defined as the 5-year average for each individual month within a one year time span.

converged in 2013-2014 including the level of demand, as well as supply chain constraints and inventory practices (see Section 5).

But demand in the winter of 2013-2014 should not be considered an anomaly. The winter of 2009-2010 was another high demand season that caused supply chain stress. However, demand in 2011 and 2012 was below the 5-year average. These fluctuations are a normal part of the industry demand cycle. Thus, the risks associated with these variations in demand should be expected to persist in the long term, as well as the need for a supporting contingency supply strategy.



Source: Stock Photography (Copyright - Anuwat Donkiewpri)

To better understand the dynamics of demand within Iowa, the demand data was disaggregated by customer sector and county within Iowa to analyze the constraints in the supply chain network that affect the ability to meet demand across the state.

The predominant consumption sectors in Iowa are agriculture and residential users. These sectors are also inherently the most seasonal and thus have the greatest impact on demand surges. The following sections will look at demand across these end user groups in more detail.

3.1 Agriculture Demand

Iowa has the highest agricultural demand for propane in the United States. Farm or agricultural uses of propane include grain drying, weed control, and fuel for farm equipment and irrigation pumps (U.S. Energy Information Administration). It is also used for space heating in farm buildings for swine and other livestock. However, being the largest producer of corn in the country, Iowa's agriculture demand for propane is driven by corn drying demand.[20]

Source: Stock Photography (Copyright - Steven J. Everts)

The demand for propane for corn drying is highly seasonal, concentrated from late September to early November. Proper corn storage requires moisture content of less than 15 percent. However, farmers often cannot leave corn in the field to dry, due to the risk of crop losses as the weather changes – or if the market price for corn drives an earlier time to market. Thus, corn producers use dryers to reduce the moisture content after the corn is harvested and before it is put into storage[21]. Propane is one of the most common fuel sources for dryers, given its historical cost relative to electricity or other energy options.

[20] Iowa is ranked #1 in the U.S. for corn production at 16 percent of total U.S. production, and #1 for hog and egg production at 28 and 16 percent of total U.S. production respectively. (U.S. Department of Agriculture, 2014)

[21] "Drydown remains as the last major in-field growing season process after the grain reaches physiological maturity – 'black layer.' The grain, although still connected to the cob, is disconnected physiologically from the plant because of the abscission or black layer - no further exchange of either nutrients or water between the cob and the kernel occurs. Although corn is harvested at higher grain moistures for silage and seed corn, ideal harvest moistures for field corn range from 15 to 20 percent and higher. Delaying harvest until corn dries to 15 to 20 percent will save considerable artificial drying costs. Yet as corn dries, hybrids and fields with poor stalk quality become increasingly

Source: Stock Photography (Copyright – Propane Education and Research Council)

However, the level of propane needed can vary greatly from year-to-year. Weather affects the timing of the corn harvest. And rain or snow during the fall harvest can increase dry time. It can take twice the energy per bushel of corn to dry in a cool, wet fall versus a warm, dry harvest season. Studies document a direct correlation between moisture content, corn bushels harvested and propane grain drying demand. The gallons of propane consumed during drying depend on the incoming and final corn moisture content, ambient air conditions during drying, and the degree of saturation reached by the drying air[22]. Propane consumption for high-temperature drying can range from 0.010 to 0.025 gallons per bushel per percentage point of moisture, averaging 0.018 gallons per bushel per point. The volume of grain to be dried depends on harvest timing, weather and other factors[23]. The challenge is that there are wide variations in demand volumes, based on harvest conditions and this demand is highly concentrated within a few weeks. Figure 12 illustrates the magnitude of these potential variances in propane demand, based on moisture and propane consumption, applied against corn yield. Farmers require large volumes of propane within a very short window. During peak periods, propane may be delivered daily depending on size of the propane storage tank(s) on the farm and the corresponding volume of propane need for drying (see Section 5.1.3).

	Moisture (%)			
Incoming Moisture Content	25%	22%	20%	17%
Outgoing Moisture Content	13%	13%	13%	13%
Gallons to dry (per 1000 bushels)	216	162	126	72
Sample Propane Cost at $1.70/gallon	$ 367.20	$ 275.40	$ 214.20	$ 122.40
Sample Propane Cost at $2.20/gallon	$ 475.20	$ 356.40	$ 277.20	$ 158.40
Sample Propane Cost at $2.70/gallon	$ 583.20	$ 437.40	$ 340.20	$ 194.40
Sample Propane Cost at $3.70/gallon	$ 799.20	$ 599.40	$ 466.20	$ 266.40
Sample Propane Cost at $4.70/gallon	$ 1,015.20	$ 761.40	$ 592.20	$ 338.40

Figure 11 - Example of gallons of propane and associated cost required to dry 1000 bushels of corn based on moisture content[22]

susceptible to stalk lodging. Harvest efficiency decreases rapidly and harvest losses increase in fields with lodged corn." (Abendroth, 2010)

22 (Mark Hanna, 2014)

23 "Weather conditions strongly influence in-field grain drydown. Plant characteristics can also influence in-field grain drydown. Early grain maturation usually means faster in-field grain drydown. Later grain maturation usually means slower in-field grain drydown." (Nielsen, 2013)

"Grain moisture loss in the field occurs at a fairly linear rate within a range of grain moisture content from about 40 percent down to 15 to 20 percent, and then tapers off to little or no additional moisture loss after that. The exact rate of field drying varies among hybrids and years." "Field drying of mature corn grain is influenced primarily by weather factors, especially temperature and humidity/rainfall. Simply put, warmer temperatures and lower humidity encourage rapid field drying of corn grain." "Because grain drydown rates are greater when the drydown period is warmer, it stands to reason that a corn crop that matures in late August will dry down faster than one that matures in mid-September." (Nielsen, 2013)

	Moisture (%)			
Incoming Moisture Content	**25.0%**	**22.0%**	**20.0%**	**17.0%**
Gallons to dry 15% of 2013 harvest	70,032,600	52,524,450	40,852,350	23,344,200
Gallons to dry 25% of 2013 harvest	116,721,000	87,540,750	68,087,250	38,907,000
Gallons to dry 50% of 2013 harvest	233,442,000	175,081,500	136,174,500	77,814,000

Figure 12 – Example of gallons of propane required to dry percent of corn harvest based on moisture content [24]

In order to minimize their costs, farmers often wait until they have a definitive need before ordering or taking delivery of propane. They do not want to purchase any excess inventory, nor buy it at the wrong price, which would reduce already narrow margins on a commodity crop, like corn.

In the fall of 2013, these factors had a substantial impact on the propane shortage in the following January. A wet spring delayed planting. Also, cooler-than-normal weather in July and August delayed the corn harvest. By September 2013, the agriculture community was not anticipating a substantial need to source additional propane for grain drying after a dry summer and excess inventory from the prior year[25]. Sales of propane in September in Figure 13 reflect these predictions with demand down 19 percent from the 5-year average.

However, within a couple of weeks the situation changed dramatically, with demand spiking to a 5-year high in October 2013. With above-average rainfall in October, and what turned into a record corn crop, the demand for propane surged. The propane industry was unprepared for the level of propane demand that month. As a result, the sudden demand spike depleted Midwest inventories of propane and reached the limits of the supply chain capacity (see Section 5).

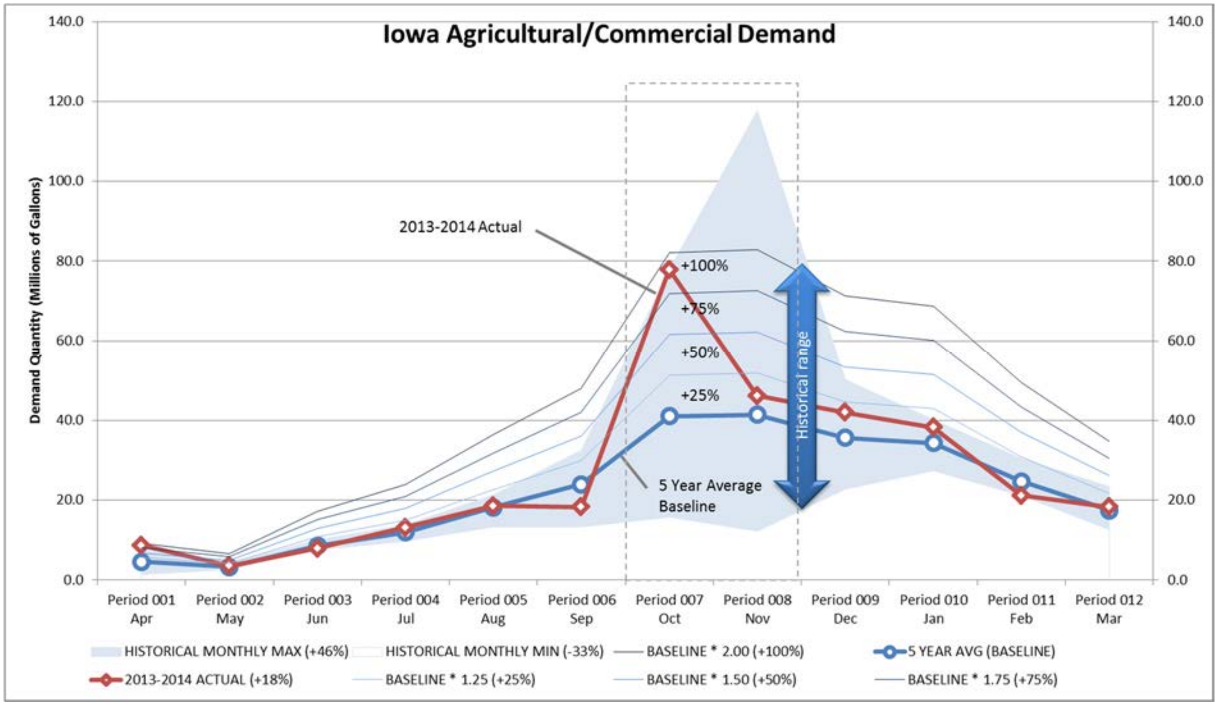


Figure 13 – Agriculture and Commercial Demand Trends (2009 to 2014) (U.S. Energy Information Administration)

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24 (U.S. Department of Agriculture, 2014)

25 It has been reported that the low demand for propane in 2012 due to drought may have resulted in excess inventories in that year. It is believed that some orders may have been lower at the start of the 2013 fall grain drying season, in order to avoid a similar excess inventory situation as the prior year.

These large variations are an inherent part of the demand for propane in agriculture. Where weather and crop conditions change, there will be a corresponding shift in demand. Price also plays a key role. If propane prices are higher, or crop prices lower, farmers may take greater risks and let the crops dry in the field, in order to minimize the costs of drying. In the inverse scenario, more corn may be dried if corn prices are high and/or propane prices are lower, in order for farmers to maximize the economic opportunity. Figure 14 illustrates potential variations in total propane costs to the agriculture community based on changes in price and moisture content.

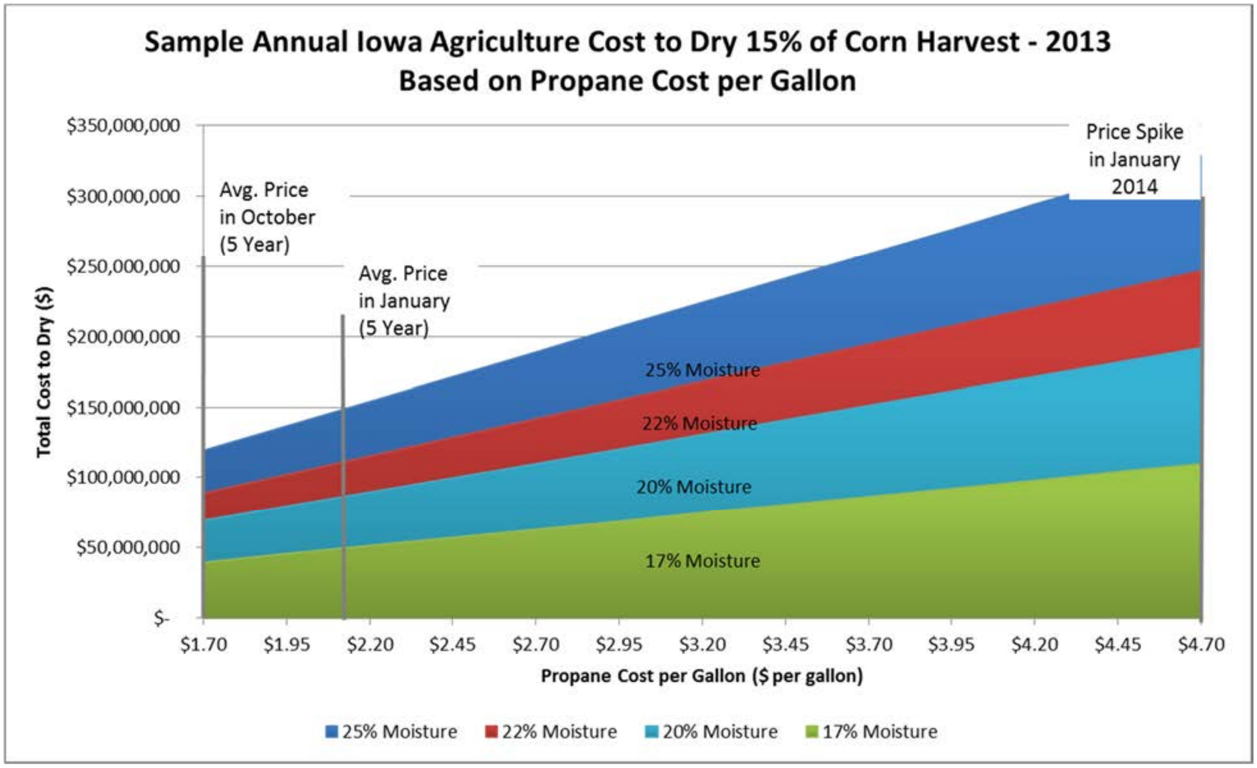

Figure 14- Potential agriculture cost impact scenarios based on changes in propane prices and moisture

The scale of the deviations is one of the Iowa propane industry's greatest challenges. It is essential to plan for contingency supply to meet the demand surges and understand what infrastructure is needed to support it (see Section 4.1). Although grain drying is not the only use for propane in agriculture, it has the greatest volatility and thus presents the greatest risks to its supply chain.

3.2 Residential Demand

Propane is used for a number of applications by consumers within the residential sector. Being the most common fuel used for heating in rural areas where natural gas service is not available, it is an important heating fuel for home and farm residences[26].

As a result, the demand for propane surges within the residential sector based on the number of heating degree days (HDD)[27] from late November through March. Demand is correlated to the weather conditions. Agriculture use for heating livestock buildings and/or commerical and institutional users for space heating, further contributes to the demand during these winter months.

In 2013, the winter weather hit early, increasing the demand for heating right after the surge from fall grain drying. The cold weather conditions persisted through January and February and lasted into May.

Figure 15 illustrates that residential demand represented the highest demand levels with the preceding 5 years throughout this same period. This period of sustained cold stretched the bounds of the supply chain network.

The issue is getting the supply into Iowa to those who need it. With the surge in agriculture demand just prior to the cold weather, the industry faced challenges getting supply to residential users in the next surge. Residential users tend to think of propane as a “utility” based on its use as a heating fuel. However, as an unregulated, open market commodity, consumers are more susceptible to supply chain risks than they would be with a regulated utility[28], like natural gas or electricity. Regardless of its status, meeting demand is essential to public safety and thus of great concern.

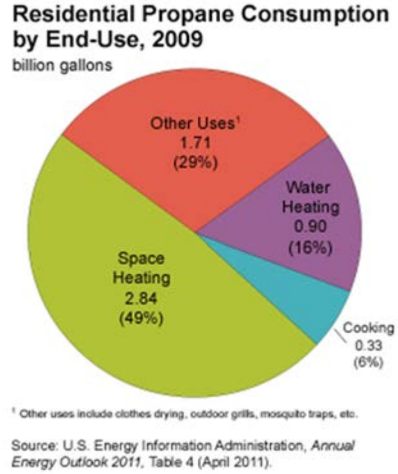

Figure 15 - U.S. Residential Propane Consumption by End-Use (U.S. Energy Information Administration)

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[26] In 2013, 13.3 percent of households within Iowa heated with propane. By county, percentage ranges from 2.3 to 45.8 percent of households.

[27] Heating degree days provide a way to relate each day's temperatures to the demand for fuel to heat buildings. The heating degree days for a particular day are determined by calculating the day's average temperature, by adding the day's high and low temperatures and dividing by two. If the number is less than 65, the value is subtracted from 65 to find the number of heating degree days. (National Weather Service)

[28] “Propane dealers do not have an “obligation to serve” (i.e., an obligation to sell to the public at large); instead, they market to a limited number of customers through individual transactions.” “Propane dealers do not have the attributes of a public service company: they do not deliver propane to consumers by way of permanent physical connections, they do not have an exclusive service territory in which the state has authorized them to operate, they are not monopolies, and they do not have the power of eminent domain. In sharp contrast, providers of regulated public utility services deliver their services by way of a permanent physical connection and are franchised by the state to operate as monopolies exclusively within a given service territory. Such attributes necessitate regulatory control of these entities’ prices and services.” (National Propane Gas Association)

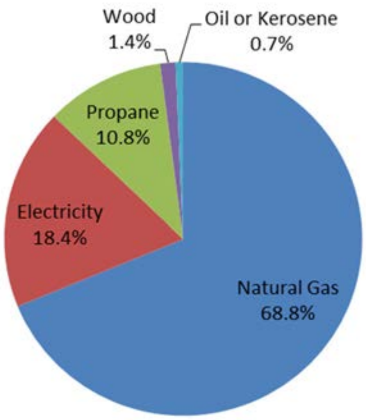

Figure 16 - Heating Source of Iowa Households in 2013

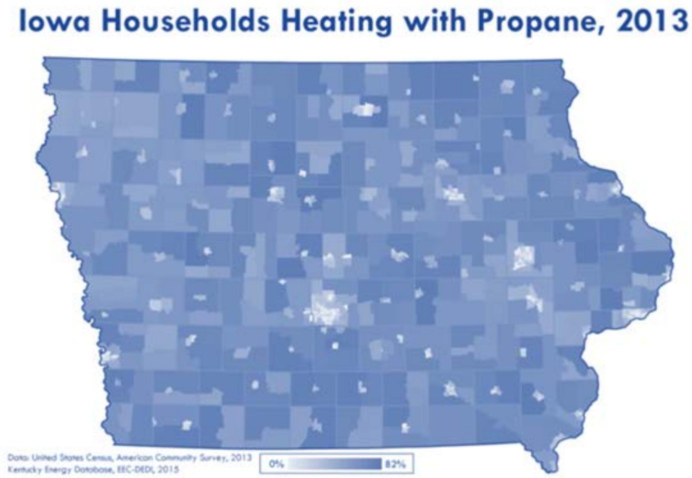

Figure 17 - Iowa Households Heating with Propane, 2013 (Iowa Economic Development Authority, 2015)

These dynamics also have a strong economic impact for Iowa residents. Figure 19 illustrates the potential variations in heating costs to consumers based on fluctuations in propane prices and demand.

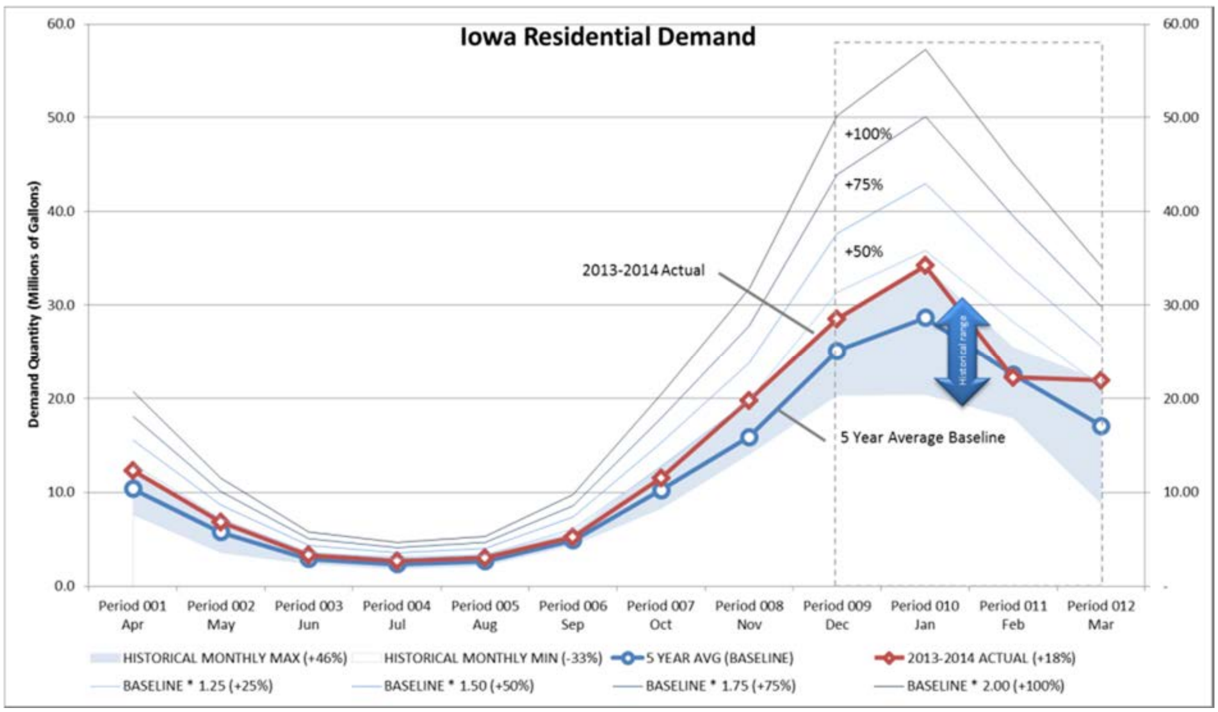

Figure 18 - Iowa Residential Demand Trends (2009-2014) (U.S. Energy Information Administration)

These residential and agriculture demand patterns are regional, centered in the Midwest. National statistics may obscure the issues specific to Iowa. Thus, it is important to analyze demand within Iowa and the region. Where there are commonalities in other Midwestern states and similar needs, it also represents a competition for resources, which affects the overall ability of the propane industry to meet demand. The highly seasonal nature of Iowa's demand for propane also affects the return on investment and business case for industry participants to invest in propane infrastructure within the state (see Section 5.2), further complicating the situation.

	Sample Annual Iowa Residential Cost to Heat - Per Household			
	5-Year Average Demand	2013-2014 Actual Demand	5-Year Minimum Demand	5-Year Maximum Demand
Avg. Annual Gallons per Household	909	1,051	684	1,091
Annual Cost to Heat at $1.70/gallon	$1,545	$1,786	$1,163	$1,854
Annual Cost to Heat at $2.20/gallon	$1,999	$2,311	$1,505	$2,400
Annual Cost to Heat at $2.70/gallon	$2,454	$2,837	$1,846	$2,945
Annual Cost to Heat at $3.70/gallon	$3,363	$3,887	$2,530	$4,036
Annual Cost to Heat at $4.70/gallon	$4,272	$4,938	$3,214	$5,127

Figure 19 - Example of gallons of propane and associated cost required to heat average Iowa household annually[29]

3.3 Other Demand Sectors

Commerical and industrial uses of propane tend to be less seasonal and on a smaller scale within Iowa. Thus, the demand is more predictable and less variable than agricultural and residential use in Iowa. As a result, these sectors are combined with agriculture demand in the optimization analysis.

However, outside Iowa, these sectors are significant. The largest user of propane is the petrochemical industry, centered on the Gulf coast, representing over 49 percent of the demand in the U.S. propane industry for the production of plastics and other products. In particular, there has been significant growth in propane dehydrogenation (PDH) plants to produce propylene that is then processed into the high demand and versatile plastic, polypropylene. Polypropylene is used as packaging material for foodstuff and other goods, as well as many other products, such as household items, clothing and vehicles[30]. Although this industry does not have a signficant presence in Iowa, it creates external competition for propane supply.

Similar competition exists with the export of propane. The production of propane in the U.S. exceeds the domestic demand for propane (see Section 5.1.1). Thus, the industry is investing in facilities to increase the export of propane to other, higher-priced markets around the world. The demand for propane for heating and PDH production is rising in Europe and Asia. And southern hemisphere markets provide additional counter-cyclical outlets for propane in the off-season.

Despite these influences, the optimization model focuses on demand “in Iowa” for propane. Although there is demand for propane in these other sectors or other parts of the United States, the optimization goal is focused on the ability to service demand in Iowa, not in these other markets. Instead, demand outside of Iowa acts as a “constraint” within the model, limiting the resources and supply to the Iowa market (see Section 6.1). For example, an increase in out-of-state, Midwestern demand results in a reduction in available capacity at Iowa terminals. Or an increase in export demand equates to a reduction in available supply at market centers. If Europe’s winter had not been mild in 2013-2014, the challenges in meeting supply in the U.S. would have been even greater in that season. As an open market commodity, economics drive where the propane supply goes.

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[29] Sources: (Iowa Economic Development Authority, 2015), (U.S. Energy Information Administration) (Oil Price Information Service (OPIS))

[30] Approximately two-thirds of global propylene (PP) output is processed into polypropylene (Ceresana, 2014). Global demand for polypropylene totaled 55.1 million tonnes in 2013, with revenues expected to rise by 5.8 percent p.a. until 2021. More than half of global PP output is processed into flexible and rigid (e.g., containers and caps) packaging products. The highest growth rate in upcoming years is expected from the automotive industry, followed by the construction and the electrical and electronics sector (Ceresana, 2014).

4 Sourcing Strategy and Practices

The supply chain optimization model incorporates the sourcing strategy and practices of industry participants. Sourcing policies determine where a propane order will be sourced from and the relationships between parties.

There are four main participants in the Iowa propane supply chain:

- Producers
- Wholesalers
- Marketers
- End Users

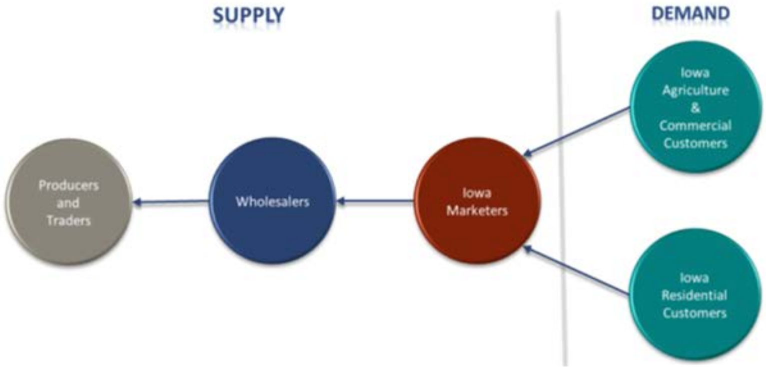

Figure 20 - Propane Supply Chain Sourcing Relationships

Understanding the relationship between these industry participants, as well as their typical behavior, is important in order to effectively analyze future challenges facing the entire supply chain.

4.1 Production and Wholesale Markets

Producers generate propane as by-product of oil refining and natural gas production. As a result, propane is produced prior to demand or consumption by an end user.

Production activities are centered on shale plays in the United States and Western Canada (see Figure 22). Propane is then moved[31] and sold into wholesale market centers or hubs for resale by traders and other buyers. These hubs are commodity exchanges where propane is bought and sold to domestic and international buyers.

Located near major refining and production areas, there are 3 major market centers servicing Iowa, the Midwest, as well as other domestic and international markets.

- Conway, Kansas
- Edmonton, Alberta
- Mont Belvieu, Texas

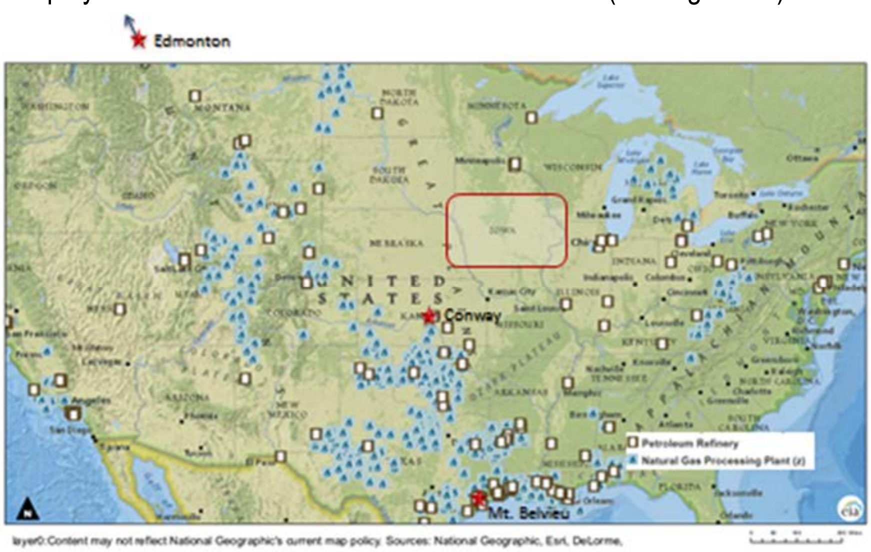

Figure 21 - U.S. Petroleum Refinery and Natural Gas Processing Plants (U.S. Energy Information Administration)

[31] Propane can be sold directly from production facilities. However, the majority of volume is moved to market centers, as producers lack the local storage capacity to maintain inventory for future resale.

Smaller exchanges exist in other locations, such as Hattiesburg (Louisiana), Sarnia (Ontario), and on the West Coast. However, these exchanges are less liquid due to their smaller size and are less accessible via pipeline to the Midwest.

All of the production facilities, major supply sources and exchanges are located outside the State of Iowa (see Figure 21).

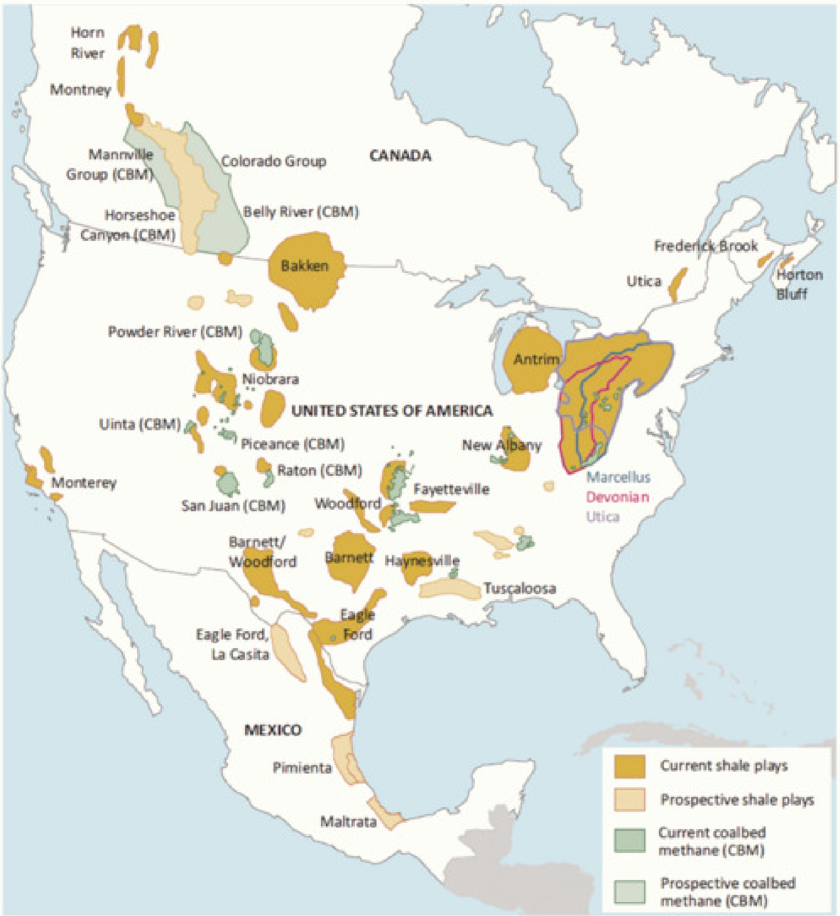

Figure 22 - Map of North American Shale Plays[32] (U.S. Energy Information Administration, 2011)

Wholesalers source direct from producers, as well as from traders who maintain inventory in the market centers. Wholesalers operate across multiple states and source from different locations across the continent, based on the geography of their customers and their needs.

Marketers (or retailers) will source their propane from wholesalers. Marketers can have multi-state, multiple location / single-state or single location operations.[33] Cooperatives and other members of the agriculture industry

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[32] EIA maps are based on studies that estimate undeveloped technically recoverable shale gas and shale oil resources remaining in discovered shale plays. Iowa does not currently have any current or prospective shale plays.

[33] Of Iowa marketers surveyed, 39 percent operate out of a single location. Forty-four (44) percent operate out of 2 to 10 locations. The remaining 17 percent have more than 10 locations. (Propane Supply Chain Survey of Iowa Marketers, 2014)

are also involved in propane distribution in Iowa, due to the large demand in the Midwest region for agricultural applications.

Independent of the organization size, marketers service Iowa end users from locations within Iowa or close to its borders with neighboring states. These Iowa marketers are typically supplied out of inventory in Conway, being the closest market center and accessible via multiple pipelines.

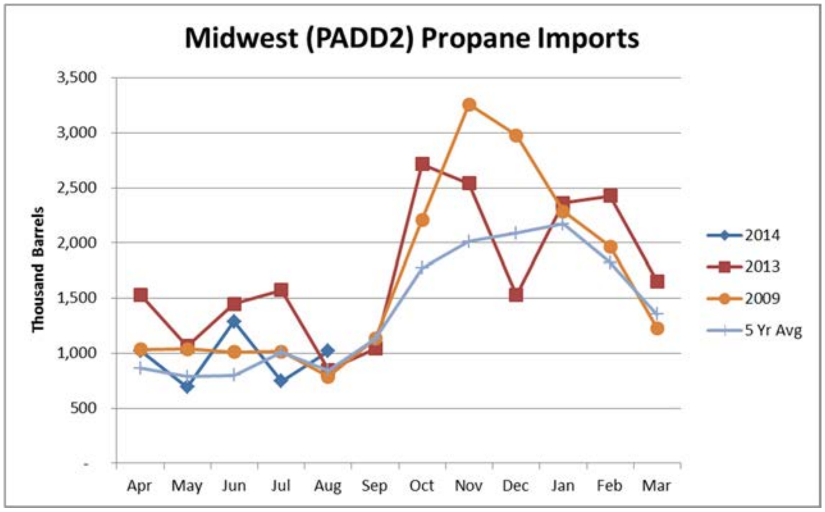

Figure 23 - Propane Imports into Midwest Region, 2013-2014 versus 5 Year Average (U.S. Energy Information Administration)

Pipeline users are incented to focus their sourcing efforts, in order to earn pipeline allocation rights for peak demand periods (see Section 5.2.1). In the summer season, the pipelines run below capacity due to the seasonal nature of propane. In contrast, during the winter months, demand exceeds the capacity of the individual pipelines. Each pipeline has established allocation rules that determines who has access to the limited pipeline capacity during peak periods. In general, allocation in the winter months equals up to 2 to 3 times the volume transported through the pipeline during the summer period. As a result, sourcing efforts are focused on Conway as a "primary supply" source, in order to maximize allocation in winter months.

Given this concentration of supply, marketers are "Iowa-centric" in their sourcing approach, accessing supply via pipeline terminals within the State. Sourcing from other locations is an exception. Yet marketers do need to maintain "contingency supply" sources to meet seasonal surges in demand. In the past, given an abundance of supply in Western Canada, Iowa marketers would leverage Canadian import supply via the Cochin pipeline (that connected the Edmonton market center with New Hampton, Iowa and neighboring Midwestern states[7] as a contingency source. With the Cochin's permanent closure in July 2014, and no other pipeline link between Western Canada and the Midwest, Iowa marketers are forced to look elsewhere for alternative sources for supply.

In their sourcing strategy, marketers must determine when to commit to both inventory and price in their contracting relationships with wholesalers. Until they commit to purchase a particular quantity of propane, there is no guarantee that inventory will be available to the marketer when they need it. In the event of a surge in demand, the marketers must compete with marketers in other states, the petrochemical industry, as well as higher-priced export markets. If these competitors are willing to commit to supply in advance, inventory may not be available to Iowa marketers who do not commit.

It is best practice, according to recent guidance from the National Propane Gas Association (National Propane Gas Association, 2014), for marketers to contract for 50 to 70 percent of its supply, if they have firm demand. The goal is to commit to close to the total estimated demand, so that winter propane needs are readily achievable. Where winter sourcing is difficult or outages are common, it is suggested the marketers contract at the higher end of the range. If more is needed than forecasted, marketers should have contingency contracts at storage facilities, rail terminals, and other supply points. Contingency supply is bought at a premium and usually requires an upfront fee to reserve the right to procure. A contingency strategy usually requires long haul transport contracts as well, taking delivery of propane at more geographically-dispersed, supply points.

It is a separate decision for marketers on when to take delivery of the propane within Iowa. Contracts typically span a predefined period of several weeks or months, where a marketer may take delivery of propane in minimum quantities during that period. Contracts specify a particular pipeline terminal for delivery. But marketers have the flexibility to select an alternate terminal at time of delivery, paying for any differential in pipeline tariffs between the contracted and the delivery terminal.

In addition, marketers are very concerned about when they should lock into a price for propane. End user markets, especially agricultural and commercial, are highly competitive, where a cost differential of a few cents per gallon is said to make a difference in a competitive situation. When locking into a price for propane based on futures markets, marketers take the risk that prices will decline before they can sell it to their customers. In such a scenario, a marketer could lose money if they cannot turn around and sell the propane at a particular price in the retail market. The inverse risk also exists. If the market price increases and a marketer has not locked in a price, they will pay a premium for the propane and strain cash flow during high demand periods. Marketers have to effectively manage through this price volatility, in order to maintain their profitability, as well as their competitiveness.

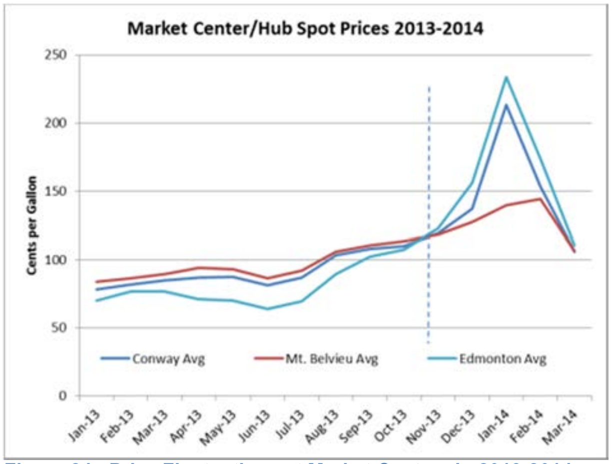

Figure 24 - Price Fluctuations at Market Centers in 2013-2014 (U.S. Energy Information Administration)

To minimize these risks, marketers prefer to gain a commitment from their customers, before committing themselves to an order. Traditionally, suppliers do not take on price risk, ordering based on customer demand. But emergency supply can cost them upwards of $3 to $5 per gallon. With a cost of $30,000 to $50,000 per transport load, 10 loads of propane would result in an immediate cash outlay for a marketer of $500,000. With retail terms with their end user customers of 30 to 60 days, a marketer could face over $1 million in negative cash flow in a peak month.

Price hedging arrangements are available to help marketers manage end user and sourcing cost risks, and protect their margins. Participants leverage swaps to buy at a fixed cost for winter and then sell at an average cost. However, some risks remain with hedging arrangements. As a result, there is a credit risk component (e.g., $25,000 to $30,000 credit line) before a marketer can be approved for such a program. Smaller marketers are the most vulnerable to propane price volatility and the least able to weather its effects. Due to their organization size, these smaller marketers may not meet the financial and credit standards to leverage these price risk management tools, putting them at a disadvantage versus larger competitors.

4.2 Retail Markets

End users, including residential and agricultural customers, typically buy their propane from marketers[34]. End users will either contract with a marketer for propane or order on a will call basis without a contract. Most end users buy from local marketers within a 50 to 100 mile radius, but do have choices on where to source propane[35]. If an end user contracts, he/she will typically source from a single marketer[36]. Will call customers, on the other hand, have a greater tendency to shop around to different marketers, in an attempt to obtain the lowest price upon order.

Similar to marketers, end users have options on when they commit to supply, including:

- No contract / Will Call: Customer determines when the tank is filled
- Have contract: Customer determines when the tank is filled
- Have contract: Marketer determines when the tank is filled on behalf of the customer
- Have contract: Customer pre-buys propane

The greater the commitment from the end customer to the marketer, the better opportunity the marketer has to more effectively manage its own supply situation. Also, the customer will have a lower priority in a high demand situation without the commitment and face greater delivery risk during a shortage.

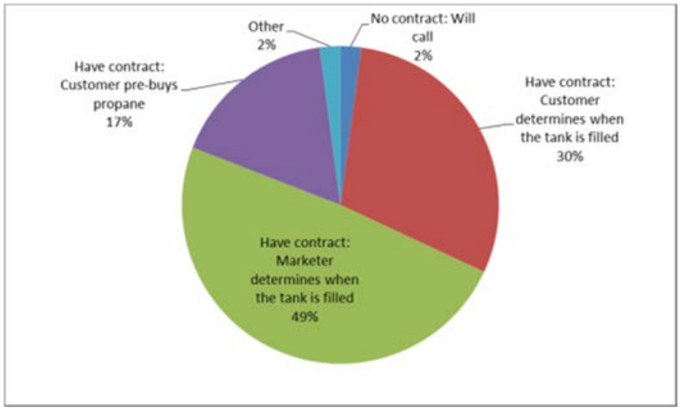

Figure 25 - Most Common Contracting Practices for Agricultural Customers (Propane Supply Chain Survey of Iowa Marketers, 2014)

Although all contract types exist across end user groups, the typical behavior differs between residential and agricultural customers. Residential customers are more likely to contract with a marketer and have the marketer manage their inventory for them. They rely on the expertise of the marketer to determine when the tank needs to be refilled.

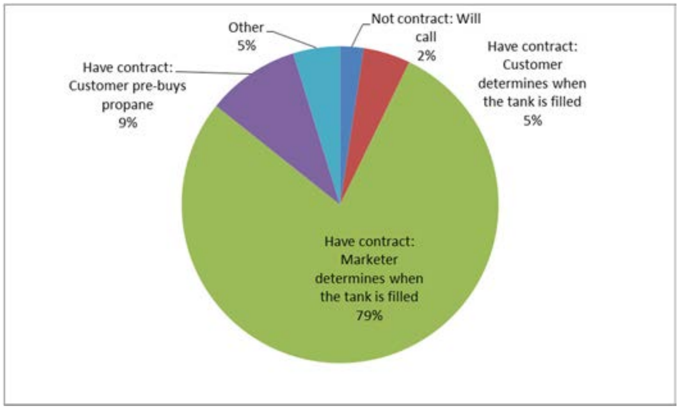

Figure 26 - Most Common Contracting Practices for Residential Customers (Propane Supply Chain Survey of Iowa Marketers, 2014)

Agricultural customers, on the other hand, may contract, but are more likely to manage their inventory on their own. Due to the narrow margins on corn and other agricultural commodities, they want to obtain the lowest cost and minimize an excess inventory. As a result, they are more likely to wait until they have a definite need for propane – and/or try to buy it at the lowest price in the market.
Contracted end users also have the access to pricing programs to help them manage their own price risk

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[34] With larger commercial and industrial customers, there may be exception cases where the end user purchases propane directly from a wholesaler. However, in most cases, end users purchase propane via a marketer or retailer.

[35] Propane is an open market commodity with no regulatory restriction of the geographic service area of a marketer. In practice, the service area is driven largely by economics, with the cost to service increasing with the geographic distance between marketer and end user.

[36] Where a customer is renting or leasing a tank, they would be required to single source from the marketer as part of the agreement. Where a customer owns their tank, they will have greater flexibility to use multiple marketers.

and/or spread out the cost more evenly over a longer period of time. The default is paying market price at time of delivery. Price management options to help end users better manage market volatility include:

- Guaranteed price with monthly payments
- Guaranteed price with pre-pay/pre-buy option
- Guaranteed price with payment on delivery
- Market price with monthly payments

Year	Corn Price ($/bushel)	Propane % of Corn Price - 25% Moisture	Propane % of Corn Price - 20% Moisture
2014	$3.70	9%	6%
2013	$4.49	8%	4%
2012	$6.92	4%	3%
2011	$6.20	7%	4%
2010	$5.23	7%	4%
2009	$3.59	9%	5%
2008	$4.10	10%	6%
2007	$4.29	9%	5%
2006	$3.03	11%	6%
2005	$1.94	17%	10%

Figure 27 - Sample margin impact of propane drying costs as percentage of corn revenue per bushel

Although many have access to these types of programs, not all end users take advantage of the offerings. With residential customers, some of the reasons may include lack of education. If they have experienced relatively stable pricing in the past, they may be fully conscious of the price risk associated with an open market commodity. In other instances, they may think that they can get a lower price by timing their orders to the market.

Often, the behavior is driven by their last experience. After two low demand years in 2011 and 2012, there was little focus on pricing risks for many propane users going into the winter of 2013-2014. However, when product shortages at Conway and in the Midwest region resulted in a spot price spike[37] in January 2014, many end users were surprised by the corresponding effect on the retail prices in Iowa.

Due to the primary supply source originating in Conway, the pricing impact was felt downstream at Iowa terminals[38] for marketers and consequently by retail customers[39]. Having not experienced this type of price volatility in the past, many individuals were unaware of the potential price risk and paid the high market prices (see Figure 1 and 2).

In response, the awareness and adoption of pricing and other risk management mechanisms increased going into the 2014-2015 winter season. However, a continuous decline in propane prices based on propane market conditions and trends in the oil and gas industry may have some individuals questioning the value of these arrangements (see Section 8.3).

The reality is with the ongoing growth in export and PDH demand (see Section 5.2.1), potentially in excess of domestic propane production levels, price volatility will only increase in the foreseeable future. Until domestic and international markets reach equilibrium, pricing mechanisms could help manage through the up and down fluctuations in the market (see Section 5).

[37] Spot prices represent the wholesale prices paid at the market centers or hubs. (Oil Price Information Service (OPIS))

[38] Rack prices represent the prices paid by marketers at pipeline terminals. (Oil Price Information Service (OPIS))

[39] Retail prices represent the prices paid by retail customers. Typically, residential prices will be higher than agricultural or commercial customers due to larger order size.

5 Capacity and Constraints in the Supply Chain

With an understanding of the balance between supply and demand, the analysis then seeks to understand the capacity of the supply chain and the constraints that limit the ability to meet demand. The key constraints in the Iowa propane supply chain are:

- Inventory management; and
- The transportation network.

5.1 Inventory Management

The propane industry maintains inventory in three different types of storage facilities:

- Primary Storage
- Secondary (or Marketer) Storage
- Tertiary (or End User) Storage

Primary storage is defined as stocks of propane at refineries, gas plants, pipelines, and bulk terminals or market centers[40]. These primary storage facilities are where large regional stocks of propane are maintained after production. Most of the primary storage capacity is concentrated at market centers, like Conway, Mount Belvieu and Edmonton, and directly connected into the pipelines and other core transportation networks. Storage is typically underground in pressurized, depleted mines and underground salt caverns[41,42] delivering the required scale and capacity to maintain propane stocks until demanded in the end user markets (see Section 5.1.1).

Secondary storage refers to storage at marketer or retailer locations. It is typically maintained in large, pressurized above-ground tanks[43] at marketer locations in their end user markets.

Tertiary storage refers to storage at end user locations, such as residences, farms and commercial facilities. It is typically maintained in above-ground or underground storage tanks[43] and consumed as needed.

5.1.1 Primary Storage at Market Centers or Hubs

Since propane is inventoried after production and not made to order, primary storage is the main source of propane supply during peak demand periods.

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40 (U.S. Energy Information Administration)

41 “Salt caverns are ideal for gas storage because the salt is impermeable, so the gas cannot escape. This proven technology, which is widely used for propane, natural gas, compressed air and other products, uses brine injection and removal to control propane inflow and outflow from the sealed, pressurized cavern. To receive and store propane, the cavern is completely filled with salty brine. As propane is injected, brine is forced out and stored in adjacent brine ponds or sent to the plant for salt production. To remove propane, the facility operator re-injects brine to force the propane out. Propane is lighter than brine, so the brine inside the cavern resides as a separate layer below.” (Oil and Energy Online, 2014)

42 Not all underground caverns are suitable for propane storage due to potential contamination issues (e.g., aquifer caverns for natural gas storage). Oil storage facilities are also not compatible with propane storage.

43 Above-ground tanks are more common. Underground storage tanks are gaining popularity for larger residential homes.

In general, the cost of propane increases with the distance between the primary storage location and where it is ultimately consumed. Given its proximity and connectivity to Iowa via multiple natural gas liquid pipelines, Conway is the main primary storage facility servicing Iowa.

Marketer and end user storage capacity is insufficient to meet all demand during the peak winter demand period (see Section 6). As a result, propane stocks at Conway are critical to the ability to meet agricultural and residential demand in Iowa.

Figure 28 - PADD Region Maps by State (U.S. Energy Information Administration, 2012)

Historically, the stocks in Conway built in the summer months, as production continued steadily, but market demand across the country was down. This pattern was consistent over time. Based on their past experience, marketers came to rely on a predictable supply at Conway, when demand started to ramp up in the fall.

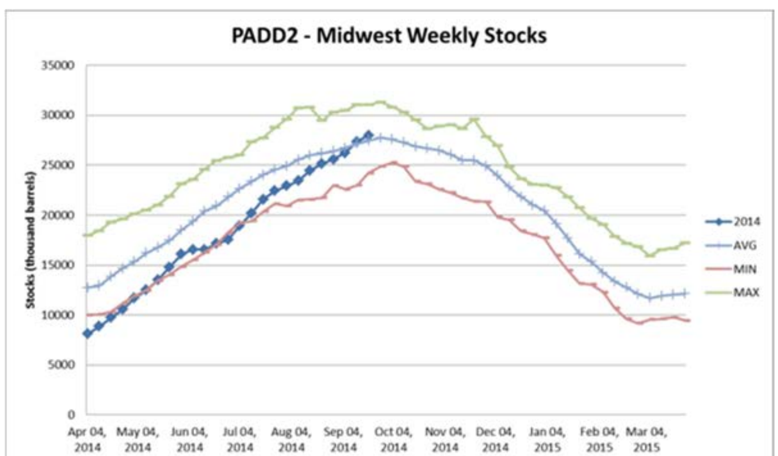

Figure 29 - Midwest Propane Inventory Trends (U.S. Energy Information Administration)

In 2013, this pattern changed. The inventory levels at Conway, represented by PADD 2 Midwest weekly propane stock statistics[44], did not build in the summer of 2013 as supply moved to the Gulf region to support export and petrochemical demand. By the time demand rose with the high grain drying requirements in the fall, inventory levels at

[44] "The Petroleum Administration for Defense Districts (PADDs) are geographic aggregations of the 50 States and the District of Columbia into five districts: PADD 1 is the East Coast, PADD 2 the Midwest, PADD 3 the Gulf Coast, PADD 4 the Rocky Mountain Region, and PADD 5 the West Coast. (U.S. Energy Information Administration, 2012) See Figure 28 for map of states included in PADD 2. The area surrounding Conway and nearby Bushton, Kansas represents the majority of primary storage in the PADD 2 district. Thus, PADD 2 stock levels are used as a proxy for inventory levels at this market center.

Conway had fallen below the historical 10-year minimum.[45]

The repercussions were felt for the rest of the season. The industry struggled to meet demand in Iowa and other Midwestern states, as the prolonged cold weather fueled demand without the opportunity to restock reserves. In January 2014, when the market realized that Conway faced a potential shortage or ultimately a stock-out, the wholesale price spiked at the market center in response to the supply-demand imbalance.

This change in the seasonal inventory trend was not a single year anomaly. It represented a shift in market infrastructure and an illustration of the open market nature of the commodity. Although Iowa marketers have historically been able to rely on predictable supply from Conway, the availability of inventory to marketers, and ultimately end users, in Iowa is not guaranteed now or in the future.

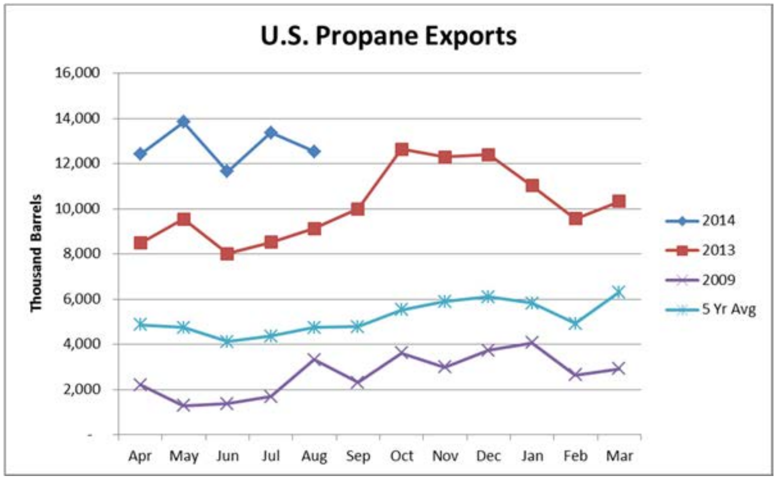

Figure 30 - U.S. Propane Export Trends (U.S. Energy Information Administration)

Inventory is maintained at the market hub by traders, wholesalers and other market players. It can be sold or committed to a buyer of wholesale propane. But the propane may not actually leave the primary storage facility until a future point in time, closer to end user consumption. Thus, not all propane stocks reported in PADD 2 are accessible by the Iowa propane market. There is little transparency with current U.S. Energy Information Administration (EIA) statistics into what volume of propane is actually "available" in practice[46].

[45] (U.S. Energy Information Administration, 2012)

[46] EIA data lacks granularity and there is a time lag in reporting. NPGA has been pursuing changes in EIA reporting to include collecting (1) detailed data on propane storage, including separate data for propane and propylene; (2) inventory data at higher resolution than PADD level; (3) storage capacity at major market centers including Conway, KS, Mt. Belvieu, TX, and sub-PADD regions, as well as more timely propane export data from the Commerce Department. (National Propane Gas Association, 2014)

Company	Export Capacity Mil. Gallons/m	Location	Start-up	Cost ($Million) *Estimated
Targa	154	Galena Park, TX	2014, Q3	$240
Sunoco Logistics LP	51	Marcus Hook, PA	2014, Q3	$270
Occidental	96	Corpus Christi, TX	2015, Q1	$400
Sunoco Logistics LP	253	Nederland, TX	2015, Q1	$400*
Enterprise	63	Houston Ship Channel, TX	2015, Q1	$100*
Pembina Pipeline Co.	51	Prince Rupert, BC	2015, Q3	$320*
Boardwalk	128	Moss Lake, LA	2015, Q4	$700*
Enterprise	291	Houston Ship Channel, TX	2015, Q4	$500*
Phillips66	185	Freeport, TX	2016, Q3	$1,000
Sage Midstream	60	Longview, WA	2016, Q4	$275
Total Proposed	1,332			$4,305*

Figure 31 - Projected Growth in Export Terminal Capacity (ICF International, 2014)

Because it is an open market, propane supply will gravitate to markets where there is increasing demand and higher prices, in order to maximize margins and return on investment. With the growth in the oil and gas industry in recent years, the United States has become a net exporter of propane. The U.S. produces more propane than it can consume in its domestic markets. Domestic demand is also trending flat or declining by segment, due to increases in efficiencies, insulation, etc. As a result, the U.S. propane industry has sought new outlets for its supply. Heating and PDH demand in Europe and Asian markets, like China, provide a market for this excess production at a premium price. And Central and South American markets provide similar opportunities with countercyclical demand, reducing the economic challenges of demand fluctuations and underutilization of assets in the off-season.

In 2013, two major new propane export terminals came online in the Gulf region, developed in response to the demand potential in these international markets. With a new outlet, supply that would have normally built propane inventory levels in Midwest during the summer months moved south to the Gulf for export. The result was a significant increase in export levels in 2013 and 2014. With several more export terminals scheduled to open over the next few years, this trend is expected to continue (see Figure 31). As long as propane garners a premium price in these markets over domestic markets, the natural market tendency will be for propane supply to be exported[47].

The growth in demand for products made with PDH has contributed to this supply movement. As new PDH production facilities open, more propane is demanded in the Gulf region to fuel the PDH production. Combining projected PDH and export capacity growth over the next few years, the total domestic and international demand for U.S. propane is on pace to exceed U.S. production forecasts.

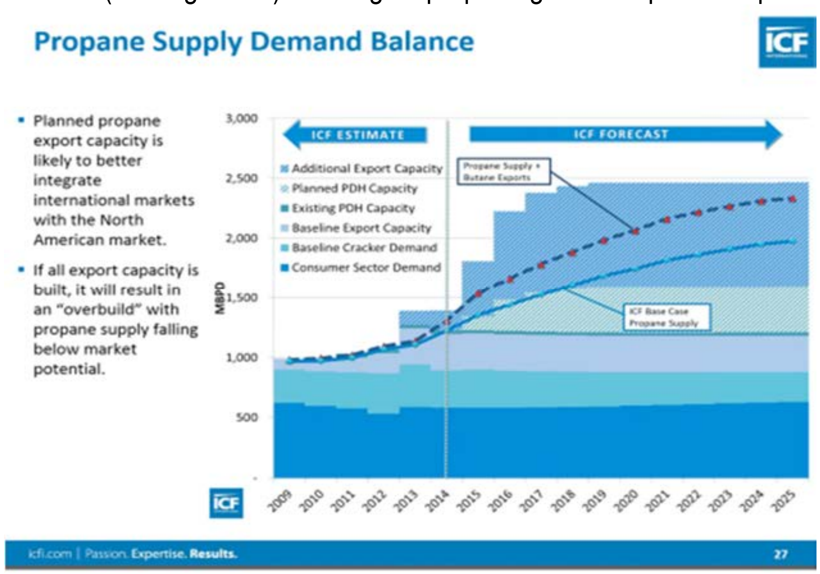

Figure 32 - Forecasted Supply versus Demand (ICF International, 2014)

[47] The demand for U.S. propane exports depends on the arbitrage between U.S. LPG spot prices against other markets, and the freight and terminal costs to transport the propane to the international market. The lower cost of U.S. propane needs to outweigh the higher freight cost to create an arbitrage opportunity and drive propane exports from the U.S. Conversely, high ocean freight costs dampen the demand for U.S. propane exports. (Fattouh, 2014)

There are two key implications of these developments for Iowa marketers:

- **Inventory levels at Conway are not guaranteed.** Supply will continue to move to the Gulf and other international markets.
- **Access to what inventory does exist at Conway is not guaranteed.** Just because there is propane in storage, does not mean it is available.

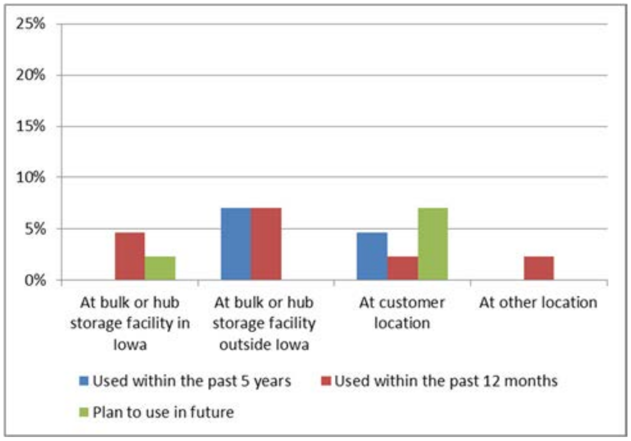

Figure 33 - Marketer Utilization of Primary Storage Facilities (Propane Supply Chain Survey of Iowa Marketers, 2014)

Propane supply will go first to those parties that are willing to commit to buying the inventory in advance. It is common for exporters to commit to supply due to corresponding commitments to leverage export terminal capacity. Marketers, on the other hand, prefer to wait until they have a commitment from their customers until they commit to supply (see Section 4). This historical inventory management practice of the marketers and their end customers presents greater risks to the Iowa propane industry as infrastructure and demand patterns change.

5.1.2 Secondary Storage at Marketers

To effectively manage these risks, Iowa marketers need to look at their inventory capacity and management practices.

Marketers maintain propane inventory in their storage tanks at their locations within or near Iowa. Inventory is stored in these tanks until delivery to their end user customers. Iowa marketer storage capacity averages around 250,000 gallons[48], but varies based on the size of the marketer.

Source: Stock Photography (Copyright - Sherry Yates Young)

However, how many days of supply that the marketer has on hand can vary greatly, depending on their inventory policies around minimum inventory levels, review frequency and reorder points. Ten to fourteen days of supply is recommended, with a national average across marketers of 8 to 10 days (National Propane Gas Association, 2014). Actual days of supply on hand for some marketers are estimated at as low as two. Marketers with a fewer number of days of inventory on hand are more vulnerable, if there is an unexpected surge in demand. They have to source propane from primary storage in Conway or other markets, in order to replenish their supply and service their customers. Access to propane supply in the Conway market center, as well as the available capacity in the transportation network, is consequently going to have a significant impact on the ability to meet customer demand (see Section 6).

Inventory management is particularly challenging during fall grain drying. The storage capacity of its agricultural customers can be of similar size and scale as that of the marketer. With corn drying demand concentrated into a

[48]Typical bulk storage plant tank size is 18,000 to 30,000 gallons per tank (National Propane Gas Association).

few short weeks, marketers do not have the storage capacity to meet high agriculture demand from inventory. Marketers have to manage through an intense period of frequent, if not daily, inventory turns (see Section 3.1).

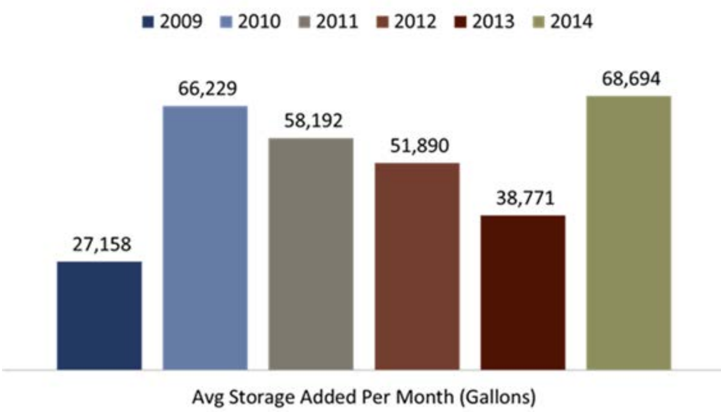

Figure 34 - Growth in Storage Capacity for Tanks Over 2,000 Gallons (Iowa Department of Public Safety, State Fire Marshal Division, 2009-2014)

To reduce these risks during peak demand, filling tanks in the off-season can reduce demand exceeding inventory storage and transportation capacity. Summer (or spring) fills ensure that more propane is in Iowa when demand starts to surge, relieving the pressure on the transportation networks to bring high volumes of additional supply into the State. These early fills allow for the reduction in the seasonality and better utilization of transportation and inventory assets. They also require an earlier commitment by end users to inventory.

Increasing marketer storage can also help increase secondary storage capacity within Iowa and the associated transportation network risks (see Section 5.2). After the shortage in 2013-2014, many marketers and large end users increased their inventory capacity by adding storage tanks (see Figure 34)[49]. A similar response was seen in 2010 after the last major demand surge. If a marketer commits to the supply in advance, as well, they reduce the risk of inventory at the Conway primary storage facility not being sufficient to meet their needs. However, they may also increase their price risk (if not mitigated), if end user prices fall in proportion to what they committed to in the wholesale markets in advance (see Section 4).

5.1.3 Tertiary Storage at End Users

Logically, marketer inventory practices are driven by demand and the inventory practices of its end user customers.

End user storage represents the largest storage capacity within the boundaries of the State of Iowa. End user storage capacity is estimated at nearly eight times more than the inventory capacity across marketers[50]. Residential users maintain above-ground propane storage tanks in backyards with an average capacity of around 500 gallons. Agricultural and commercial users often have tanks ranging from 2,000

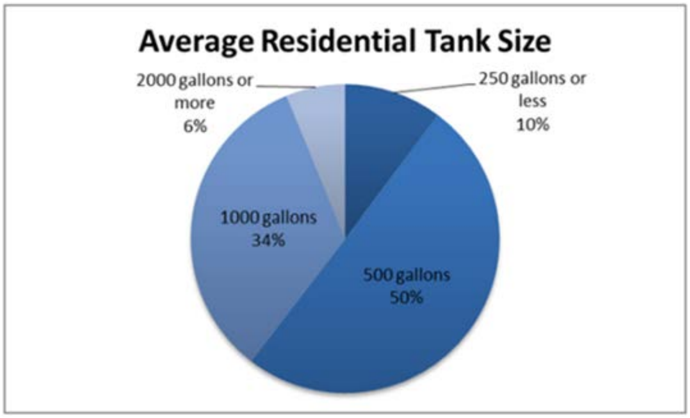

Figure 35 - Average Residential Tank Size in Iowa (Propane Supply Chain Survey of Iowa Marketers, 2014)

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[49] Inspections/installations of LP tank installations and systems have to be conducted to determine code compliance in accordance with NFPA 58, 2014 edition, as formally adopted by the Iowa Administrative Code 661-226 (101). Statistics are based on plans submitted to the State Fire Marshal's Office for "Stationary installations utilizing storage containers of over 2000-gallon individual water capacity, or with aggregate water capacity exceeding 4000 gallon". (Iowa Department of Public Safety, State Fire Marshal Division)

[50] National estimates of tertiary storage are at nearly nine times greater than marketer plant storage (National Propane Gas Association, 2014). Tertiary storage estimates in Iowa from optimization study are close to eight times greater than Iowa marketer plant storage.

gallons up to over 30,000 gallons (see Figure 36 and Figure 37)[51]. However, how the two groups manage their inventory is quite different.

Roughly 56 percent of Iowa marketer customers are residential[52]. Approximately 78 percent of residential users have a contract with a marketer (versus a will call arrangement) and have the marketer manage their inventory. Thus, Iowa marketers have a significant influence or opportunity to drive inventory management best practices at the end user level.

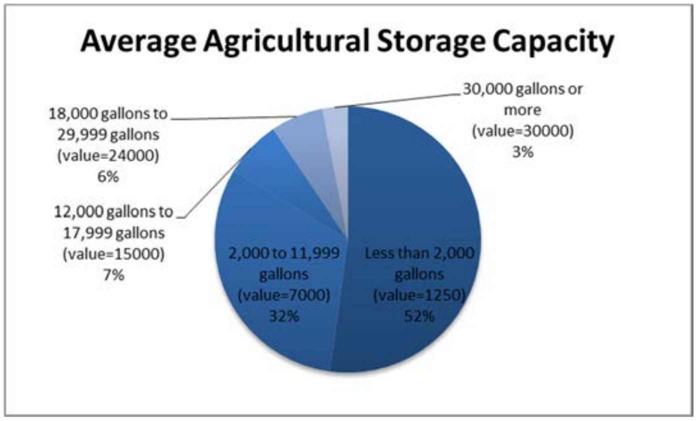

Figure 36 - Average Agricultural Storage Capacity in Iowa (Propane Supply Chain Survey of Iowa Marketers, 2014)

Service level is critical for residential users. Being used for home heating, a stock-out is not acceptable due to the public safety risk. Thus, effective inventory management is essential.

Given the convergence of factors that resulted in a propane shortage in the winter 2013-2014, there was great risk to the ability to meet service levels that season. Many marketers also are reported to have half-filled tanks, in order to stretch their inventory further, but at increased operational and transportation costs.

In 2014, there was an effort by many marketers to look at those inventory management practices, reporting summer fills at approximately 71 percent of residential customers. Roughly 31 percent used budget or monthly billing and 58 percent locked in price as well, in order to manage through the inventory cost and cash flow timing implications (Propane Supply Chain Survey of Iowa Marketers, 2014). With agricultural users, Iowa marketers have less influence on inventory practices. Agriculture users are less likely to commit to inventory in advance (see Section 4). The consequences are great if they pay too much for propane, versus the revenue earned on crops, and/or if they buy excess propane. With low grain drying demand in 2011 and 2012, many agriculture users experienced the effects of excess inventory, which reduced their willingness to commit to inventory in advance in 2013 (see Section 3.1).

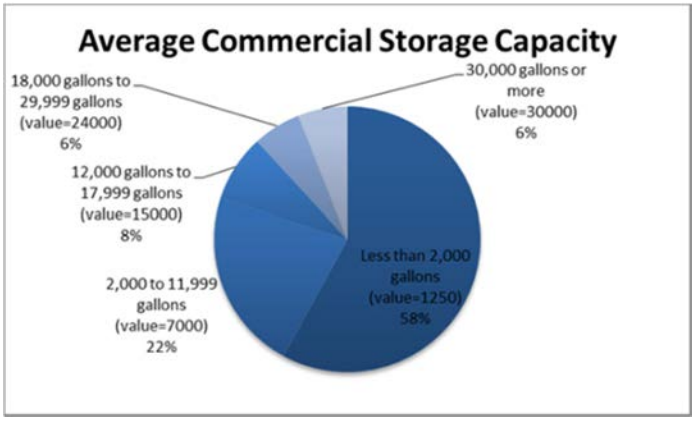

Figure 37 - Average Commercial Storage Capacity in Iowa (Propane Supply Chain Survey of Iowa Marketers, 2014)

[51] See Figure 40 - Sample Propane Tank Sizes and Uses

[52] (Propane Supply Chain Survey of Iowa Marketers, 2014)

One of the best practices is to ensure that end user storage is proportional to the need. In agriculture, inventory turns could range greatly depending on corn yield, moisture content and available on-farm storage (see Figure 38 and Figure 39)[53].

Some agriculture users increased storage after the winter of 2013-2014 (see Figure 34). However, the challenge is that competition across industries for steel, especially with the growth in rail tanker demand in the oil industry (see Section 5.2.2), may increase lead times on new tanks for up to 15 months. Thus, increases in inventory capacity require advance planning versus providing a short-term fix.

Marketers need to work with customers on inventory best practices, in order to facilitate better inventory management further upstream in the supply chain. More effective inventory management by all parties is essential to increasing available capacity and supply for the Iowa propane industry during future periods of high demand.

Acres Dried Per Tank (based on 185 bushels per acre)

	Moisture (%)			
Tank Capacity (Gallons)	**25.0%**	**22.0%**	**20.0%**	**17.0%**
2,000	50	67	86	150
5,000	125	167	215	375
18,000	450	601	772	1,351
24,000	601	801	1,030	1,802

Figure 38 - Estimated Acres Dried by Corn Moisture and Tank Size

# of Tank Fills at 20% Moisture

	Acres per Farm			
Tank Capacity (Gallons)	**333**	**500**	**1000**	**2000**
2,000	3.9	5.8	11.7	23.3
5,000	1.6	2.3	4.7	9.3
18,000	0.4	0.6	1.3	2.6
24,000	0.3	0.5	1.0	1.9

Figure 39 - Estimated Tank Fills based on Acreage and Storage Capacity

53 Calculations based on propane consumption assumptions for grain drying noted in Section 3.1

Figure 40 - Sample Propane Tank Sizes and Uses (GasTec, 2014)

Sample Tank Sizes	80% Capacity[54]	Residential Use	Commercial Use
20 lb. 	Holds close to 5 gallons of propane	• BBQs • Mosquitos catchers • Patio Heaters	
420 lb. or 125 gallon 	Holds 100 gallons of propane	• Home heating • Hot water • Dryers • Fireplaces • Pool heat	• Heating • Commercial cooking • Dry cleaning • Temporary heating
500 gallon 	Holds 400 gallons of propane	• Whole home systems • Home heating • Generators • Pool heat	• Heating • Commercial cooking • Dry cleaning • Crop drying • Temporary heating
1000 gallon 	Holds 800 gallons of propane	• Whole home systems • Home heating • Pool heat	• Heating • Commercial cooking • Dry cleaning • Crop drying • Temporary heating
30,000 gallon 	Holds 24,000 gallons of propane		• Large communities with metered service • Commercial facilities • Bulk plant storage • Agricultural uses

[54] Tank sizes are quoted in water gallons. However, a tank filled to 80 percent of capacity with propane is considered full, allowing for expansion.

5.2 Transportation Network

The transportation network supporting the movement of propane into Iowa is comprised of 4 primary modes of transportation:

- Pipeline
- Rail
- Bulk Transports (or Tanker Trucks)
- Local Delivery Trucks (or Bobtails)

The key challenge faced by the Iowa propane industry in the winter of 2013-2014 was the ability to get propane to the end users who needed it, when they needed it. Thus, understanding the constraints in this transportation network is crucial, in order to ensure that Iowa end users have access to propane during demand surges.

5.2.1 Pipeline

Pipeline is the predominant method of shipping propane within the United States. There are over 70,000 miles of interstate pipelines[55] connecting:

- Production areas with market centers for primary storage and large petrochemcial facilities for consumption; and
- Primary storage facilities with end user markets in the Midwest and other regions.

Pipeline is the most economical method to move propane over long distances (see Section 6.2). As a result, where production and storage facilities are not accessible via pipeline, the price for propane may be discounted versus other markets to account for the higher cost of transportation via other modes. In some production areas, propane may even be flared off (where permissable) when it is produced during oil refining or natural gas production, due to the high cost and difficultly of transporting it to a wholesale propane market.

Iowa is serviced by 3 major pipelines out of the MidContinent market center near Conway, Kansas (MAPL East, MAPL West and ONEOK North), facilitating movement of the majority of propane consumed in the State of Iowa. These pipelines service the end user demand in agricultural, commercial and residential markets within Iowa and neighboring Midwest states.

One of the pipelines is dedicated solely to the movement of propane with the other two being “batch” pipelines, supporting the movement of other natural gas liquids (NGLs), like butane and ethane.

The cost of moving propane is a fixed price for a defined volume of propane moving from a specific origin to a specific destination. Generally, the cost increases the further the destination terminal is from the source. The cost of the movement is a published tariff and regulated by the Federal Energy Regulation Committee (FERC)[56].

For the most part, delivery of propane from Conway to an Iowa pipeline terminal for pickup by a marketer is a “just-in-time” type of process. A small amount of inventory is maintained at the pipeline terminal[57] to speed loading of

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[55] (U.S. Energy Information Administration)

[56] “The Federal Energy Regulatory Commission, or FERC, is an independent agency that regulates the interstate transmission of electricity, natural gas, and oil. FERC also reviews proposals to build liquefied natural gas (LNG) terminals and interstate natural gas pipelines as well as licensing hydropower projects.” (Federal Energy Regulatory Commission)

[57] There are two terminals located beside primary storage facilities within the State. However, this storage capacity is operated independently of the pipeline. There is mined storage in Des Moines with 155,000 gallons of capacity in Iowa City with 340,000 gallons of capacity. (S.C. Whitley, 2011)

tanker trucks for bulk transport[58]. When a marketer takes delivery of a propane order from a wholesaler with inventory at Conway, the propane is accessible from terminal inventory or when the next batch of propane reaches the terminal. In a typical flow, the marketer is not waiting for the propane to move from Conway to an Iowa pipeline terminal. At the time that delivery is requested, the propane is typically either already at the terminal or in transit from Conway.

5.2.1.1 Pipeline Capacity and Utilization

The capacity of the pipelines is fixed. The flow of liquids cannot exceeed the maximum theoretical capacity of the physical pipe. In practice, the available capacity for propane may be less, where a portion of a batch pipeline is commited to the flow of other natural gas liquids. Building new pipelines or changing the types or flow of products (beyond the current mix of compatible NGLs) moved through a pipeline requires signficant financial investment, as well as time to implement. Thus, changes in pipeline capacity are long-term infrastructure investments and not flexible, short-term constraints.

Due to the seasonal nature of propane demand in Iowa and other Midwest states, the pipelines servicing Iowa are underutilized in the summer or off-season and run at capacity during the peak demand periods during the winter.

Issues arise when demand rises during peak periods and the flow of propane required to replenish inventories within Iowa exceeds the capacity of the pipelines from Conway. Constraints exist at three points during the movement via pipline:

- The maximum flow available to move propane through the physical pipe;
- The number of loading spots available to offload propane into a tanker truck at a pipeline terminal[59]; and
- The speed at which the trucks can be loaded at the pipeline terminal.

The maximum flow is based on the physical characteristics of the pipeline, as well as the contractual commitments for its use.

Because the capacity of the pipeline is fixed, the pipeline operators need a means of determining who can use the limited capacity of the pipelines during peak periods. The industry has adopted supply "allocation" systems to do so. In addition to the cost of the pipeline movement or tariffs[60], the pipeline operators publish rules regulated by FERC that determine the allocation of pipeline capacity to shippers on the pipeline.

Although the allocation rules are specific to each individual pipeline, in general, the system allocates a share of the pipeline capacity in the peak winter season to a shipper based on the shipper's utilization of the pipeline in the summer season. For example, a shipper may earn allocation in the winter of 2 to 3 times the volume transported during the summer[61].

This concept of a "winter-to-summer ratio" drives an Iowa- and pipeline-centric sourcing strategy for Iowa marketers. To be competitive as a propane reseller, marketers want to minimize their transportation costs. With

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58 Loaded propane from terminal inventory may be 2 to 3 times faster than loaded it directly from a pipeline.

59 See Section 6.1.4.

60 A tariff is a compilation of all effective rate schedules of a particular pipeline operator. Tariffs include General Terms and Conditions along with a copy of each form of service agreement. (Federal Energy Regulatory Commission)

61 Note: This winter-to-summer ratio is a simplification of the net effect of the allocation rules in practice. The specific rules of each pipeline can be accessed via the FERC website.

pipelines being the most cost-effective, transportation method, marketers want to maximize the volume of propane that they move via pipeline from primary storage, and pick it up at a terminal near their Iowa operations.

5.2.1.2 Contingency Supply via the Cochin Pipeline

To leverage a pipeline in the high demand periods, marketers are incented to focus on increasing pipeline utilization in the summer, in order to maximize its use when the pipeline goes on allocation[62] in the winter. Historically, marketers were able to manage through seasonal peaks and surges in demand by leveraging a fourth pipeline, the Cochin, connecting the Midwest to the market center in Western Canada near Edmonton, Alberta. With the oil and gas industry in Alberta driving an abundant reserves of propane, the Cochin provided an outlet for Canadian propane to service Midwest winter demand.

Utilized as a contingency source, the Cochin was a flexible solution to alleviate the constraints of the 3 domestic pipelines in Iowa during high demand periods. The pipeline was permanently reversed from the Midwest to Edmonton in 2014, with the Iowa terminal shutting down in July of that year.

Figure 41 - North American Propane Pipelines (ICF International, 2014)

The pipeline was temporarily closed in the fall of 2013 for maintenance to facilitiate the pending reversal. When the demand surge hit at the end of 2013, with high agricultural demand and early cold termperatures, the impact of the potential loss of the Cochin was felt. Although advance notice of the future reversal was provided, the maintenance downtime in 2013 highlighted its role for the Iowa propane industry in overcoming domestic pipeline constraints.

The Cochin pipeline was reversed to flow diluent from the U.S. Midwest to Western Canada. Diluent, a diluting or thinning agent, is used to facilitate the transport of oil sands[63] via pipeline from Alberta. Due to the strength of the oil industry year-round, the demand for diluent is much less seasonal than propane. The pipeline operator was able to secure commitments for diluent transport sufficient to justify the return on investment to convert the pipeline from propane to diluent and obtain the required regulatory approvals for reversal.

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[62] The pipelines are not on allocation for the entire winter season. When a pipeline is constrained based on increases in demand, the pipeline operators will put all or certain terminals on allocation through the high demand period only.

[63] The Canadian oil sands represent the world's third-largest crude reserves behind Saudi Arabia and Venezuela. The raw bitumen of the oil sands is too heavy and thick to flow easily through pipelines. It must be blended with around 30 percent of a lighter oil, known as diluent. The Cochin reversal transports light condensate from the United States into Alberta to be used as diluent (Reuters, 2014).

5.2.1.3 Economics and Utilization

The Cochin's reversal highlights the fact that economics drives the utilization and investment in infrastructure in the propane supply chain[64]. The commodities and markets[65] that drive higher utilization of the pipelines will drive increased profitability for pipeline operators. As for profit operations, their goal is to maximize the pipeline's utilization and obtain commitments for its use to support their economic future.

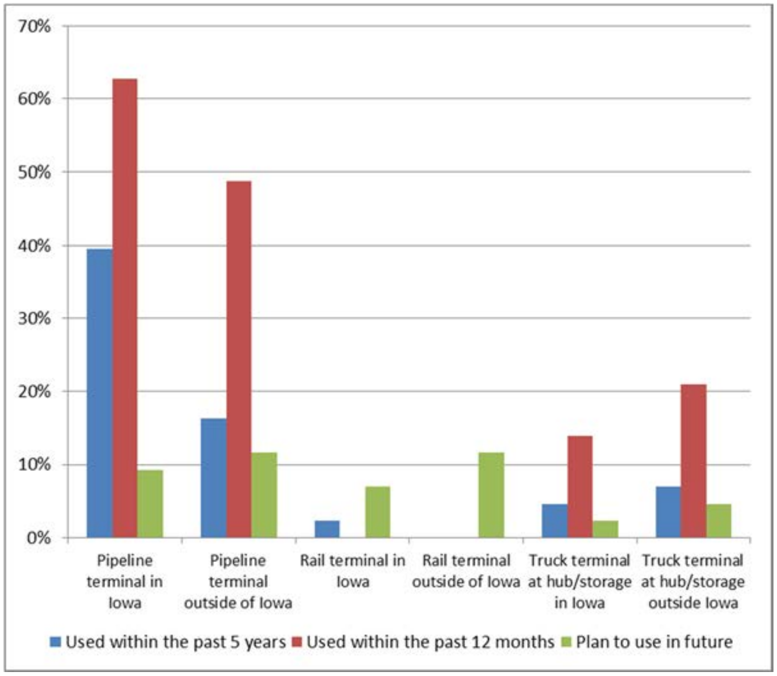


Figure 42 - Usage of Transportation Modes by Iowa Marketers (Propane Supply Chain Survey of Iowa Marketers, 2014)

These commitments also determine access to capacity on the existing pipelines. If shippers of other NGL commodities are willing to commit to movement of product via the batch pipelines shared with propane, these other products will consume more of the overall capacity. Similarly, as marketers in other states revise their sourcing strategy to accommodate the loss of the Cochin, they are commiting to more movements via Iowa pipeline terminals to earn allocation for winter and help secure their own propane supply.

With Midwestern demand for propane continuing to be highly seasonal, there currently is not a business case to invest in the development of a whole, new pipeline to transport propane[66]. For the same reasons that the Cochin was reversed, other alternative investments will drive greater returns to private industry than a propane pipeline. There are other uses for propane, like transportation, that would increase off-season usage of propane. However, with the strength of the Iowa corn industry and prevalence of ethanol as an alternative transportation fuel, no major changes are expected in the seasonal demand patterns for propane in Iowa in the near future. Thus, if seasonality is not changing significantly, but infrastructure is with increased constraints, marketers need to adjust their sourcing and transportation policies to continue to meet demand within the bounds of current transportation network constraints.

[64] The reversal of the Cochin pipeline cost approximately $310 million (Kinder Morgan Energy Partners, L.P., 2013). To build the business case for reversal, Cochin held an Open Season in 2012. Cochin offered discounted rates as an incentive to execute Transportation Service Agreements (TSAs) and make long-term volume commitments to ship light condensate on the Cochin Reversal Project. According to Cochin, the Open Season received more than 100,000 bpd of binding volume commitments for a minimum of ten years. The capacity requests were prorated down to allocate 90 percent of the total pipeline capacity to Committed Shippers at 85,000 bpd. (Federal Energy Regulatory Commission, 2012)

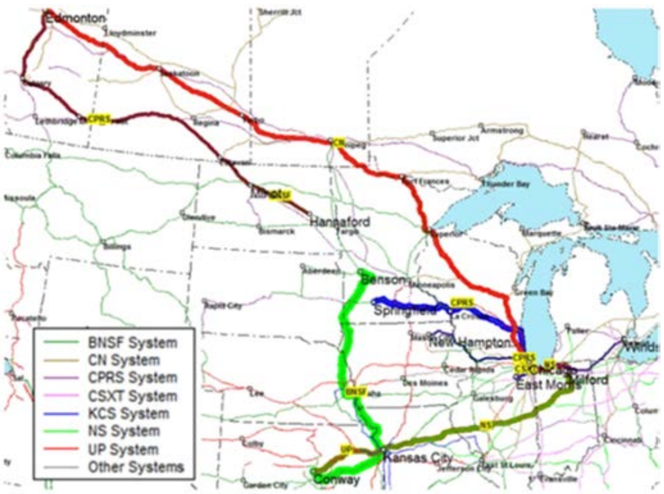
[65] Dynamics between domestic and export propane markets could also drive pipeline reversals in the future.

[66] Note: The business case for smaller investments (versus a large investment in a "new" pipeline) that drives better utilization of existing pipeline or other transportation assets may exist. Reference is in response to the question of the likelihood that a new pipeline would be built to connect Northwestern U.S. or Western Canadian supply to the U.S. Midwest in the near term.

The Cochin reversal was not an isolated change in infrastructure. A portion of the TEPPCO pipeline (ATEX) was also reversed in 2013 for ethane service. In addition, removal of the Todhunter storage facility in Ohio from service, taking several Midwest refinery and gas processing plants offline for maintenance, and a fractionation outage at Mount Belvieu caused additional disruptions in the supply chain in 2013. Even though these examples are outside Iowa[67], any major increase in infrastructure constraints affects the rest of the supply chain in the U.S., as regional participants adjust their practices to work within the new constraints. It also reinforces the fact that more changes will occur in the future. Thus, it is important to monitor and understand these changes.

5.2.2 Rail

With adding new pipeline infrastructure not being a short-term option to overcome capacity constraints, wholesalers and marketers have to look to alternative modes to move propane long distances from production areas and market centers to end user markets. Rail is one of those alternatives, with transport in bulk via rail tanker car. One rail car may transport up to four times the capacity of a highway tanker truck. Large rail cars have capacities up to 34,500 gallons and smaller rail cars have capacity between 11,000 and 12,000 gallons.[68]



Source: Hellerworx, ICF

Figure 43 - Rail Access to Market Centers (ICF International, 2014)

Rail has advantages as an alternative long distance transportation option, because it facilitates movement of propane in greater volume than via a single tanker truck. It can be used to supplement pipeline movements. Rail also provides reach and connectivity to propane supply sources without pipeline access. As such, it is used by wholesalers to bring in supply to end user markets without pipeline access.

States like North Dakota, Minnesota and Wisconsin were impacted more by the reversal of the Cochin pipeline, because they were more reliant on the Cochin as a primary supply source. In response, wholesalers are investing in rail terminals within the Midwest region to make up for some of the flow lost with the closure of the Cochin propane terminals in those states[69]. In addition, rail access to primary storage in Western Canada as a contingency source helps mitigate potential risks from disruptions in the supply chain at Conway itself or within the truck transportation network.

However, rail has its own challenges and constraints. Rail is much less reliable than pipeline as a means of transport. In the winter peak season, when the rail network is needed most to supplement the pipelines, snow and ice can disrupt rail shipments. Rail is also much less timely in its delivery window. As opposed to pipeline, which is just-in-time, rail shipments have to be initiated weeks in advance.

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[67] As of the fall of 2015, no other pipelines servicing Iowa had been identified as having plans for reversal. A new terminal in Rock Rapids, Iowa on the NuStar's East System pipeline was announced (see Section 8.3). (Yanik, NuStar, CHS to bring more propane to Upper Midwest, 2015)

[68] (Propane Education and Research Council)

[69] (Yanik, Cochin reversal project creates pipeline pressures, 2013)

There are 22,000 rail tanker cars[70] across the U.S. that can be used to transport propane. So there is competition for these rail car assets to meet demand. In addition, rail is also used as a primary means to transport oil out of the developing shale regions across the country[71]. Given the higher profitability of oil as a commodity, steel to build new tanks and usage of rail tracks is dominated by the oil industry[72], making it difficult for the propane industry to invest in additional assets in a timely manner.

Rail terminals and assets also tend to be proprietary. Thus, rail capacity is specific to wholesalers or other parties, who build the terminals, invest in the rail cars, etc. Thus, usage of its capacity may be less accessible than other modes across the industry as a resource.

For Iowa, the typical demand for propane can be serviced via its 3 core pipelines (see Section 6.1). Therefore, the use of rail is and would likely continue to be supplemental. However, because rail requires advance planning and ordering, it is not well-suited to emergency supply. Iowa lacks the in-state storage to hold the type of reserves required to inventory a large volume of propane brought in by rail in advance of demand.

The cost of rail (see Section 6.2) is close to the cost of long distance movements via tanker truck. Cost includes the rail movement, fuel surcharges, loading and unloading costs, as well as the cost of the fleet. This cost structure, combined with the prior attributes and limitations of rail, results in the lack of a strong, financial business case for significant rail investment in Iowa to support the propane supply chain.

The business case is, however, much stronger in the neighboring states that were more reliant on the Cochin[73]. Thus, for the region, investment in rail is very important to bring more supply into the area. Without regional rail investments, Iowa faces a reduction in pipeline capacity, as Iowa marketers are forced to compete for pipeline terminal capacity with their counterparts in neighboring states.

Barge is another mode that can be used to support the movement of propane over long distances[74]. There are approximately 60 inland waterway barges that could support the movement of propane (U.S. Energy Information Administration). Despite the waterway access via the Mississippi and Missouri rivers on either side of the state, barge is not considered a viable option as contingency supply source for propane in Iowa. With peak demand in the winter months, the waterways are likely impassable when the contingency supply of propane is most needed within the State.

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[70] (U.S. Energy Information Administration)

[71] "Rail carloadings of oil and petroleum products totaled 672,118 tank cars during January-October 2014, 13.4 percent higher compared to the same period last year, according to the Association of American Railroads (AAR). Rising U.S. crude oil production, particularly in North Dakota's Bakken Shale formation, where pipeline takeaway capacity is limited in moving the state's growing oil volumes to market, is one of the main reasons for this increase in rail shipments of petroleum and petroleum products." (U.S. Energy Information Administration, 2014)

[72] Changes in the oil industry, since the writing of this report, have changed the demand for steel and rail assets in 2016. These changes will be addressed in a future report update, as well as any future impact of pipeline accessibility into the Bakken region.

[73] For example, 90 percent of propane transported to Minnesota has historically been brought in leveraging the pipeline systems. Of this volume moved via pipeline, 75 to 80 percent of the propane is transported into Minnesota from Canada via the Cochin pipeline. (Minnesota Department of Agriculture, 2011)

[74] Ocean-going tanker is also a mode used to transport propane. However, since Iowa does not have ocean ports, the use of ocean-going vessels was not explored as part of the study.

5.2.3 Bulk Transport or Tanker Trucks

Once the propane is delivered to a pipeline or rail terminal in Iowa, it has to be loaded onto a tanker truck for highway transport to marketer storage[75]. Propane can also be picked up and loaded onto a tanker truck directly at a primary storage facility, like Conway. A typical highway transport or tanker truck can move 9000+ gallons of propane given weight and capacity limits. Costs are based on cents per mile per gallon moved.

Source: Stock Photography (Copyright – Propane Education and Research Council)

Despite similar economics, truck is a more flexible option than rail to supplement pipeline usage. However, there is a limit to the number of tankers available for transport via truck[76]. And when tanker trucks are used for long distance transport from market centers at least 3 trucks are needed to compensate for the additional time and distance to pick up the load.

Propane requires a dedicated tanker due to potential contamination issues. Anhydrous ammonia is the only other bulk liquid that can be transported in a propane tanker in the off-season, requiring modifications to the tanker to facilitate the conversion from propane only to a dual commodity use. Given the oil industry demand on steel, there are long lead times for ordering additional tankers. Also, the same return on investment issues are faced when expanding truck fleets and investing in a seasonal-use asset. If a propane pipeline was to go down for an extended period of time, there would not be sufficient truck capacity available to replace the lost flow.

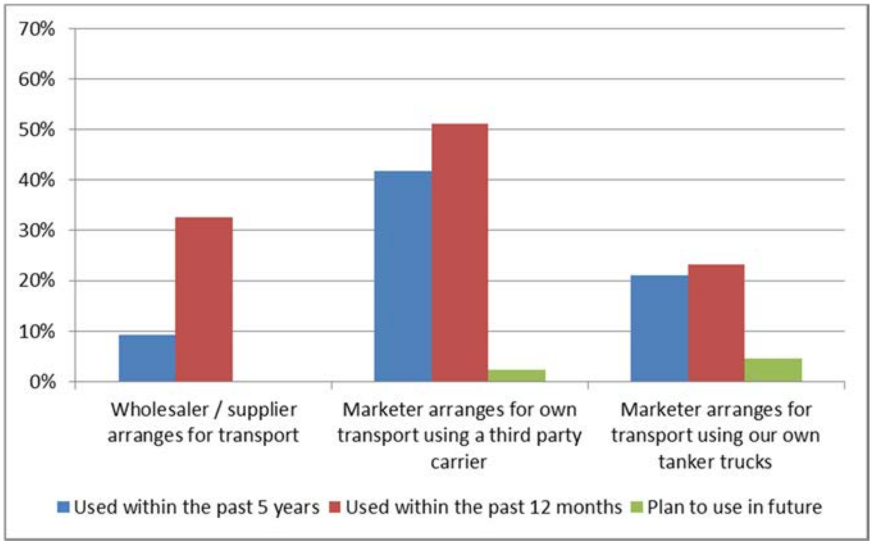

Figure 44 - Industry Roles in Arranging Transport from Terminal to Marketer Bulk Storage (Propane Supply Chain Survey of Iowa Marketers, 2014)

Even if there are trucks available, there is also a constraint on how many trucks can be loaded at an individual pipeline terminal. The average pipeline terminal has two loading spots, where a tanker truck can be loaded with propane for transport. However, loading spots may range from 1 to 4 depending on the location. If there are more than 2 trucks at the terminal for loading, a queue forms. Trucks load at most terminals on a first-come, first-served basis. As a result, in peak demand periods, lines form at the terminals with many transporters trying to load within the same time windows during regular business hours.

[75] In some instances, it may be transported directly to a large commercial user from a terminal.

[76] There is roughly 6000 highway bulk transports across the U.S. (U.S. Energy Information Administration).

Truck transport may be conducted by a wholesaler with its own trucks, a third party transporter, or via a larger marketer with its own trucks (see Figure 44). All these independent parties are loading at the terminals without coordination between the disparate parties.

When a line forms, it consumes truck capacity by reducing the hours that drivers can deliver propane to its intended destination. This situation also presents safety and regulatory issues, as hours of service limitations are reached and hours consumed in line versus delivering propane (see Section 5).

The volume of propane that can be moved via truck is also limited by the fill rate at the pipeline terminal locations. Trucks filled from inventory at the pipeline terminal are loaded up to 2 to 3 times faster than trucks filled directly from the pipeline. As a result, during peak periods when terminal inventory is depleted, there is a reduction in the volume that can be transported via truck from the terminals.

In addition, as a hazardous material, drivers of propane trucks are required to have appropriate certification and training. So availability of qualified drivers, even if truck capacity is added, will further constrain truck capacity.

5.2.4 Local Delivery Trucks or Bobtails

The same types of constraints exist downstream in the supply chain with local delivery trucks or bobtails. Typical bobtail size can range from 1,800 to 3,500 gallons, with actual capacity adjusted for expansion requirements. Bobtails are used to transport propane from marketer storage to end user tanks in backyards, on farms and at commercial facilities.

The number of bobtails per marketer location varies based on the size of the marketer. The bobtail capacity is also considered a fixed constraint in the short-term. Adding more bobtails to increase capacity is a longer-term activity, like tanker and rail investments, with long delivery times associated with steel-based assets.

Fleet expansion also requires the appropriate return on investment to justify investment in the seasonal asset. Again, challenges come into play during demand surges. The business case is difficult to justify for periodic increases in demand only. Yet, the number of bobtails required to service demand increases significantly during a surge. So, during peak demand periods, bobtail capacity is another constraint.

If inventory levels are down at end users, marketers will struggle to deliver sufficient propane to meet demand via bobtails during peaks. As the network becomes further constrained, marketers face similar issues to truck transporter in trying to find qualified drivers to work multiple shifts during peaks and/or bumping up against hours of service limits.

Bobtail constraints are, however, impacted less by the closure of the Cochin than tanker truck constraints. The origin-destination legs between marketer storage and end users exist independent of how the propane moves from the wholesale market into Iowa. However, other sourcing and inventory participants have a direct bearing on capacity and determine how much transportation demand is put on this part of the network.

Source: Stock Photography (Copyright – Propane Education and Research Council)

6 Ability to Service Future Demand

The underlying question and focus of the optimization analysis centers on the ability to service future demand, given the capacity of Iowa's propane supply chain and its corresponding constraints.

However, whether or not the current industry infrastructure can service future propane demand is not a black and white issue. If a product shortage will occur in Iowa is based on a myriad of factors, including demand, infrastructure constraints and the behaviors of the industry participants.

The analytical approach is to model the sensitivities of different parameters that could affect the ability to meet the required service levels (i.e. demand) and to determine the corresponding impact on the supply chain. The analysis starts with:

- Defining future demand scenarios;
- Looking at what is "feasible" given the infrastructure; and
- Assessing the risks and impact of different market conditions and constraints.

6.1 Demand Scenarios and Risk Factors

The optimization analysis was performed across a variety of demand scenarios including:

- The baseline demand for propane based on a 5-year historical average or mean;
- Percentage increases in Iowa propane demand over the baseline;
- The historical monthly maximum demand over the 5-year historical period; and
- The actual demand for the 2013-2014 propane season.

As discussed in Section 3, the baseline demand within the optimization model is the average monthly demand for propane over a 5-year period from April 2009 to March 2014.

Based on historical data and future industry projections, the demand for propane is expected to remain relatively flat[77]. There is no data to suggest any fundamental shifts in the demand for propane within Iowa (such as a significant demand increase from new industries or applications adopting the use of propane; or demand decreases from large-scale replacement of propane with an alternative energy source). Therefore, the historical, five-year average provides a starting point to evaluate if the supply chain infrastructure of today can sustain the same levels of demand as the past.

Even though there is not a major shift in the baseline demand, the changes in the supply chain infrastructure are significant. The optimization analysis has to first look at the ability to meet demand without the Cochin pipeline providing transportation capacity into Iowa and the Midwest (see Section 5.2). Assuming it is feasible to service the baseline need for propane, the analysis further delves into the demand levels, or volume thresholds, where it is no longer feasible to meet demand given the current infrastructure, market conditions or practices.

The first variables modelled within the scenarios are increasing levels of demand. Average demand can be anticipated and planned for with relative ease. However, the seasonal deviations in each individual year can vary widely from the baseline. Using an average normalizes these fluctuations within a seasonal trend. Although there will be low seasons, as evidenced in 2011 and 2012, the key concern with the study is the ability to handle the year-to-year fluctuations in demand <u>above</u> this average. The different demand scenarios within the model are based on historical fluctuations, future forecasts and theoretical extremes or variances from the mean.

[77] Total propane consumption across all sectors is expected to increase by 1.1 percent per year nationally from 2013 to 2040, with residential demand declining by 2.0 percent and commercial and industrial demand increasing by 0.7 percent and 1.4 percent respectively. (U.S. Energy Information Administration, 2015)

- The percentage increases in demand over the baseline evaluates incremental levels of demand throughout an entire year and the corresponding stress on the supply chain.
- The historical monthly maximum demand assesses the impact, if the maximum demand experienced in the past is realized, in each individual month throughout the year.
- The actual demand for 2013-2014 evaluates the ability to handle the same demand conditions that resulted in the product shortage in the winter of that year.

These increasing levels of demand through actual and theoretical extremes provide an indication of when the supply chain infrastructure can no longer support the demand for propane within Iowa.

The demand scenario data provides guidelines and a reference point to illustrate what demand levels are represented by each scenario and when potential risks may be presented.

6.1.1 Constraints and Risk Factors

Starting with this baseline demand, additional assumptions were loaded into the model for:

- Production and supply availability
- Inventory and transportation capacity
- Product and transportation costs
- Inventory management practices
- Sourcing management practices

These parameters are based on the current infrastructure situation and the typical past behavior of its market participants. When the optimization algorithms are applied against the dataset, the baseline optimization scenario evaluates whether it is "feasible"[78] to meet demand with current industry conditions. Running additional demand scenarios then produces a "theoretical" demand threshold, where it is no longer possible to meet the required service level with the available infrastructure.

However, these demand thresholds are not absolutes. The optimization scenarios assume a consistency in past behaviors and conditions. But these factors are dynamic, interrelated and constantly changing. Thus, changes in these assumptions or supply chain constraints were modelled to determine the effect on feasibility and the sensitivity of the supply chain to changes in the parameters.

[78] "Feasible" within the context of the optimization model means that it is theoretically possible to meet demand, given current infrastructure and a given set of assumptions on typical market conditions and behaviors. However, a feasible demand scenario does not guarantee that demand will be met. Actual conditions, including the influence of human factors of market participants, will ultimately determine whether demand is met or there will be a propane shortage.

The other consideration is that not all market participants will behave optimally. Although the adoption of best practices will drive more optimal behavior, it is unrealistic in practice to believe that all distinct market participants will work in coordination to deliver the "most optimal" solution. Thus, the model seeks to find "feasible" versus the "most optimal" solutions for each scenario, providing a more realistic assessment of risk in practice.

The resulting output of the model looks at the "relative" versus "absolute" areas of risk, because it is the combination of factors (versus the individual factors and extremes) that present the most risk. The sensitivity analysis represents an iterative process, evaluating the combinations and refining the constraint parameters that cause infeasibility or restore feasibility.

The core scenarios analyzed in the model include:

- Supply and Demand
  - What is the impact in an increase in export capacity and/or demand outside of Iowa?
- Inventory and Sourcing Management
  - What is the effect of an increase in inventory capacity in the primary, marketer or end user storage?
  - What is the impact of a change in timing in inventory builds or a summer build?
  - What is the impact of changing order or inventory management behavior (e.g., reorder point, review period, sourcing lead time)?
- Transportation Management
  - What is the effect of a reduction in pipeline capacity?
  - What is the impact of pipeline terminal loading and utilization on capacity and hours of service?
  - What is the impact of utilization of new or alternative sites?
  - What are the corresponding truck and/or rail capacity requirements?

These scenarios seek to define what is feasible with current infrastructure, feasible with a more optimal network or behaviors, as well as the impact of investments in different infrastructure or assets.

6.1.2 Sensitivity Analysis: Baseline

The **baseline** model indicates that it is feasible to support historical and high demand scenarios with:

- An **Iowa-centric, sourcing** strategy for marketers
- **Without the Cochin pipeline** access to Western Canada propane inventories; and
- With a **30 percent reduction in terminal capacity** in northern Iowa pipeline terminals, driven by an increase in out-of-state demand[79].

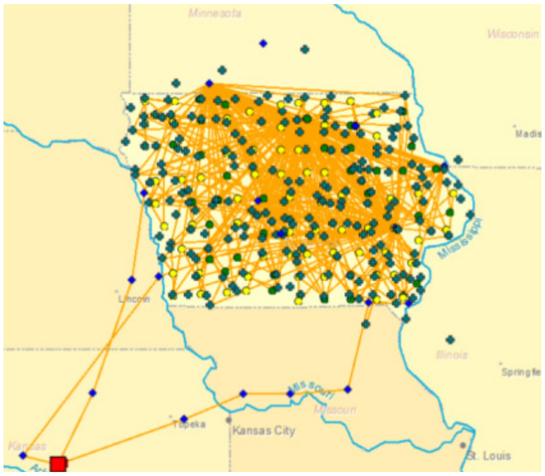

Figure 46 - Iowa-Centric Propane Supply Chain Flow without Cochin Pipeline

Based on the analysis and market observations in 2014-2015, these factors are assumed to reflect the current baseline behavior. Given terminal accessibility within Iowa and the low cost of transport, pipeline will remain the primary mode of transporting propane for Iowa marketers (see Section 5.2). However, propane movements into the Midwest via the Cochin pipeline ceased permanently as of July 2014. So

[79] Out-of-state demand within the model is represented by a reduction in truck loading capacity at pipeline terminals. As more out-of-state marketers take delivery of propane at Iowa terminals, the truck loading capacity available to Iowa marketers decreases, with increased competition for transportation resources.

the Cochin is no longer available as a resource. Consequently, marketers from neighboring states, like Minnesota and Wisconsin, are and will continue to fill their trucks at Iowa terminals, due to the lower cost of pipeline transportation versus other mode options.

In this Iowa-centric baseline, the pipeline flow across the remaining 3 Iowa pipelines is the key constraint. In this scenario, it is the only constraint without slack in the model. Thus, whether the demand from Iowa agriculture and residential users can be met in the future is highly dependent on the availability of pipeline capacity on the current pipelines. A significant outage, planned shutdown or reversal on any of the remaining propane pipelines servicing Iowa presents significant risks.

Demand	Iowa-Centric Historical	Without Cochin; Initial Inv = 50%	Without Cochin; 30% OOS Initial Inv = 30%;	Without Cochin; 30% OOS Initial Inv = 40%;
Baseline	Feasible	Feasible	Infeasible	Feasible
+ 25%	Feasible	Feasible	Infeasible	Feasible
+ 50%	Feasible	Feasible	Infeasible	Infeasible
+ 100%	Feasible	Feasible	Infeasible	Infeasible
+ 150%	Feasible	Feasible	Infeasible	Infeasible
+ 175%	Feasible	Infeasible	Infeasible	Infeasible
+ 200%	Feasible	Infeasible	Infeasible	Infeasible
Historical max	Feasible	Feasible	Infeasible	Infeasible
2013/14 Actual	Feasible	Feasible	Infeasible	Infeasible

Figure 47 - Effect of Changes in Inventory Management Practices

6.1.3 Sensitivity Analysis: Inventory Management

Although it is theoretically possible to meet demand given the current industry infrastructure, not all market conditions may align in reality to support the required demand.

The sensitivity analysis indicates that **feasibility is highly sensitive to inventory management practices of end users and marketers**. Demand levels that were once feasible cannot be supported, if adequate inventory levels are not maintained. For example, demand scenarios become infeasible when initial inventory levels are reduced from 50 to 30 percent, where users are reordering when on-site inventories reach a lower level.

This analysis supports the market data and supposition that if adequate inventory is not maintained within the borders of Iowa that a product shortage may result.

The transportation constraints in the supply chain for pipeline, truck and rail capacity make it infeasible to bring in adequate supply into the State of Iowa, if inventory levels are not maintained. Similarly, a change in other constraints, like an increase in out-of-state usage of Iowa pipeline terminals, decreases the likelihood that service levels will be met. However, a corresponding increase in inventory management may mitigate the risk of a shortage by building capacity. Thus, the implementation of inventory management best practices can help build supply chain capacity within Iowa to lessen the impact of infrastructure changes.

The greatest impact is driven by the management of end user inventory. Marketer inventory practices do have an impact. But the sheer scale of end user versus marketer inventory capacity within the state results in a more significant influence from end user inventory and capacity changes. Within the sensitivity analysis, some scenarios remain feasible with lower marketer inventory, but not with corresponding changes in end user inventory.

Changes in other factors from the baseline assumptions continue to result in some feasible scenarios despite:

- Reduction in production levels or market center/hub inventory
- Increases in fall agriculture demand beyond historical peaks
- Implementation of outage at pipeline terminal
- Implementation of marketer single sourcing from terminals

Demand	No Cochin	Out of State Usage*	Initial Inventory	Ag Min Inventory	Tertiary Inventory	Production	Feasibility
+50%	N/A	30% North	--	--	--	--	Feasible
+50%	N/A	30% North	--	--	--	<20%	Feasible
+50%	N/A	40% All	--	--	--	--	Feasible
+50%	N/A	30% North	<20%	--	--	--	Infeasible
+50%	N/A	30% North	<20%	--	+50% +100%	--	Infeasible
+50%	N/A	30% North	<20%	<100%	--	--	Feasible
+50%	N/A	30% North	<20%	--	--	<20%	Infeasible
+50%	N/A	30% North	<20%	<80%	--	<20%	Feasible
+50%	N/A	30% North	<20%	<80%	+10%		Feasible

* *Reduction in pipeline capacity at northern terminals (Sanborn, Clear Lake, Dubuque) for out of state usage*

Figure 48 - Impact of Factor Changes at 50 Percent Increase in Demand

However, these same scenarios will become infeasible as inventory management parameters change. These results underscore that the risks remain in the market practices, despite the overall capacity of the supply chain. It is the combination of factors and extremes, as well as the actual behavior of the market participants under changing industry conditions (e.g., How does the market react to an outage?), that could jeopardize service levels.

Additional scenarios were modelled to evaluate these combinations of factors to understand the interdependencies and sensitivities. The results further illustrate that:

- **The overall Iowa propane market is highly sensitive to inventory management practices in the agriculture sector**. The inventory management practices of agriculture users can increase the risk to meeting demand or, conversely, increase supply chain capacity.
- **Increases in end user or tertiary inventory capacity can reduce the risk of a product shortage.** Increases in end user storage can mitigate the impact of increasing demand, constraints and/or other risk factors across multiple scenarios.
- **Inventory levels at market center/hubs and can increase supply chain risks, in combination with other factors.** A reduction in normal inventory levels at market centers / hubs, a decrease in available domestic propane production or increase in propane exports threaten service levels, despite changes in factors that are manageable in isolation.

6.1.4 Sensitivity Analysis: Pipeline Terminal Capacity and Usage

The other variable that has a significant impact on the ability to meet end user demand is pipeline terminal capacity and/or usage. "Terminal usage" within the optimization model represents a combination of factors in practice, including:

- The number of hours that a terminal is utilized for loading trucks versus hours available;
- The effect of terminal lines on volume of propane moved in Iowa, truck capacity and hours of service;
- The effect of reduced loading capacity (trucks loaded per hour) during peak periods; and
- Planned or unplanned outage(s) at pipeline terminals.

Demand	No Cochin	Out of State Usage	Terminal Usage*	Ag Min Inventory	Tertiary Inventory	Production	Feasibility
+50%	N/A	30% North	24 hours	--	--	--	Feasible
+50%	N/A	30% North	16 hours	--	--	--	Feasible
+50%	N/A	30% North	12 hours	--	--	--	Infeasible
2013-14	N/A	30% North	16 hours	--	--	--	Feasible
2013-14	N/A	30% North	16 hours	--	--	<20%	Feasible
2013-14	N/A	30% North	12 hours	--	--	--	Infeasible
2013-14	N/A	30% North	12 hours	<100%	+50%	--	Feasible
+50%	Available	N/A	8 hours	--	--	--	Feasible
2013-14	Available	N/A	8 hours	--	--	--	Feasible

** Reduction in number of hours terminal is utilized or reduced loading spot available with out of state*

Figure 49 - Impact of Terminal Usage Changes at Varying Levels of Demand

It can also represent some of the effects from:

- Competition for terminal loading capacity in Iowa due to out-of-state propane demand; and
- The diversion of propane supply to other markets and geographies outside of Iowa and/or the United States.

The analysis indicates that peak periods for propane require higher utilization of terminal resources to manage the surges in demand. It is infeasible to meet the equivalent of 2013-2014 demand with current infrastructure, without terminal loading rates beyond an 8 to 12 hour loading schedule[80]. Thus, when these terminal resources are utilized, and how efficiently they are utilized, are key components of the feasibility equation.

[80] Actual required loading hours may be longer depending on the impact of related factors.

6.1.5 Feasibility Thresholds and Potential Risks

With an understanding of the constraints that impact feasibility, the question becomes how to interpret rising demand patterns, in order to determine if there is a risk of a product shortage within Iowa.

The approach is to outline the model output in a matrix that identifies when demand scenarios present the risk of a shortage, given key constraints.

The process starts by selecting constraint(s) for the sensitivity analysis that are representative of the key factors that influence the ability to meet demand. The primary constraint selected for the feasibility matrix axis is terminal usage, because it represents a decrease in available supply at terminals, as well as a multitude of other factors (such as a supply chain outage, out-of-state competition and the diversion of supply for exports).

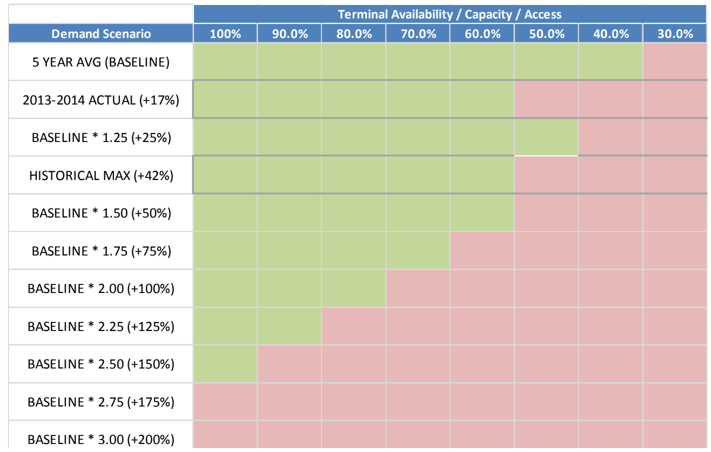

Figure 50 - Feasibility of Baseline Demand Scenarios

Given the demand scenarios that have been defined (see Section 6.1), the feasibility analysis was run against terminal usage as the representative constraint. This analysis produces a "redline", defining the threshold or measurement criteria where it is infeasible to meet demand based on current constraints and typical behaviors (see Figure 50). The green area of the matrix shows the theoretically-feasible, demand scenarios, given increasing reductions in terminal availability, capacity or usage. The red area of the matrix represents the areas where the defined conditions make servicing all demand infeasible.

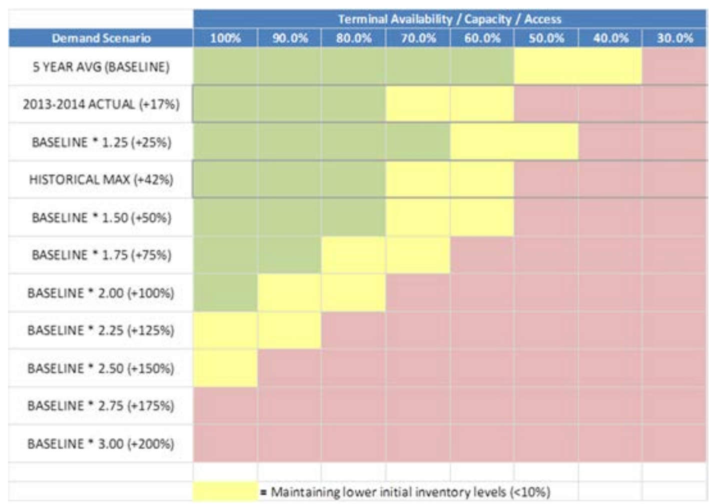

Figure 51 – Feasibility Risk Thresholds by Demand Scenarios

As previously noted in Section 5, risks still exist prior to reaching this redline, based on additional influences and constraints. There is an area of risk, defined by the yellow area in Figure 51 that represents where the combination of additional factors and constraints "could" make servicing demand infeasible. The matrix focuses on the addition of the key constraints, like inventory management practices, with a strong influence on ability to meet demand and with higher predictability. This yellow area defines the higher risk areas, where demand may exceed supply chain capacity.

6.2 Supply Alternatives

Ensuring that all propane end users are serviced during high demand periods requires implementation of a contingency sourcing strategy that accesses propane at terminals outside of Iowa. Where it becomes infeasible to meet demand with an Iowa-centric strategy for primary propane supply, it is necessary for Iowa marketers to define a sourcing strategy to meet these contingency needs.

However, a marketer's goal is still to minimize its cost, while doing so, in order to competitive with other propane marketers and, in the long run, alternative energy sources.

In the past, supply from Western Canada served as that contingency supply source, with low cost transportation into Iowa via the Cochin pipeline. With the Cochin's reversal, the question becomes what is a cost-effective alternative to manage contingency strategy?

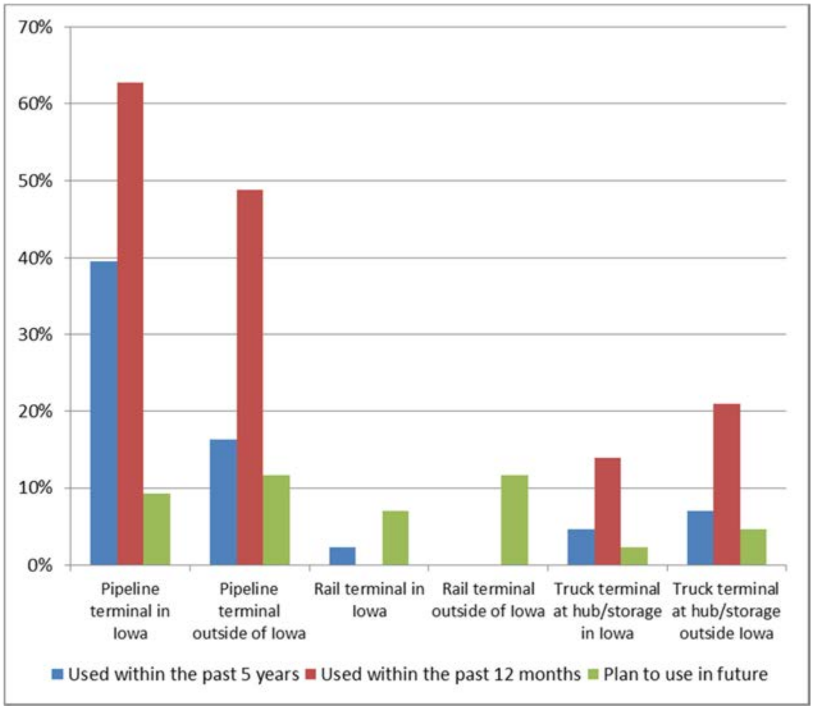

Figure 52 - Marketer Sourcing Sites

Evaluation of alternative sites is an economic analysis of trade-offs between:

- **Product or sourcing cost** (i.e. cost to purchase a gallon of propane); and
- **Transportation cost** (i.e. cost to move a gallon of propane).

The further that a marketer has to go to source propane, the higher the marketer's transportation costs (see Figure 53). With a longer distance travelled, the marketer has to either acquire the propane at a lower price per gallon or pay a higher cost overall for the acquisition of propane. In order to be economically viable, a marketer has to consider these incremental costs into its pricing strategy to its customers to be able to recoup the expense.

The optimization model was leveraged to evaluate the cost-benefit of these different alternatives. Although there are a variety of costs that comprise activities across the supply chain, the core costs that were the basis for analyzing the alternative sources are:

- The transportation cost from a market hub or product source to terminal via pipeline or rail;
- The transportation cost from the terminal to marketer via truck; and
- The sourcing cost paid by a marketer at the terminal where the propane is picked up.

Terminal for Pick Up	Transportation Cost from Hub to Iowa (Average $ per gallon)		Bulk Tanker from Pipeline Terminal	Total Avg Cost per Gallon	Cost Differential vs. Dubuque
Conway	Tanker	$0.27	--	$0.27	+$0.06
Mt. Belvieu	Tanker	$0.70	--	$0.70	+$0.49
Edmonton	Tanker	$1.09	--	$1.09	+$0.88
PT_ME Dubuque	Pipeline	$0.09	$0.06	$0.15	$0.00
PT_MW Ogden	Pipeline	$0.07	$0.08	$0.14	+$0.01
PT_OK Clear Lake	Pipeline	$0.09	$0.08	$0.17	+$0.04

Figure 53 – Sample Scenario Transportation Costs to Select Sites

The model was modified to evaluate costs of sourcing propane at alternative sites. The model was adjusted to neutralize any preferences for locations with higher inventory levels[81] to isolate the product versus transportation cost trade-offs between sites. Then the optimization algorithms were run and the total costs converted to an average cost on a per gallon basis, in order to allow for a comparison between different marketer sites and demand levels across periods. The scenarios were analyzed across the 4 main demand scenarios for the current state supply chain, i.e. without access to the Western Canada propane inventories via pipeline and higher out-of-state marketer use of northern Iowa terminals.

It is important to note that the analysis is used to compare the "relative" costs between options, based on common and/or historical scenarios. The intent is to understand the differences between alternatives. However, actual costs may vary depending on the market costs for propane and transportation and the factors that affect it (e.g., demand, fuel costs), as well as the specific sourcing strategy and mix of source sites leveraged by an individual marketer.

6.2.1 Iowa-Centric Baseline

The first set of scenarios looks at the baseline costs for an Iowa-centric sourcing strategy. This primary sourcing strategy assumes propane is accessed from the Conway market hub via pipeline and picked up for delivery to a marketer at a terminal in Iowa.

The cost is the combination of the pipeline movement into Iowa, the tanker truck cost from the Iowa terminal to the marketer storage site and the cost of propane[82] paid by the marketer at the pipeline terminal (see Figure 54). The cost of propane is the average rack price[83] by month at the terminal over the 5-year time horizon of the model. Access to terminal capacity above 16 hours per day is assumed, in order to support all demand levels across the modelled scenarios.

Figure 54 - Cost Components for Iowa-Centric Sourcing Strategy

Based on the different demand scenarios in the model, the combined baseline costs are similar, within a few cents between scenarios (see Figure 55). Variances are due to timing of demand, seasonal product cost fluctuations and source site mix based on the level of demand. However, the costs are fairly consistent given an Iowa-centric approach leveraging pipeline transportation into Iowa.

Scenario - No Alternate Sites; 16 hr	Transportation Cost Per Gallon	Sourcing Cost Per Gallon	Combined Cost per Gallon
BASE DEMAND	$ 0.1625	$ 1.1185	$ 1.2811
MAX DEMAND	$ 0.1614	$ 1.1163	$ 1.2777
BASE + 50%	$ 0.1639	$ 1.1026	$ 1.2665
2013 DEMAND	$ 0.1634	$ 1.0981	$ 1.2615

Figure 55 - Sample Propane Acquisition Costs for Iowa-Centric Scenarios

81 The core model considers inventory capacity and availability between sites as one of the factors that determines where a marketer may source supply in the optimization algorithms. To isolate the product versus transportation cost trade-off between locations, the preference factor for sites with higher inventory was neutralized.

82 Note: The analysis does not model changes in the sourcing cost of propane driven by changes in demand. The price is the average price across the 5-year period at different levels of demand and market conditions.

83 The sourcing or product cost is represented by the rack price at the terminal location (Oil Price Information Service (OPIS)).

6.2.2 Direct Access to Market Hubs

One of the alternative sourcing strategies is to access propane directly from primary storage sites at the market hubs.

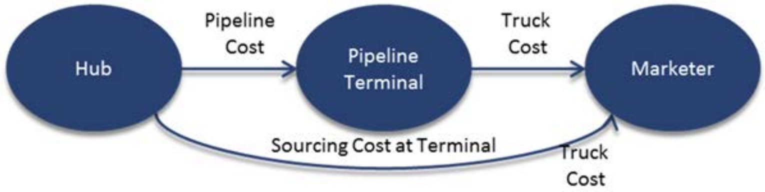

Figure 56 - Cost Components with Addition of Direct Access to Market Hubs

With this approach, any propane sourced directly from the hub is picked up via tanker truck from a terminal at the storage site. This strategy was leveraged by many marketers during the propane shortage of 2013-2014. Marketers picked up propane directly at Conway to meet increasing levels of demand. When prices spiked at Conway as the facility approached record lows, trucks were also sent to Mt. Belvieu in Texas to source propane, after appeals to the State of Texas temporarily lifted restrictions on LPG trucks and operators.[84]

With this type of strategy, the marketer must bear the incremental truck transportation cost (see Figure 56) of moving the propane from primary storage: the farther the distance, the higher the cost. The model scenarios were rerun by lowering terminal utilization in Iowa to require the use of alternative sites to meet demand.

Scenario - Major Hubs Only; 8 hr	Transportation Cost Per Gallon	Sourcing Cost Per Gallon	Combined Cost per Gallon	Variance to Iowa-Centric
BASE DEMAND	$ 0.3436	$ 1.3327	$ 1.6763	$ 0.3953
MAX DEMAND	$ 0.5150	$ 1.2791	$ 1.7941	$ 0.5164
BASE + 50%	$ 0.5251	$ 1.2765	$ 1.8016	$ 0.5350
2013 DEMAND	$ 0.5470	$ 1.2466	$ 1.7936	$ 0.5321

Figure 57 - Sample Propane Acquisition Costs with Addition of Direct Access to Hubs

With the addition of direct access to the market hubs, it is feasible to meet demand given the scenarios. But the addition of the contingency supply sourced via truck, increases total costs on average by $0.40 to $0.50 per gallon (see Figure 57). The cost increase is a combination of the higher transportation and differing product costs at the alternative sites.

These increased costs to the marketer impacts the cost of propane to the end user and/or will directly affect the marketer's profitability and viability in the long run. The marketer has to consider these increased costs, along with truck capacity and driver availability, and how it will directly affect their sourcing behavior.

[84] In January 2014, the States of Iowa and Maine made appeals to the State of Texas to declare a liquefied petroleum gas emergency. Under the emergency declaration, the State of Texas waived certain Texas licensing, permitting and certification requirements regarding liquid petroleum gas trucks and operators that limit the ability of Midwestern operators to access Mt. Belvieu supply under normal operating conditions. (State of Texas, 2014)

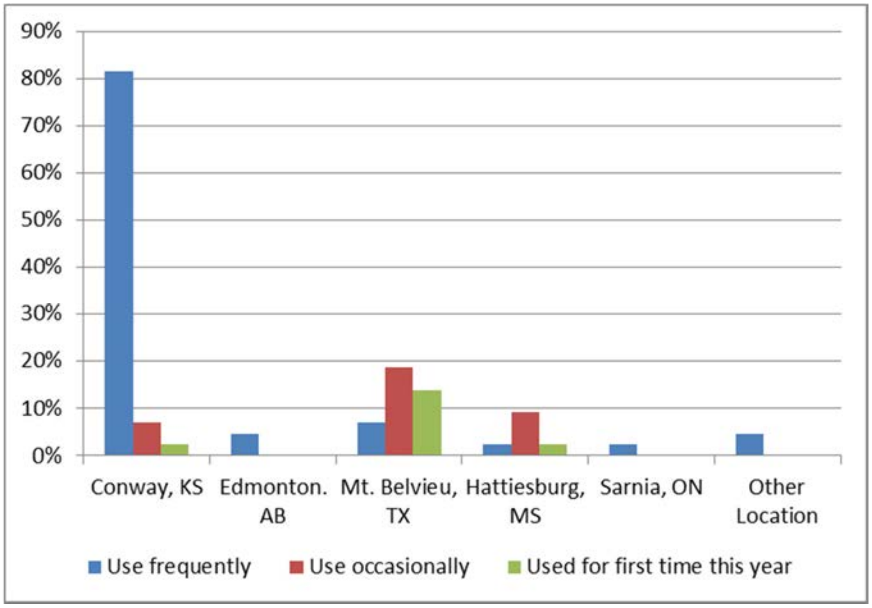

Figure 58 – Wholesale Inventory Supply Locations for Suppliers Servicing Iowa Marketers (Propane Supply Chain Survey of Iowa Marketers, 2014)

6.2.3 Addition of Alternative Pipeline Terminals

The next set of scenarios looks at the addition of alternative pipeline terminals. The cost components are the same as outlined in Figure 56 with the inclusion of market hubs. However, the transportation cost between the pipeline terminal and the marketer storage increases with the addition of pipeline terminal sites farther away from Iowa.

Scenario - Alternate Pipeline Sites; 8 hr	Transportation Cost Per Gallon	Sourcing Cost Per Gallon	Combined Cost per Gallon	Variance to Iowa-Centric
BASE DEMAND	$ 0.5277	$ 1.2813	$ 1.8090	$ 0.5279
MAX DEMAND	$ 0.4692	$ 1.2832	$ 1.7525	$ 0.4748
BASE + 50%	$ 0.5573	$ 1.2731	$ 1.8305	$ 0.5639
2013 DEMAND	$ 0.5616	$ 1.2619	$ 1.8235	$ 0.5620

Figure 59 - Average Cost with Addition of Alternative Pipeline Terminals

With the addition of the alternative pipeline terminals, the cost per gallon increases by approximately $0.02 to $0.10 per gallon over the market hub scenarios, in order to meet the required demand levels.

Although there is some increase in total costs with the addition of alternate pipeline terminal sites, these incremental locations are an important consideration in a contingency strategy. Contingency planning is not just about handling increases in demand. It is also about being able to meet demand with current and/or changing constraints.

There are constraints on the number of loading terminals, propane tanker trucks and drivers, as well as inventory at the market hubs. As these constraints are reached, there will be restrictions on the ability to meet demand. These issues were manifested with the market reacting to the low inventory levels at Conway, during the 2013-2014 demand surge, with a sharp propane price spike at the hub. Similarly, long truck lines resulted at Mt. Belvieu, during this same shortage, as the market sought alternative and more cost-effective sources to Conway.

In addition, an alternative strategy based on market hub(s) alone does not provide protection in the event of a disruption or outage at Conway itself. Adding alternative pipeline terminals to a sourcing plan provides some risk mitigation, in the event of a disruption at Conway or one of the primary Iowa pipelines sourced from it.

The challenge remains that it is difficult for marketers to absorb the higher transportation costs, unless there is a:

- Product discount or
- Marketer pre-planning.

The price of propane will tend to be lower at market hubs or other source sites where there is excess supply, but less access to pipelines or other cost-effective transportation options.

In most contingency situations, however, product discounts may not be available and pre-planning as part of the marketer sourcing strategy would be required to effectively manage the higher expenses (see Figure 59). Marketers may:

- Enter into sourcing or pricing agreements with wholesalers to lock in costs in advance;
- Sign corresponding pricing agreements with its end user customers to secure retail price levels; and/or
- Establish long haul agreements with transport companies to secure truck transportation for contingency supply.

The only way to effectively manage through the cost changes is to account for the increase in supply chain costs in advance, using similar approaches to balance revenue and expenses.

Although costs are paramount, the other consideration is access to the alternative sites. When supply is short pipelines are on allocation. Thus, marketers may also need to build allocation on these alternative sites and/or modes, in order to be able to access supply at these locations during demand surges.

6.2.4 Rail Terminals as Alternate Sites

Rail provides access to a broader range of propane sources across the country, including refineries, fractionators and market hubs. Rail facilitates movements of propane in larger quantities than truck and can reach into areas not currently accessible by pipeline[85]. Thus, rail terminals are an additional option for contingency sourcing strategies.

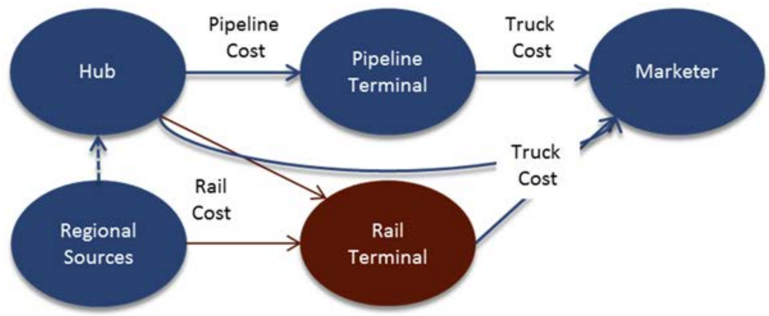

Figure 60 - Cost Components with Additional of Rail Transport

There are multiple cost components to rail, including the cost of rail transportation, fuel surcharges, as well as loading and unloading costs. With rail cars being privately owned and specific to propane transport, there is also a cost associated with the rail fleet that must be considered beyond the rail movement. The cost of the car will vary depending on the term and commitment to cars: the longer the commitment, the lower the unit cost, but the higher the cost of excess capacity.

The transportation cost is also going to vary, not just with mileage, but with the number of switches between the origin and destination on the rail route. The product cost, however, may be less in the summer at regional source points, when supply is moving into storage.

As a result of these variables, the cost per gallon to move propane from its source to a Midwestern rail terminal near Iowa can vary greatly, estimated at $0.24 to $0.41 per gallon of propane. The incremental cost of truck transport from the rail terminal to the marketer in Iowa brings the total costs for the rail movements into a similar range as alternate hub and pipeline terminal site strategies (see Figure 61).

Since rail costs are more expensive than an Iowa-centric, pipeline strategy and in similar range to other alternative site strategies focused on truck transport, there is not a cost preference for including rail in an alternative sourcing strategy. The main driver for rail is in building transportation capacity beyond pipeline and truck and bringing additional contingency supply into the Midwest from an alternative source to Conway, in order to meet regional demand (see Section 5.2.2).

Rail Terminal	Distance to Sample Marketer (miles)	Truck Cost per Gallon per 100 miles	Truck Cost Per Gallon	Estimated Rail Cost per Gallon		Total Est. Transportation Cost per Gallon			Total Est. Transportation Cost per Gallon	
DES MOINES, IA	86	$ 0.06	$ 0.05	$ 0.24	$ 0.41	$ 0.29	$ 0.46	Iowa-Centric Pipeline	$ 0.16	$ 0.16
MANLY, IA	100	$ 0.06	$ 0.06	$ 0.24	$ 0.41	$ 0.30	$ 0.47	Iowa-Centric + Hubs	$ 0.34	$ 0.55
BENSON, MN	312	$ 0.07	$ 0.22	$ 0.24	$ 0.41	$ 0.46	$ 0.63	Iowa-Centric + Alt. Pipeline	$ 0.47	$ 0.56
ROCKFORD, MN	311	$ 0.07	$ 0.22	$ 0.24	$ 0.41	$ 0.46	$ 0.63			
TOMAHAWK, WI	366	$ 0.07	$ 0.26	$ 0.24	$ 0.41	$ 0.50	$ 0.67			
LEMONT, IL	443	$ 0.07	$ 0.31	$ 0.24	$ 0.41	$ 0.55	$ 0.72			
FAIRMONT, ND	433	$ 0.07	$ 0.30	$ 0.24	$ 0.41	$ 0.54	$ 0.71			

Figure 61 - Sample Transportation Cost Scenarios from Midwestern Rail Terminals

85 After the closure of the Cochin pipeline, the primary storage center near Edmonton in Western Canada would be considered a region not accessible via pipeline, without an alternative pipeline into the Midwest.

7 Optimizing the Supply Chain

Iowa and other Midwestern states will face ongoing volatility in propane supply and demand. As an open market commodity, domestic and international propane demand and infrastructure will continue to be driven by industry economics and market dynamics.

However, ensuring a consistent supply of propane remains critical to public safety, where it is a primary heating source, and to the economics of Iowa businesses, for grain drying and other agricultural and commercial uses. The analysis evaluates:

- The ability to handle current demand with current infrastructure;
- The ability to handle future increases in demand with current infrastructure;
- And the impact of changing and/or new infrastructure constraints.

The analytics regarding the demand for propane, as well as status of its supply chain, provide insights into improvement opportunities and their relative impact. Recommended actions based on those opportunities fall within the following categories:

- **Monitoring** market conditions and infrastructure;
- **Communicating** and educating on changes, risks and recommended actions;
- **Incenting behavior** change; and
- **Incenting infrastructure** investments.

These recommendations will allow the State of Iowa to assess potential risks to Iowa end users of propane, to work with industry to take proactive steps to avoid or mitigate shortages based on those risks, to understand the adoption of best practices by industry participants and infrastructure changes, in order to ensure ongoing supply to Iowa constituents. Quantifying these risks and progress will provide an objective foundation for change.

Figure 62 provides a summary of the recommendations and key participants[86]. The subsequent sections provide more detailed commentary on the strategies and corresponding considerations.

Note: The recommendations are grouped based on subject matter. The order of the recommendations does not reflect an implied priority to the individual recommendations.

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[86] Key participants or entities involved in executing against the deliverables are represented by the following acronyms.

- PL = Pipeline / Storage Operators
- RL = Rail Carriers
- TR = Truck Transport Companies
- WH = Propane Wholesalers
- MK = Propane Marketers
- AG = Agriculture End Users
- RES = Residential End Users
- PR = Producers
- ST = State Agencies
- FD = Federal Agencies
- OT = Other Stakeholder or Data Source

Figure 62 - Summary of Recommendations by Category

Category	Recommendations	Monitoring	Communication	Incentives / Behavior	Infrastructure	Key Participants			
Managing Demand	1. Monitor factors that forecast market demand or supply chain stress	●				PL RL OT	WH		ST
	2. Define metrics on when to react to demand and/or constraint changes	●							ST
	3. Expand internal reporting, communication and action plan as reach thresholds	●	●			PL RL TR	WH MK		ST OT
	4. Communicate with wholesalers and pipeline operators to understand supply chain status and to help prioritize propane movements, as needed		●			PL	WH		ST
	5. Communicate, educate and incent marketer behavior to influence other factors that affect feasibility with high demand.		●				MK		ST
	6. Explore joint working group between State agencies and industry participants to encourage ongoing knowledge sharing and communication		●	●	●	PL RL TR	WH MK	AG OT	ST OT
Inventory and Supply Management	1. Ongoing communication and education with Agriculture and Residential end users on market changes, risks and best practices	●	●	●				AG RS	ST
	2. Provide retroactive incentive to end users and/or marketers to:								
	• Increase end user residential storage			●	●		MK	RS	ST
	• Right size farm storage based on grain drying needs			●	●		MK	AG	ST
	3. Explore incentives focused on heating demand to:								
	• Increase marketer summer to winter fill ratio			●			MK		ST
	• Provide incentive or funding to increase smaller marketers access to pricing risk management tools			●			MK OT		ST
	4. Explore incentives focused on grain drying demand to:								
	• Drive early tank fill on farms before peak drying season			●			MK	AG	ST
	• Commit to supply and/or pricing contract versus will call			●			MK	AG	ST

	Recommendations	Monitoring	Communication	Incentives / Behavior	Infrastructure	Key Participants			
	• Explore exchange or other mechanism for farmers to sell excess inventory or capacity to marketers			●			MK	AG	ST
	5. Monitor investments in storage via incentives and inspection processes to assess progress against best practices	●		●	●		MK	AG RS	ST
Pipeline and Rail Transportation	1. Monitor future changes in national pipeline, export and petrochemical infrastructure	●				PL OT	PR		ST FD
	2. Analyze impact of infrastructure changes on the ability to service demand	●				PL RL TR	WH MK		ST
	3. Monitor rail investments in Midwest region to assess ongoing impact of out-of-state marketers on pipeline capacity in Iowa	●				RL	WH		ST
	4. Communicate changes in infrastructure and implications to industry participants		●			PL RL TR	WH MK	AG RS	ST
	5. Monitor building of winter allocation via summer pipeline movements to Iowa	●		●		PL OT	WH MK		ST
	6. Track outages across modes; Implement defined action/communication plan	●	●			PL RL TR	WH		ST
Truck Transportation	1. Incent/require multiple driver shifts during peak season; Work proactively to avoid an emergency declaration.		●	●		TR	MK WH		ST
	2. Explore reservation system(s) for terminals; Incent investments in infrastructure	●			●	TR PL	WH MK		ST
	3. Implement regulatory option for Hours of Service waiver only during shortage			●		TR			ST FD
	4. Develop shared understanding of metrics for when emergency will be declared; Quantify and track metrics	●	●	●		TR	WH MK		ST
	5. Reporting and monitoring should integrate with triggers for hours of service reviews	●		●		TR PL	MK WH	OT	ST

7.1 Managing Demand Recommendations

The focus of the supply chain optimization effort is to ensure the ability to service demand at a reasonable cost. Thus, understanding demand levels and whether there is a corresponding potential for a shortage is critical.

7.1.1 Monitor factors that forecast market demand or supply chain stress.

Section 3 provides insights into both short-term and long-term factors that affect the demand for propane. Systemic monitoring processes should be established to determine:

- When Iowa faces a higher risk of a propane shortage; and
- When to proactively enact a corresponding action plan.

A core component of monitoring should focus on factors that "forecast" the demand for propane in the near term. Actual demand data is a lag indicator and thus is not timely enough to drive appropriate action to avoid a shortage or future emergency.

Key forecasting data sources include:

- **Winter temperature forecast** – Provides a leading indicator of timing and level of demand for propane for winter heating for both residential and agricultural buildings; and
- **Fall temperature, precipitation, crop yield forecasts and moisture content data** – Analysis of combined metrics can be used to predict potential demand for propane for grain drying.

Weather monitoring should focus on 15, 30 or 60 day forecast data, from a source, such as National Oceanic and Atmospheric Administration (NOAA). Adjustments to a marketer's supply plan 30 days out can still have an impact on the ability to meet demand. However, long range forecasts are much less reliable and thus less actionable.[87]

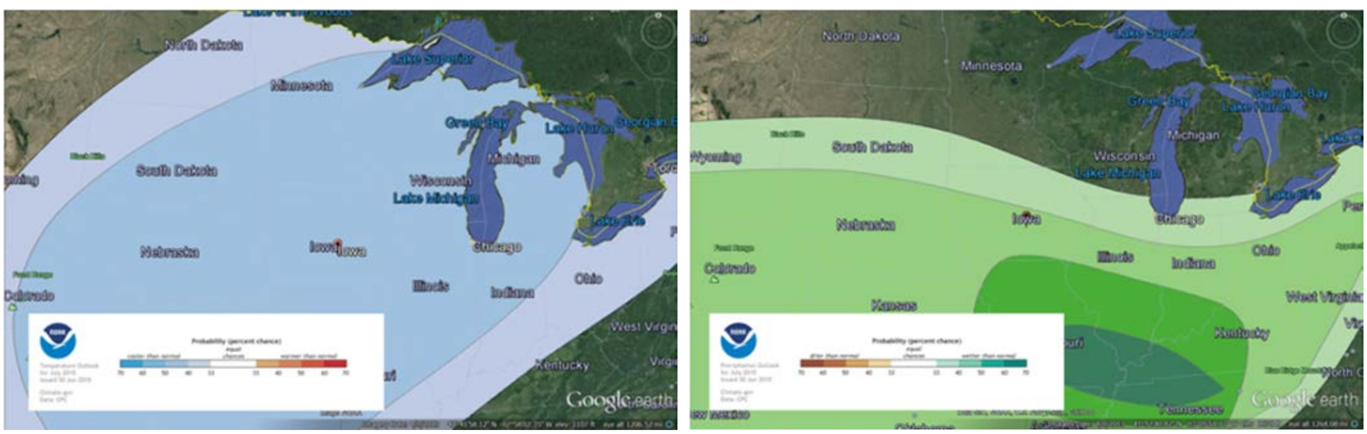

Figure 63 - Monthly Temperature and Precipitation Outlook (National Oceanic and Atmospheric Administration)

In addition, combining this information with agricultural data on crop progress and yield, from sources like the U.S. Department of Agriculture's (USDA's) National Agricultural Statistics Service (NASS), can be used to forecast and monitor the demand for propane for corn drying. Leveraging existing research[88] that correlates moisture content, corn bushels harvested and propane grain drying demand, the data can be converted into analytics to forecast and track agricultural demand at the start of the peak season. Given the significance of corn drying demand in Iowa on the supply situation for the remainder of the winter season (see Section 3.1), understanding the agriculture demand

[87] (National Propane Gas Association, 2014)

[88] See Section 9 for referenced research.

level is essential. A similar model can be developed to predict heating demand, leveraging existing industry forecasting tools or methodologies.

Other short-term factors should also be monitored to determine if the forecasted demand could result in or is causing increased stress on the Iowa propane supply chain.

- **Inventory trends within the Midwest region** – Provides an indication on whether the industry is preparing for increases in demand; and
- **Propane price data** – Illustrates the market reaction to the supply and demand situation (e.g., shortage).

Although inventory or propane stock data is a lag indicator, it can be leveraged to understand how inventory levels are trending versus history, and whether there are seasonal stocks being built in the summer. These patterns would indicate a greater ability for the Iowa market to manage through winter demand surges.

Inventory stock information is limited to regional data, aggregated across states. EIA data for the PADD 2 district represents Midwest regional stocks of propane (U.S. Energy Information Administration). It is primarily an indication of stock levels at the Mid Continent market center in Conway, Kansas, the largest primary storage facility in the region. However, since Conway is a wholesale, commodities marketplace, there is no guarantee that its inventory will be available to serve demand in Iowa. Stock levels reported by EIA may be designated for sales in other regions. However, if inventory levels are not trending upward at the Conway market center, it is a sure sign of pending supply chain stress in Iowa in the future, as overall propane supply and availability in the Midwest declines.

Aggregated pipeline allocation data (see Section 7.3.5), if available, could be a source of trend data to help better understand the potential supply destined for Iowa. Summer pipeline usage is a predictor of available supply during peak allocation periods. Canadian propane import data can also provide information about the changing supply dynamics for contingency supply with the loss of the Cochin.

Price is another factor that should be monitored to determine the status and/or health of the propane market. Short-term demand is highly sensitive to price, with the market reacting to identify alternative supply sources or to drive conservation behavior (see Section 3). In January of 2014, when Conway faced a propane shortage due to stock depletion, there was a swift market reaction resulting in a price spike (see Section 4.1), as well as an increase in spread between the prompt and out month prices[89]. These fluctuations in spot prices at the market centers, outside normal historical ranges, provide an indication of the potential risk of a propane shortage.

These variances are also predictors of an increase in transportation network demand. During the price spike in 2014, Iowa marketers shifted to sourcing supply from the Gulf market center at Mt. Belvieu, Texas. As a result, there was increased demand for truck transportation assets. In addition, hours of service became an issue, as transport companies had to travel much farther distances to bring propane supply into Iowa. Thus, spot pricing should be monitored both at Conway and Mt Belvieu. Although geographically dispersed, the two marketplaces are interconnected with current supply chain dynamics.

Even if there is minimal advance warning, price monitoring can highlight a rising price trend, and/or provide as timely of information as possible of an impending shortage. The quicker the issues are recognized, the sooner actions can be put in place to mitigate or shorten the emergency period. Weekly pricing data is available from EIA. Or daily data could be accessed through a subscription service, such as Oil Price Information Service (OPIS).

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[89] "Out month" represent transactions for product that buyer and seller agree will be delivered any time in the next calendar month. "Prompt" timeframe signifies delivery in the earliest possible pipeline cycle slot or within 48 hours. Typically, prompt transactions will be at a higher cost than out month. (Oil Price Information Service (OPIS)).

Existing weekly residential pricing tracked under the SHOPP program[90] could also be integrated as part of the effort, to consolidate and create efficiency in reporting practices.

Longer-term monitoring should also be implemented focusing on the factors that drive long-term changes in demand (e.g., new natural gas service, increase in housing starts (see Section 3), as well as changes in infrastructure constraints (e.g., export capacity changes, rail capacity/investments, storage investments)[91]. These factors are more forward-looking in their impact on the Iowa propane supply chain. But they are usually more significant and sustained in that impact, requiring as much preparation time as possible to adapt effectively to the change. For example, the permanent Cochin pipeline reversal was announced well in advance of the closure. However, there was not a concerted effort amongst many market participants to adjust practices to compensate for the closure until much later, when the shortage hit in early 2014 and its impact was felt.

Export and petrochemical demand are also important parts of the picture both in the short-term and long term. Increases in exports and PDH production indicate a movement of supply away from domestic markets, like Iowa. The winter weather in Europe could further restrict supply in the U.S. during winter peaks. Asian demand has limited seasonality. And Central and South American demand is counter-cyclical. All these factors increase the year-round competition for propane in the international market, and divert U.S. supply as export and production capacity increases. As the propane market becomes more global, it becomes increasingly important to monitor these factors and its influence on the local market (see Section 5.1.1). Monitoring of propane prices in global LPG spot markets, as well as corresponding freight costs, will also provide an indication of increased competition for U.S. propane supply. If an arbitrage opportunity exists between U.S. and international markets, the cost differential will drive increased U.S. exports.

The data strategy should also leverage and integrate any national efforts to improve propane industry data transparency in its execution[92].

7.1.2 Define metrics on when react to demand and/or constraint changes.

An important part of the monitoring effort is to establish a process to collect the disparate data and convert it into actionable analytics. A lot of information is available, both formally and informally, from the marketplace. The monitoring process can provide additional structure and automation in bringing these data sources together. Without it, key information can also get lost in the sheer volume of data and reports.

Analysis needs to be performed against the raw data to transform it into information. Then the information needs to be filtered to identify, via trends, when action needs to be taken. The focus should be on:

- Establishing the key metrics;
- Defining when the metrics would require action by a state agency; and
- Providing notifications when metric thresholds are met.

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[90] State Heating Oil and Propane Program (SHOPP) is a joint effort between EIA and participating states to collect weekly residential heating oil and propane price data. The SHOPP program has traditionally included 24 states in the Northeast and Midwest regions, but the program was expanded after many other states expressed interest in the program following the winter of 2013-14. Weekly residential heating oil and propane price data is collected at a State level from October through March. (U.S. Energy Information Administration, 2012).

[91] See Section 7.3.

[92] NPGA has been working with EIA expanding and increasing the level of detail of propane reporting. (National Propane Gas Association, 2014)

The propane optimization model assesses the "feasibility" of meeting demand, given the available infrastructure. Given a set of variables, including transportation network and storage capacity, sourcing and inventory practices, the model provides an indication of where demand exceeds the potential capacity of the network. In the winter of 2013-2014, there was a general lack of market awareness of the pending shortage and supply chain issues until the price spiked at Conway. At this point, the market was already in a shortage situation. Defining metrics with input from the propane industry (see section 7.1.6), and when to react to those metrics, will allow state agencies to implement more proactive measures and preventative strategies.

Although the theoretical capacity of an optimized propane network can be modelled, the combined behaviors of its market participants are less than optimal. The factors that contribute to whether or not different levels of demand can be met are highly variable. Despite best efforts, not all market participants will adopt best practices. And infrastructure changes or outages may change or temporarily increase constraints.

The metrics should define what the absolute maximum capacity of the supply chain is. But then it should indicate when the most common constraints reduce the maximum demand that can be supported. Section 6.1 analyzes these thresholds by:

- Defining different demand scenarios based on historical averages and potential future peaks;
- Identifying demand levels or thresholds where it is no longer feasible to meet demand; and
- Using additional factors and constraints to define areas of potential risk.

The specific metrics that should be reacted to, the level of severity of the event, and what the corresponding and appropriate action is (e.g., communication, evaluate emergency declaration, etc.) should be defined.

Although a multitude of variables were analyzed and could influence the risk of a potential shortage, the focus is on factors with greater predictability. The baseline looks at the current constraints in the market, including the absence of the Cochin pipeline and out-of-state marketer sourcing at Iowa pipeline terminals. To analyze the areas of potential risk, the focus is on decreases in available supply or capacity at terminals versus the baseline, representing a variety of market situations, including:

- Outage on a pipeline or at a terminal (e.g., pump down, natural or man-made disaster, maintenance)
- Increasing out-of-state competition for terminal capacity
- Diversion of supply out of the Midwest region for exports or petrochemical demand
- Inadequate number of transportation assets (e.g., tanker trucks) to transport from terminals or storage
- Inefficient terminal usage or reduction in terminal output rate

The emphasis is on the constraints with the strongest influence on the ability to meet demand.

The other key constraint is inventory practices and capacity. What inventory levels are maintained will have a significant impact on the ability to recover from a short-term constraint change (such as an outage). Thus, it will affect the riskiness of different demand levels.

But not every theoretical combination of factors and influences are evaluated in the short-term, demand scenarios. To do so would cause the risk analysis to start to lose relevance. Longer term factors, such as inventory capacity in Iowa, are equally important in determining the ability to meet demand. However, they cannot be adjusted in the short term. Thus, the objective is to understand how these factors build network capacity and what their effect is on the propane supply chain in Iowa. The emphasis in the evaluation of these other factors is adoption and implementation of best practices to build capacity for the long term.

7.1.3 Expand internal reporting, communication and action plan as reach thresholds

Once the thresholds are understood, it is important to formalize the action plan for what happens, as those thresholds are reached. Leveraging best practices in business continuity planning, disaster and/or risk management, a contingency plan or playbook should be established to define what action needs to be taken at different levels of probability and severity.

One of the first steps is expanding internal reporting to get the information to those who need it. There is some reporting around propane pricing and communication of information to key stakeholders within the state agencies. There are also numerous public sources of data and information on the propane industry nationally. However, reporting available to state agencies should be expanded, so that it is more systemic and scalable. Disparate and ad hoc sources of information make it difficult to collect, disseminate and digest.

The reporting should focus on turning the data into information to analyze the trends. It should answer key questions, as well as highlight when changes in information require action, e.g.

- What is the forecasted demand for propane for grain drying?
- Is demand expected to result in a local shortage? Is there already a shortage?
- What is the current status of terminals in Iowa? Fill rate? Lines?
- Are there any outages in the Iowa supply chain? Planned? Unplanned?
- Are there outages in other states or regions that could indirectly impact Iowa?

The significance of the statistics and associated findings are irrelevant, if the information is lost in the sheer volume of data. In most cases, the potential users of this information have multiple roles and are not dedicated to managing propane supply chain issues. They need assistance in determining what is important and where specifically they can or need to provide assistance. Trend reporting and analytics that look at historical averages, normal ranges and identifies outliers will help to highlight the pertinent data.

The information also has to be relevant to the Iowa propane market. For example, national statistics on propane inventories provide little insight into whether propane can get to the end users who need it, when they need it, and where they need it within the State. There could be an abundance of propane in the Gulf, but a significant shortage in Iowa. But a national statistic may show no issues outside the norm, when data is aggregated across states. Thus, filtering the data to understand the status of the Iowa propane market is important.

Once the information is generated, it needs to be communicated to those who need it. A communication strategy should be established that defines, based on an event probability and severity:

- Who needs to be notified at different state agencies, when and why;
- Which propane industry participants should be engaged, when and why;
- When should end users be notified and/or engaged and why; and
- What are the communication methods to each stakeholder?

The focus is on formalizing and expanding the lines of communication in advance, so that the right people are part of the dialogue and working to define a solution to avoid, mitigate and/or resolve a shortage. The communication plan should also outline the strategy and processes to communicate best practices and recommendations to build capacity in the Iowa supply chain for the long term.

Next, the actions that will be implemented, if an event occurs or a metric is reached, should be defined and documented in advance. While in the midst of a potential emergency is not the time to identify or define contingencies. A variety of stakeholders became engaged in the propane discussion after the shortage in 2013-2014. As the nature of the supply chain issues emerged, state agency involvement expanded. Essential elements of a coordinated and effective response include defining and documenting:

- What are the appropriate actions based on the situation;
- What are the standard operating procedures to support it;
- Who is responsible for taking the action; and
- What are their roles?

The contingency plan should identify potential scenarios considering additional qualitative risk dimensions such as:

- Cause of event (intentional, natural, or accidental);
- Magnitude; and
- Nature of the impact on the propane supply chain and end users.

This type of qualitative classification helps to define an appropriate level of escalation, based on the severity of the situation. It also helps provide structure and objectivity to an event. Removing some of the subjectivity using established risk management methodologies can help avoid the event turning into an emergency (see Section 7.4.4) and ensure that action is focused on the steps that will most quickly resolve the issue.

Where the severity escalates the issue to a potential emergency, the associated procedures should be integrated into other state agency emergency response programs and exercises (e.g., planning for response to electrical grid disruption due to flood). Agencies like Iowa Homeland Security and Emergency Management should provide input into the metrics and procedures, based on their experience with similar contingency planning issues. In addition, coordination with these groups is essential if other events (like a severe winter storm) further complicate recovery from a propane shortage and/or a transportation network outage.

Efforts should also include coordination with other state and federal agencies outside Iowa, where applicable, to help with implementation of action plans and information sharing.

7.1.4 Communicate with wholesalers and pipeline operators to understand supply chain status and to help prioritize propane movements, as needed.

The propane industry plays a key role in this process both now and in the future. Continued, ongoing communication with wholesalers and pipeline operators, in both the Midwest and Gulf regions, is a valuable part of this effort. With the pipelines being the primary constraint for propane deliveries into Iowa, these groups can provide a timely pulse on demand and the status of supply chain issues, as well as play a major role in their resolution.

The goal would be to formalize communication channels and engagement, as part of the contingency planning process, to identify the different resources within each group, when they are engaged and the value that they can provide. In the event of an emergency, they can work together with state agencies to mitigate and shorten its duration, by being responsive and helping to prioritize propane movements and/or working through alternative actions.

In addition, consideration should be given to inviting pipeline operators to join the Iowa Freight Advisory Council. The role of the Council is “to guide the Iowa DOT in fostering a safe, efficient, and convenient multimodal freight transportation system to enhance the competitiveness of Iowa’s business and industry.” (Iowa Department of Transportation). Inclusion of pipelines would provide greater representation across all modes on the council.

7.1.5 Communicate, educate and incent marketer behavior to influence other factors that affect feasibility with high demand.

Marketers are the key conduit between the national wholesalers, pipeline and storage operators, and the end users in Iowa. Marketer behavior and practices drive the movement of propane within the State of Iowa. Thus, their policies and actions have a strong influence on the ability to meet Iowa propane demand.

In May 2014, a National Propane Gas Association (NPGA) working group released a set of recommendations to help educate marketers on propane supply planning best practices (National Propane Gas Association, 2014).

Working with the Iowa Propane Gas Association (IPGA) within Iowa, there should be an effort to build upon this work to:

- Communicate and provide ongoing reinforcement of best practices;
- Educate on the status of the propane supply chain specific to Iowa;
- Share analytics that quantify the impact of best practices to Iowa marketers and the industry;
- Provide incentives to drive targeted marketer behavior[93]; and
- Help marketers to educate their end customers to enable their own best practice adoption.

Education should center on contracting and contingency supply, pricing and inventory management practices (see Sections 4 and 50) regarding:

- The inability for Iowa marketers to meet demand, if they do not have contingency supply strategy;
- What the impact is of the loss of the Cochin pipeline in high demand seasons;
- What the impact is of other changing national infrastructure on Iowa;
- What the impact is of out of state marketers pipeline usage on Iowa supply practices;
- The criticality of inventory management practices; and
- Price management, risks and consequences.

Ongoing education is important to drive behavior change. Many individuals may perceive the shortage of 2013-2014 as an event versus an ongoing risk. However, as demand levels fluctuate season-to-season, there can be a false sense of security after milder or average demand winters. With the infrastructure changes within the industry, and globalization of the propane markets, the risks will only increase versus decline.

Key to the long-term health of the Iowa propane industry is adoption of the best practices. Many marketers have turned these recommendations into action. However, without visibility into these changes, it is difficult to assess the current state of the market as a whole. Any incentives to drive behavior with marketers or other stakeholders should tie in reporting requirements, in order to quantify the results and help manage future risks (see Section 5).

7.1.6 Explore joint working group between State agencies and industry participants to encourage ongoing knowledge sharing and communication.

Core to all of the recommendations is cooperation and communication across all industry participants and State agencies. Whether there is a propane shortage within Iowa is not determined by any one individual. It is the combined actions and behaviors of all market participants, including marketers, wholesalers, transport companies, pipeline operators, storage operators and end users, that determines the supply and demand status within Iowa.

These groups also have the greatest knowledge of what is happening in the marketplace at any given moment, and are the drivers of change to bring any shortages or outages to resolution. They have knowledge and understanding of:

- End user demand and needs
- Transportation network and qualified driver availability
- Transportation network outages and bottlenecks
- Current inventory status and orders
- Other supply chain risks and challenges

An industry working group (see Section 8.1) could play an important role in driving communication and knowledge sharing across industry and state agency stakeholders. Pipeline and storage operators, transporters, wholesalers,

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[93] See Section 5.

marketers and the propane industry association (i.e. IPGA) are the closest to what is happening in the marketplace today. By working cooperatively together, they are critical sources of information that can help identify issues, impact and solutions, as well as assist in disseminating recommendations out to other parties who need it.

Given their involvement in managing the transportation network and propane situation within Iowa, State agency participation should be led jointly by the Iowa Department of Transportation (Iowa DOT) and Iowa Department of Agriculture and Land Stewardship (IDALS) with support from the Iowa Governor's office. Other agencies should be involved as needed, such as Iowa Economic Development Authority (IEDA), Iowa Homeland Security and Emergency Management and Iowa Utilities Board (IUB), to coordinate broader efforts around contingency planning and emergency management. Information and best practice sharing across neighboring states and nationally should also continue through the Midwestern Governor's Association, NPGA, Federal agencies and other communication and resource channels.

Although quantitative metrics are highly valuable, they need to be combined with qualitative considerations. Quarterly updates, or other frequency, with a propane working group could facilitate dialogue amongst industry groups. Subject matter experts could provide insights into industry changes and forecasts, help interpret quantitative measures, as well as report on the impact in practice within Iowa. A working group could also help facilitate ongoing outreach to industry participants to monitor progress against best practices and recommendations, while gaining a better understanding of the ongoing challenges that they face day-to-day.

Regular discussions also provide an opportunity to focus on long-term planning and progress, which can get lost if communication revolves solely around shortages, outages and other issues.

End user participation within the working group, especially from the agriculture community (e.g., Iowa Corn Growers Association), would also provide more comprehensive representation of stakeholder needs in the discussion. Participation from additional stakeholder associations, such as Iowa Institute for Cooperatives and Iowa Motor Truck Association (IMTA), will also help represent a broader population of stakeholders within the group.

7.2 Inventory and Supply Management Recommendations

Inventory capacity and management practices are major determinants of the ability for the propane industry to meet end user demand during peak periods (see Section 5.1). If adequate inventory is not maintained within the State of Iowa, there is no way for the propane supply chain to keep up with surges in demand.

7.2.1 Ongoing communication and education with Agriculture and Residential end users on market changes, risks and best practices

The behavior of all industry participants affects whether or not increasing demand levels will result in a shortage within the State. However, what inventory level is maintained in Iowa and when is it replenished, as well as the overall inventory capacity within the State, will often be the determining factor (see Section 6.1). With end user (or tertiary) inventory estimated at 8 times marketer storage capacity within Iowa, changes in inventory levels in farms and backyards have a significant impact on the market status. As a result, communication and educational efforts should also extend to the end user community, not just to marketers.

Most residential end users view propane as a “utility”, similar to electricity or natural gas. They expect that a regular, steady supply of propane is available to heat their homes at a reasonable price. It wasn’t until the price spike in January of 2014, and subsequent supply restrictions, that many residential users obtained a glimpse into the open market nature of this heating fuel.

Agricultural users, on the other hand, do view propane as a commodity. However, their primary focus is on price risk versus other supply chain risks. When propane is used for grain drying or other agricultural uses, the agricultural user’s goal is to minimize the price that they pay for propane, in order to protect their already narrow margins on crops or livestock production. This emphasis on minimizing the price paid per gallon, however, can increase the risk of a product shortage, price spikes and other supply chain risks, because it often results in maintaining lower inventory levels.

Educating end users on the risks within the supply chain, as well as best practices to mitigate those risks, is an important step to help drive behavior that builds capacity[94]. Topics would include:

- Market volatility, globalization of the marketplace and the impact of changing infrastructure;
- Price risks and options to mitigate;
- Best practices on contracting for supply, maintaining inventory levels and the timing of tank fills;
- Understanding the appropriate tank size based on usage, as well as options to increase storage.

In addition, ongoing updates on the supply status in Iowa, as well as changes in the national marketplace that will have an impact on Iowa, should be included as part of the communication strategy.

To reinforce the messages, information should be communicated directly as a public service, as well as via marketers. Updates on market status, risks and high-level best practices can be communicated by state agencies, providing a neutral informational service to the public. Information should be accessible via the web and included in other existing communication channels (e.g., email and radio) to the target audiences.

With the greatest reach to end user communities, marketers should also be provided with educational tools to pass through to their customers, as well as deliver specific information on how to turn best practices into action. Developing a toolkit that marketers can use with their customers will help them drive best practice adoption on a larger scale, provide a value-added service, as well as increase marketer efficiency (e.g., by reducing will call accounts).

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[94] See Section 5.

The communications should be tailored to each audience. The needs of residential versus agricultural users are different (see Section 3). Thus, the tools and messages should address the specific requirements, concerns and motivations of each user group. Where possible, the communication resources should leverage industry updates and tools already provided by the propane industry, such as the Propane Education and Research Council (PERC), the Iowa Propane Gas Association (IPGA) or the National Propane Gas Association (NPGA). Iowa communication efforts would focus on providing greater access to the information, as well as interpreting its specific applicability to Iowa.

Also, the most effective communication vehicles to reach each audience should be identified as part of developing an overall communications strategy. For example, the agriculture community may utilize the iowaagriculture.gov website regularly as a resource. If so, this site may be a logical location to post resources or updates. However, residential users may not have a clear understanding of where to go for information on propane. Although the Iowa Utilities Board (IUB) does not regulate propane service or billing, it may be a resource for a consumer search for information, because consumers think of propane as a utility. Propane information links could be provided from the IUB website, to redirect consumers to a website with the needed resources.

Outbound communications need to reoccur annually at key times of the year (e.g., spring/summer fill, during fall commitments to pricing programs). The risks were top of mind for many users after the winter of 2013-2014. However, with low propane prices and no major supply shortages in the winter of 2014-2015, the urgency and severity of these issues may no longer be top of mind. Regardless of the performance of the previous season, it is important for end users to consider taking actions that will mitigate their risks, as demand and market conditions fluctuate year-over-year.

Communication resources should also provide information on any corresponding incentives to reinforce and increase adoption of the desired behavior (see additional recommendations in this section).

7.2.2 Provide retroactive incentive to end users and/or marketers to:

- **Increase end user residential storage**
- **Right size farm storage based on grain drying needs**

Building storage capacity and maintaining inventory levels within Iowa is essential to mitigating supply chain risks. The focus should be on building inventory in Iowa proportional to demand.

Having adequate marketer storage is important. However, a marketer may only be able to maintain a few days of supply during peak demand periods, even with increases in their storage capacity. Conversely, a percentage increase in end user storage will have a much greater impact on the propane supply situation across the entire state, as well as the ability to handle future demand surges (see Section 6.1).

Incentives to add storage capacity within Iowa should focus on:

- Residential storage for winter heating
- Agricultural storage for winter heating
- Agricultural storage for grain drying

Incentives should also consider increases in marketer site storage. However, given the greater impact of increases in end user storage, marketer incentives should focus their efforts to increase the capacity of their end customers.

The goal is to “right-size” the tank size or number of tanks for the individual end user need. For heating demand in a home or on a farm for livestock, adding another tank or increase the size of the tank reduces the frequency throughout the winter that a user needs to fill their tank. As a result, the end user and the marketer are better able to manage surges in demand throughout the winter season (see Section 5.1).

Having adequate farm storage for grain drying is essential. Demand is concentrated into a short window of weeks, with some periods of daily tank fills. The transportation network and marketer infrastructure is limited in its ability to support this brief, but significant, spike in demand. An agriculture user should have tank capacity proportionate to its acreage and potential yield. A simple calculator could be developed to help farmers and/or marketers evaluate farm tank requirements, based on acreage, yield and moisture content (see Section 5.1.3). Corresponding incentives should encourage investments in additional tank capacity, reducing inventory turns during grain drying and thus stress on the supply chain. Incentives could also be linked to programs to encourage acquisition of more energy efficient dryers, reducing the net demand for propane during that period.

Source: Stock Photography (Copyright – Propane Education and Research Council)

Incentives should be structured with a retroactive component, in order to not penalize those end users or marketers who have already been proactive in adding storage over the past few years.

Incentives to increase end user storage should be available directly to end users or be available to marketers, where the tank is owned by the marketer and leased back to the end user.

Marketer incentives could also be combined to drive multiple behaviors and should be linked to reporting and monitoring requirements (see Section 7.1).

7.2.3 Explore incentives focused on heating demand to:

- **Increase marketer summer to winter fill ratio**
- **Provide incentive or funding to increase smaller marketers access to pricing risk management tools**

Adequate end user storage is only part of the solution. Reorder points and the maintenance of minimum inventory levels have a significant influence on the ongoing ability to meet heating demand.

Having a full end user tank at the beginning of the season helps to more effectively manage supply chain capacity, making summer fills a best practice (see Section 5.1.2). It also increases a marketer's summer-to-winter ratio, allowing Iowa marketers to build pipeline allocation and help secure supply into Iowa in the winter. Exploring incentives to reward marketers for ordering throughout the year and working with their clients to encourage summer fills would increase the stability of the Iowa propane market (see Section 5.1).

Another means to reduce price volatility to end users is for marketers to take advantage of price risk management programs (see Section 4). But smaller marketers who are less able to weather price extremes, which also increase days sales outstanding and delinquencies, may be unable to take advantage of these risk mitigation tools. These price programs have a credit underwriting component, for which smaller marketers may not credit qualify. Looking at structures to help underwrite smaller marketer risk could be another mechanism to manage propane market volatility more effectively.

The segment of the market most vulnerable to winter supply shortages and price fluctuations are lower income consumers. The Low Income Home Energy Assistance Program (LIHEAP) helps these individuals pay for the cost of propane[95]. The prolonged winter weather in 2013-2014 caused states to expand LIHEAP funding, in order to help LIHEAP recipients manage through the high price, high demand period. In some Midwestern states[96], there was also concern expressed that LIHEAP funds were not available until October each year, when the winter heating demand has already begun to rise. Funding a spring/summer fill before the peak demand period would reduce price risk and costs for lower income families, as well as increase supply stability.

The Iowa Bureau of Energy Assistance, who administers the Iowa LIHEAP program, has made it a practice for the past several years to reserve a portion of their annual LIHEAP funds, in order to support this type of Spring/Summer pre-purchase of propane. Working with the IPGA, the Bureau also encourages local LIHEAP provider agencies to work with local propane marketers on strategies to pre-purchase propane. In the spring/summer of 2014, after the shortage, communications and efforts to lock in a price early with any available pre-purchase funds were intensified. Approximately 85 percent of the pre-purchased propane under the LIHEAP program during this period locked in a price. Based on this success, these practices will continue in the future under Iowa's LIHEAP program.

7.2.4 Explore incentives focused on grain drying demand to:

- **Drive early tank fill on farms before peak drying season**
- **Commit to supply and/or pricing contract versus will call**
- **Explore exchange or other mechanism for farmers to sell excess inventory or capacity to marketers**

In the agriculture industry, the economics of grain production drive farmers to wait until the last minute to fill their propane tanks in preparation for grain drying season (see Section 3.1). In order to minimize the impact on crop margins, agriculture users want to buy only as much propane as is needed, based on crop moisture and harvest timing, and pay the lowest price possible. As a result, agriculture users are less likely to commit to supply or price in advance. And they are more likely to be "will call" customers, in order to attempt to maintain greater control over inventory and costs.

The challenge is the transportation network has difficulty meeting the grain drying demand. It also makes it difficult for marketers to more proactively manage their inventory, if supply is depleted in the Midwest region prior to peak heating demand.

Early fills before peak drying season could relieve some supply chain stress by starting the season with full propane tanks on the farms. Also, contracting with a marketer for supply and/or leveraging pricing programs may result in better service for agriculture users in a shortage, and increase the likelihood that inventory will be better managed across the Iowa market as a whole. Generally, marketers are better able to commit to supply and manage their costs if end users commit to marketer.

Structuring a financial incentive to agriculture users to help counter the propane inventory and price risks, and protect crop margins, by rewarding early fills and price contracting may increase the level of best practice adoption in inventory and supply management. In addition, an incentive or funding mechanism for marketers to offer a metered, pay-for-use program, where farmers only pay for the propane used (versus a full tank) may mitigate some of the end user risk .

Another option is to explore implementation of a local exchange or other mechanism, where farmers could sell excess inventory or storage capacity to marketers. If farmers have an outlet to sell excess inventory after grain

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[95] (Iowa Department of Human Rights)

[96] For example, in June 2014, Wisconsin Governor Scott Walker wrote a letter urging President Barack Obama and the U.S. Department of Health and Human Services to allow Wisconsin to distribute funding from its Low Income Housing Energy Assistance (LIHEAP) program starting July 1, so that propane customers can fill their tanks during the summer while prices are lower. (Office of the Governor, Wisconsin, 2014)

drying season when heating demand is ramping up, they can further mitigate their risks. Such an approach would require:

- Adjustments to large farm storage tanks, with appropriate safety controls to allow for offloading of propane
- A method to communicate available supply to marketers
- A sales / payment mechanism between parties

At the simplest level, a farmer and marketer could contract directly for a one-on-one arrangement. Such arrangements have been pursued by some marketers as a mechanism to increase storage in response to the 2013-2014 shortage. A broader mechanism would be to implement an online, electronic marketplace to facilitate the transfer of supply between multiple agriculture end users and marketers.

These options should be explored in conjunction with industry participants to further gauge the level of potential adoption and the structure that would have the most impact on the market in practice.

7.2.5 Monitor investments in storage via incentives and inspection processes to assess progress against best practices

Given the importance of inventory practices to serving demand, tracking investments in storage is a key indication of propane supply chain capacity in Iowa.

Tank installations over 2,000 gallons of individual capacity, or with aggregate capacity exceeding 4,000 gallons, have to be inspected by the State Fire Marshal's Office[97]. Tracking these installations to monitor year-over-year growth trends in new tanks and aggregate capacity increases[98] will provide insights into the investments of both the agriculture community, as well as Iowa marketers[99].

Given the scale of residential storage as a percentage of total inventory capacity in Iowa, additions to backyard storage should also be monitored. Incentive programs that reward the addition of end user storage should be leveraged to track growth in residential capacity[100] (see Section 5.1.3).

Both datasets will provide insights into industry progress as a whole against inventory infrastructure best practices. Reporting and data collection process should be integrated within an overall data management strategy (see Section 8.2).

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[97] Inspections/installations of LP tank installations and systems have to be conducted to determine code compliance in accordance with NFPA 58, 2014 edition, as formally adopted by the Iowa Administrative Code 661-226 (101). (Iowa Legislature)

[98] Data should be monitored at an aggregate level to avoid confidentiality concerns with individual site installations.

[99] Requirements to submit plans to the State Fire Marshal's Office apply to "Stationary installations utilizing storage containers of over 2000-gallon individual water capacity, or with aggregate water capacity exceeding 4000 gallon". Due to the size of the tanks and/or installations, the data relates primarily to marketer and agricultural end users with larger tank sizes. (Iowa Department of Public Safety, State Fire Marshal Division)

[100] No centralized data source for smaller residential tank installations, equivalent to the Fire Marshal data for tanks over 2,000 gallons, was identified during the study. Administration of incentive programs would provide a mechanism to gather further information on smaller tank installations.

7.3 Pipeline and Rail Transportation Recommendations

Pipelines remain the most economical and efficient way to bring propane into Iowa, with Iowa marketers benefiting from access to a comprehensive network of pipeline terminals. However, this logistical advantage is also the supply chain's greatest constraint. The capacity of the pipelines is fixed and cannot be exceeded during peak demand periods.

The existing pipelines can meet average demand levels, even with the closure of the Cochin (see Section 6). Thus, industry investment to expand the pipeline infrastructure within the Midwest region is unlikely. With the permanent reversal of the Cochin pipeline, due to low utilization of the pipeline outside seasonal peaks, the business case does not currently exist to add pipeline capacity for movement of propane. In fact, pipeline capacity may be at risk of decreasing on a national level, as other pipeline assets are redirected like the Cochin to less seasonal commodities, like diluent and ethane.

7.3.1 Monitor future changes in national pipeline, export and petrochemical infrastructure

Ongoing changes to the national pipeline infrastructure will have an ongoing impact on capacity, inventory and demand levels within the state of Iowa. In the 2013-2014 winter season, reversals of pipelines[101], conversions to new products, outages, etc. had a significant influence on the ability of Iowa marketers to meet their customers' demand. With the seasonality of propane, the economics will continue to drive the owners of these infrastructure assets to focus on alternative uses to maximize their return on investment.

Consequently, marketplace changes should be monitored not only in Iowa, but on a national level. Changes in other parts of the U.S. causes supply shifts (e.g., propane moves to other geographies) or results in decreases in transportation network capacity (e.g., out-of-state marketers expand their reach into Iowa markets, as capacity changes within their own states). An Iowa-centric approach to propane supply and transportation management is no longer viable.

The growth in PDH production and export terminals are a significant part of these changes. As a new domestic PDH plant or export terminal comes online, there is an immediate and significant increase in the demand for propane in the Gulf region. Although U.S. propane production is growing with the corresponding growth in the oil and natural gas industry, these increases in manufacturing and export capacity facilitate the serving of much higher levels of international petrochemical and propane demand. Until domestic and international prices converge, economics will continue to drive major supply shifts, as infrastructure investments are made in order to supply these higher-priced and less seasonal propane markets. Given the scale and impact of these changes, these events should be monitored[102] including:

- Planned closures or outages to national pipeline network for propane;
- Planned reutilization of dedicated or batch pipelines for other commodities;
- Planned closures or outages to major storage facilities or other key transportation modes/routes;
- Shifts in patterns of pipeline movements of propane by PADD region;
- Capacity and timing of new Propane Dehydrogenation (PDH) plants; and
- Capacity and timing of new propane export terminals.

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[101] See Section 5.2.1.3 - Economics and Utilization.

[102] See Section 7.1.1 for additional recommendations on monitoring approach.

7.3.2 Analyze impact of infrastructure changes on the ability to service demand

The Propane Supply Chain Optimization tool, developed as part of this project, provides insights into the feasibility of servicing varying levels of demand given current infrastructure and practices. However, if there are major changes to this industry infrastructure, it is important to reassess scenarios to determine if the same levels of demand can still be supported.

For example, when there is a change in the pipeline transportation capacity, the analysis can be repeated with new constraint assumptions to assess the impact. Or if there is an increase in export terminal capacity in the Gulf region or Pacific Northwest, the situation can be analyzed to determine if a corresponding reduction in the available supply to Iowa is anticipated. Similarly, any investments in infrastructure that would increase network capacity, such as a significant increase in end user or marketer storage in Iowa, should also be periodically re-evaluated.

Key constraints and assumptions underlying the model include:

- Pipeline capacity available for the transport of propane nationally;
- Primary propane storage facilities and their capacity nationally;
- U.S. export terminal capacity and international demand for propane;
- Propane Dehydrogenation production capacity and demand for propane;
- Rail capacity available for the transport of propane regionally;
- Truck terminal capacity within Iowa, in the Midwest region and at key contingency supply sources nationally; and
- Major changes in secondary and tertiary storage in Iowa and in the region.

It is recommended that the model assumptions are reviewed annually and a new baseline rerun for any major changes in the past 12 months, or those anticipated in the near future.

The reversal of the Cochin pipeline resulted in a significant variance between the current propane supply chain model and the historical baseline (see Section 6). It affected both the level of propane demand that could be supported and the industry practices to meet that demand. Many of the challenges of the 2013-2014 season were a result of not anticipating the impact of changes in infrastructure on the ability to accommodate surges in demand.

Establishing a new baseline, based on current and/or forecasted changes in key supply chain constraints, will provide insights into practices in the short-term and investments in the long-term that will help industry participants more effectively adjust to significant change. Grasping the ongoing dynamics in the market is essential for a longer term understanding of supply chain viability.

7.3.3 Monitor rail investments in the Midwest region to assess ongoing impact of out-of-state marketers on pipeline capacity in Iowa

Although the pipelines are essential to the movement of propane into Iowa, investments to increase transportation capacity via other modes should be monitored as well. Rail investments within the Midwest region do have a significant effect on the ability to meet the needs of Iowa propane users, even if there is not a strong business case to make a significant, financial investment in propane rail infrastructure within the State of Iowa (see Section 5.2.2).

Neighboring states within the region, like Minnesota and Wisconsin, have similar propane demand patterns to Iowa for both agriculture and winter heating. However, these states do not have the same pipeline access as Iowa, and were historically more heavily reliant on the Cochin as a primary versus contingency supply source.

Since the start of grain drying demand in the fall of 2014, there has been a continued influx of marketers from neighboring states into Iowa to lift propane at its terminals. Ongoing investments in rail within the Midwest are essential to help mitigate the loss of the Cochin and ensure continued supply in these other states. For Iowa, whether these investments are made or not will have a direct correlation to truck loading capacity at Iowa terminals. Although the cost and reliability of rail versus pipeline will likely result in some permanent shift to utilization of Iowa terminals, development and monitoring of rail infrastructure within the Midwest region is important to understand and plan for the full extent of the impact.

Rail is also important from a risk management perspective. As a part of a supply chain resiliency strategy, rail helps mitigate the risks of a disruption at Conway, as well as truck capacity constraints and driver availability issues. Thus, some level of investment in propane rail service in Iowa is beneficial as part of contingency planning. Although Greenfield investment in propane rail terminals remains difficult to justify, there may be lower cost options for rail development that can be pursued.

Reutilization of existing sites for rail propane service is less expensive than building new terminals from the ground up. If a site already has the necessary hazardous materials approvals, the time and cost to repurpose the site is further reduced. However, the lack of a transportation cost advantage still makes the financial decision to invest in rail challenging for private industry. Consideration should be given within grant programs and other incentive structures to offset some of these costs and mitigate some of the supply chain risk within Iowa. In addition, facilitating access to hazardous material permitting data for sites that could be converted to rail would help to reduce the total time and cost to redevelop these existing locations. Mobile transloading from rail to truck is another lower cost alternative that has been explored by members of the propane industry. Additional discussions should occur to see if mobile transloading could be provide a flexible means to further utilize rail on a contingency basis. More research is needed into the regulatory, operational and safety considerations for mobile transloading of propane. Today, regulations impose a time limit on mobile transloading sites, making it a temporary solution. Consideration should be given to how it can be part of a more permanent contingency strategy with the potential for longer term utilization.

7.3.4 Communicate changes in infrastructure and implications to industry participants

All of these insights are beneficial, but they need to reach the entities and individuals who can affect change. As part of an ongoing dialogue with industry participants[103], a structured communication strategy should include:

- Notification to marketers and other industry participants of both short-term and long-term changes, allowing them to prepare for and adjust to the changing market conditions to sustain service levels; and
- Sharing of insights and best practices from the feasibility analysis, helping them to better understand their options and what actions they can take that will have the most influence.

Understanding the significance of the change is essential. For example, although the reversal of the Cochin was announced over a year before the event[104], marketers did not fully realize the impact until the temporary closure of the Cochin for maintenance during a demand surge illustrated its importance. Interpreting the change, not just communicating it, is important.

Transportation network insights should also be considered in the overall communication strategy to end users on industry issues, best practices and changes. Although they have less direct involvement in the transportation

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[103] See Section 7.1 for additional communication recommendations

[104] Communications included newsletter updates to IPGA members in September 2012, as well as a seminar at the 2012 North Central Convention for Iowa, Minnesota and Wisconsin propane association members.

process, end users are vulnerable to disruptions in the network. They can also take other actions (e.g., invest in storage, contract for supply) to counter its effects (See Section 5).

7.3.5 Monitor building of winter allocation via summer pipeline movements to Iowa

The capacity of the pipeline is not only determined by the physical size of the pipe, but the allocation of its use.

Since demand exceeds pipeline transportation capacity in the winter months, the pipelines have instituted an allocation system to determine what portion of capacity will be available to an individual entity. If pipeline users don't earn allocation during the summer months (e.g., through summer / early fill programs), they will have no priority to use pipeline capacity during peak winter demand.

Although competitive concerns would likely prohibit detailed reporting and tracking, monitoring summer pipeline movements to Iowa at an aggregate level would provide an indication of whether or not Iowa marketers are building allocation. For example, year-over-year, trend analysis of summer pipeline movements into the Midwest region via EIA[105], or via summary data from wholesalers of propane liftings at Iowa terminals, would provide directional insights into the pipeline capacity available to Iowa marketers in the winter season. Or if the allocation trends are not building versus history, it would provide an indication of pending risks during the upcoming winter.

7.3.6 Track outages across modes; Implement defined action/communication plan

Infrastructure changes, like altering a pipeline commodity flow, are typically implemented over an extended period of time. Thus, there is usually advance warning and a window to allow users of the infrastructure to prepare for the change.

Unplanned outages on pipelines or other transportation modes, on the other hand, can be unanticipated and cause short-term stress on the supply chain without the ability to make proactive adjustments. Thus, timely communication of the outage is critical.

State agencies involved in supporting the industry need to be informed of the outage with a defined communication strategy for disseminating the information. Having a defined action plan against different scenarios will speed reaction time and help avoid a crisis or mitigate its impact. It is important to understand the issues and help industry communicate the appropriate contingencies.

An industry working group (see Section 7.1.6) could play an important role. Pipeline operators, wholesalers, marketers and the industry association are the closest to what is happening in the marketplace today. By working cooperatively together, they are critical sources of information that can help identify issues and impact, as well as assist in disseminating recommendations out to other parties who need it.

Implementation of this type of strategy will ensure that dialogue is not short-term and merely an immediate reaction to the challenges of the 2013-2014 season. As the sense of urgency decreases in lower demand periods, the level of interaction and dialogue may as well. Defining and formalizing the lines of communication on a recurring basis is at the core of the issue.

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[105] (U.S. Energy Information Administration)

7.4 Truck Transportation Recommendations and Considerations

Moving propane via pipeline to Iowa is an essential part of the transportation network. However, truck transportation plays an equally important and interrelated role.

For pipeline movements into Iowa, the capacity for trucks to pick up propane at the pipeline terminals and move it to marketer storage is a key part of the ability to meet demand during peak periods. Where demand exceeds pipeline capacity, truck is the most viable and flexible transportation mode to deliver contingency supply into Iowa, given the limitations and higher costs of rail for propane movements (see Section 6.2.4).

Due to its importance in the ultimate delivery of propane within Iowa, truck and terminal loading capacity is a key determinant of the ability to service the end user need. Maximizing the efficiency and flow of propane from pipelines to trucks is essential to overcoming supply chain constraints.

Source: Stock Photography (Copyright – Propane Education and Research Council)

Recommendations for truck transportation center on working cooperatively with the transport companies, as well as the pipeline and terminal operators, to avoid and/or mitigate an emergency by being responsive to demand surges.

7.4.1 Incent/require multiple driver shifts during peak season; Work proactively to avoid an emergency declaration

Most pipeline terminals allow for truck loading 24 hours per day. The analysis in Section 6.1 emphasizes that maximum utilization of those loading windows is a key determinant of whether end users can be serviced during a peak period. Although terminal utilization alone does not define whether a particular demand level will result in a shortage in Iowa, it can make the difference between whether a risk threshold is crossed or a crisis averted.

During most of the year, demand can be met sufficiently with a normal daytime schedule. However, during corn drying or peak heating demand, adding later shifts and filling throughout a 24-hour period can help avoid a local product shortage or the need for an emergency declaration.

As demand rises, lines at terminals grow longer. A typical terminal with two loading spots can fill 2 to 6 trucks per hour, depending on whether trucks are being filled from terminal storage or drawing directly off the pipeline. The truck load time will extend throughout the day as terminal inventory is drawn down.

However, total truck load time is a combination of time in line, plus time to fill the actual tank. Drivers will spend several hours at the terminal in line. In this situation, the driver consumes their hours of service waiting in line, increasing costs to the transport company, decreasing productivity and reducing delivery capacity, as well as extending a driver's time on the road.

A commonly sought measure is to look to the State or other authorized authority to declare an emergency, in order to waive the hours of service regulatory limits allowing a driver to make up lost, unproductive time spent at terminals. Not being able to get propane to those who need it is a safety issue during the winter and an economic issue during grain drying season.

However, the hours of service and other safety regulations included in the scope of an emergency declaration are also in place to protect the public against the risk of tired drivers and hazardous equipment or practices. Thus, every effort should be made to avoid the need for an emergency declaration. Waiving safety regulations should not be considered an automatic or quick fix.

Proactively adjusting shifts to maximize terminal utilization is one action that can be taken to help avoid or mitigate the impact of an emergency.

7.4.2 Explore reservation system(s) for terminals; Incent investments in infrastructure

For the most part, truck loading at terminals is on a first-come, first-served basis. There is no prearranged time for pickup between the shipper and the transport carrier, like a traditional commercial transportation management process. A transport company is able to pick up propane during any terminal operating hours (see Section 5.2.3).

Although adding driver shifts during demand surges will reduce some terminal congestion by increasing utilization in off hours, it will not fully address the productivity losses from multiple tankers arriving at the same time at a site.

Establishing a reservation process for pipeline terminals would more effectively utilize all the operating hours at a location. The type of reservation process could include:

- A simple queuing system, where a driver is assigned a spot in line and is notified (e.g., via pager or text) when they have reached the top of the queue and should return for loading; or
- A more robust system that assigns a specific time to return for loading, based on when the driver entered the line; or
- A full reservation system where a loading time is prescheduled in advance of arrival at the terminal.

Regardless of the form, establishing corresponding operating policies and rules are essential to the effectiveness of the process. These standard procedures should define, for example, what happens if a carrier misses their schedule appointment time or spot in the queue. Best practices for queuing and reservations exist across multiple industries. Taking the time to define these rules and policies up front will ensure an understanding by industry participants and maximize its effectiveness.

One of these considerations is ensuring that the process applies to all terminal users. There cannot be a way to circumvent the process or for it to only be applicable to certain types of users, in order for it to be effective. For example, in many cases, a wholesaler may be the "shipper" of propane, working to coordinate pickup of product. However, multiple wholesalers supply propane to their customers at each pipeline terminal. Thus, a reservation process could not be developed or managed by one wholesaler.

The system could be developed by the pipeline operators on an individual basis at each of their terminals, or as a universal, industry resource across terminals and pipelines. Coordination amongst each of the independent parties involved in the process (i.e., transport companies, wholesalers and pipeline operators) is a key requirement, as well as challenge, in pursuing this type of scheduling solution. A system established by pipelines would likely be faster to implement at an individual terminal with direct integration with existing pipeline operations. However, a universal reservation system would provide greater value to transport companies by allowing them to schedule across Iowa (or broader geography) via a single process, driving greater efficiencies.

Management as a universal reservation system provides opportunity for the widest scope of adoption. It could be driven by an independent third party, industry association or government agency as a service. Or it could be managed by the pipelines in coordination. However, competitive concerns may limit the applicability. The tool could be expanded in the future to out-of-state terminals or other commodities that flow via pipeline. A funding model would also need to be defined to build and support ongoing operations.

In addition to the scheduling benefits, the system could also be a valuable source of industry data for monitoring propane demand and utilization of terminal assets. With data aggregated to reduce competitive concerns, the type of data generated would depend on the sophistication of system (i.e., reservation versus queuing system).

7.4.3 Implement regulatory option for hours of service waiver only during shortage

The goal during periods of peak demand for propane is to work with industry participants to take actions to proactively avoid an emergency declaration (see Section 7.4.1). However, since propane or other fuel shortages can represent a public safety issue, there will be instances where conditions will lead to the declaration of an emergency, despite these efforts.

Under the Federal Motor Carrier Safety Regulation 49 CFR 390.23[106] (Federal Motor Carrier Safety Administration), and adopted under State Law[107], the Governor or other authorized authority can declare an emergency "following an event that results in reduced fuel supplies or required transportation capacity to resupply the affected area."[108] By definition within the regulation, an emergency includes natural disasters that lead to the disruption of essential services, such as "damage or reduced capacity of the energy infrastructure that is needed to meet state and regional energy demands"[108]. But it also includes other events, such as the disruption of major pipeline, unanticipated shutdown of a major supply source, etc. within its scope of application.

In the case of a fuel shortage, the primary objective of the declaration is to temporarily waive the hours of service provision[109], which establishes maximum driving limits for commercial motor vehicle drivers transporting propane, in order to allow motor carriers to assist with the emergency relief efforts. The intent is to mitigate the damaging effects of a shortage by increasing the amount of propane transported throughout the State.

However, the scope of the regulation requires temporarily suspension of Parts 390 through 399 of the FMCSR regulation in its entirety, which includes:

- 390 FEDERAL MOTOR CARRIER SAFETY REGULATIONS; GENERAL
- 391 QUALIFICATIONS OF DRIVERS AND LONGER COMBINATION VEHICLE (LCV) DRIVER INSTRUCTORS
- 392 DRIVING OF COMMERCIAL MOTOR VEHICLES
- 393 PARTS AND ACCESSORIES NECESSARY FOR SAFE OPERATION
- 395 HOURS OF SERVICE OF DRIVERS
- 396 INSPECTION, REPAIR, AND MAINTENANCE
- 397 TRANSPORTATION OF HAZARDOUS MATERIALS; DRIVING AND PARKING RULES
- 398 TRANSPORTATION OF MIGRANT WORKERS
- 399 EMPLOYEE SAFETY AND HEALTH STANDARDS

Thus, an emergency declaration has much broader safety implications than just hours of service considerations. Regardless of the intent underlying the declaration, other safety regulations, such as inspection requirements, are also waived.

It is recommended that a modification to the regulation be explored to allow for suspension of Part 395 only, regarding Hours of Service of Drivers, without suspending the other parts of the Federal Motor Carrier Safety Regulation. Although there may be emergency scenarios where the broader scope of relief from regulations is required, adding the ability to suspend hours of service only for propane and other fuel shortages will reduce risks during an emergency by not waiving other safety requirements unnecessarily. The ability to enact a more limited scope of regulatory relief is in the best interest of public safety.

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[106] 49 CFR 390.23: Relief from regulations. (Federal Motor Carrier Safety Administration)

[107] Iowa Code 321.449 (Iowa Legislature)

[108] (National Association of State Energy Officials, 2012)

[109] 49 CFR 395: Hours of Service of Drivers. (Federal Motor Carrier Safety Administration)

7.4.4 Develop shared understanding of metrics for when emergency will be declared; Quantify and track metrics

Despite best efforts to avoid hours of service exemptions with adoption of best practices and investments in infrastructure, where conditions exist that require an emergency declaration, the decision should not be made without appropriate consideration and justification. Declaring an "emergency" is an extraordinary action upon the part of the Governor or other authorized official, given the associated safety implications and risks. The question is at what point does the severity of a propane supply shortage justify a declaration? Today that answer is not clear.

The recommendation is to start by defining the conditions and associated metrics that would justify an emergency declaration. The metrics should be developed cooperatively with industry participants to ensure both an understanding of the trigger events, as well as alignment to the practical realities that transport companies face day-to-day during a shortage. This dialogue and education should also include education on best practices to avoid the situation and shorten the duration of an emergency declaration, if needed. At the table should be more than transport companies. It should include pipeline operators, marketers, wholesalers, etc. as each party has a role in mitigating the crisis.

With an understanding of metrics defined and best practices communicated, there needs to also be transparency into the process in practice. What significant actions have the transport companies and other industry participants undertaken to proactively decrease the likelihood of a shortage? Each industry participant has reciprocal responsibilities in attempting to avoid a crisis.

A dialogue on industry progress should be part of a regular communication process with industry, including market center (Conway, Mt. Belvieu) and pipeline operators, wholesalers, marketers, as well as transport companies. Most preventative measures require time for implementation (e.g., adding storage, changing sourcing practices). The communication should be an integrated part of an industry working group (see Section 7.1.6).

7.4.5 Reporting and monitoring should integrate with triggers for hours of service reviews

Tracking industry progress against reducing and/or avoiding emergencies needs to occur over time. During an emergency is not the time to begin data collection. With defined metrics for hours of service reviews, data sources need to be identified and monitoring developed to provide greater visibility into current conditions, while contributing to a more objective decision-making process.

Driven by the agreed-to metrics, monitoring could take a variety of forms to assess the transportation network's capacity to handle a demand surge, such as:

- Tracking terminal activity via facility cameras for 24-hour cycle(s) during peak periods.
- Monitoring of average wait time at terminals, during daytime and at night.
- Tracking the number of truckloads of propane lifted per day at terminal(s).

Data collection methods need to be defined and implemented in conjunction with industry stakeholders. To be effective, the tracking mechanisms should provide information about the current situation without being overly cumbersome or adding great complexity to the current processes. In addition, existing resources should be leveraged, like terminal cameras, where feasible. If necessary, legislative requirements around a short list of key metrics may be considered to drive adoption and compliance.

Efforts should be integrated with the broader monitoring objectives across the supply chain. Triggers for State officials to take action should be integrated with reporting mechanisms as part of an ongoing data and monitoring strategy. Other reporting metrics, such as forecasted demand versus risk thresholds (see Section 7.1), regional inventory levels (see Section 5) and transportation network outages (see Section 7.3), may be leading indicators and triggers for hours of service reviews. Proactive tracking of relevant metrics, as opposed to a reactive response to an industry call, will be more effective and objective in managing through a shortage.

8 Implementing Change

The next phase of the effort will shift to **operational execution**, working collaboratively with industry and end users to refine the recommendations and implement a detailed execution plan.

This objective approach provides a reusable framework for the State of Iowa to continually assess supply chain risks and prioritize optimization strategies that will have the highest impact to propane end users and industry participants, while supporting continued economic growth and development.

8.1 Industry Working Group

Establishment of an Iowa propane industry working group is one of the first steps in executing against the optimization strategy, in order to:

- Drive communication between stakeholders;
- Refine recommendations based on subject matter input; and
- Implement the prioritized solutions.

Dialogue between state agency representatives and industry participants, including marketers, wholesalers, pipeline operators, transport companies and the Iowa Propane Gas Association, as well as key end user entities, is important to share learning, industry updates and changes.

In addition, it is essential to better understand the impact of these supply chain recommendations on the different stakeholder groups. These groups should be brought together at the start of the execution phase to discuss and prioritize the recommendations. Additional qualitative factors are an essential component to supplement the quantitative analytics, as well as understand the impact, implementation considerations and timing for execution. Once prioritized, ongoing working sessions will be established to collaborate and define the game plan for execution against high priority tasks.

For example, defining clear metrics for when an emergency declaration will be issued (see Section 7.4.4) is expected to be reviewed early in the process. This recommendation has an impact across all stakeholder groups and should be addressed prior to demand ramp up in the fall. However, jointly establishing the criteria between state agencies and the industry working group members will be critical to the success of the effort. Without a common understanding of the criteria and impact, the metrics will fail to be objective. Collaborating on their development will help ensure that the metrics are relevant and understood, as well as lay the foundation for evaluating the situation during the next demand surge.

The overall focus is on working cooperatively with industry stakeholders and being responsive to avoid an emergency or mitigate its impact.

8.2 Data Strategy

The foundation of the optimization strategy and its recommendations is data. By objectively analyzing demand, capacity and constraints, the State of Iowa is able to assess corresponding supply chain risks. To determine the effect of changes in the supply chain on an ongoing basis requires an accompanying data strategy, in order to:

- Collect data and capture metrics;
- Analyze the information; and
- Provide proactive feedback that triggers action.

Systemic monitoring and communication of core metrics will enable early warning systems, as changes in the marketplace increase the risk of not meeting end user demand for propane. As investments are made or infrastructure assets are redeployed, it will facilitate analysis of its impact. And as ongoing efforts are made by industry participants to mitigate these risks, reporting can help track progress against recommendations and evaluate their effectiveness. It also enables the communication of risks and best practices to drive further optimization across the industry.

What data is tracked, how it is tracked and how it will be used will be part of the prioritization effort, concentrating on the reporting that will deliver the most value.

8.3 Market Developments and Ongoing Efforts in 2015

Since the shortage of 2013-2014, there has been a tremendous amount of focus on the propane situation in Iowa and across the Midwest. The lack of available supply to heat residential homes and support the agriculture community was at the forefront after the price spike at Conway in January of 2014. Risks associated with the loss of core infrastructure, like the Cochin pipeline, were highlighted, directing attention to the potential impact of its reversal.

In response, there was a concerted effort by many groups and individuals across the industry to implement courses of action, including some of the best practices identified in this study, to attempt to avoid the same situation from reoccurring in the future.

In contrast, the winter of 2014-2015 was a much different situation for the propane industry in Iowa. There was less stress on the supply chain with more **moderate demand** (see Figure 64) due to a mild winter. Continued emphasis on early tank fills, with the prior year being on the mind of key stakeholders, also helped to level demand and increase end user inventories within Iowa.

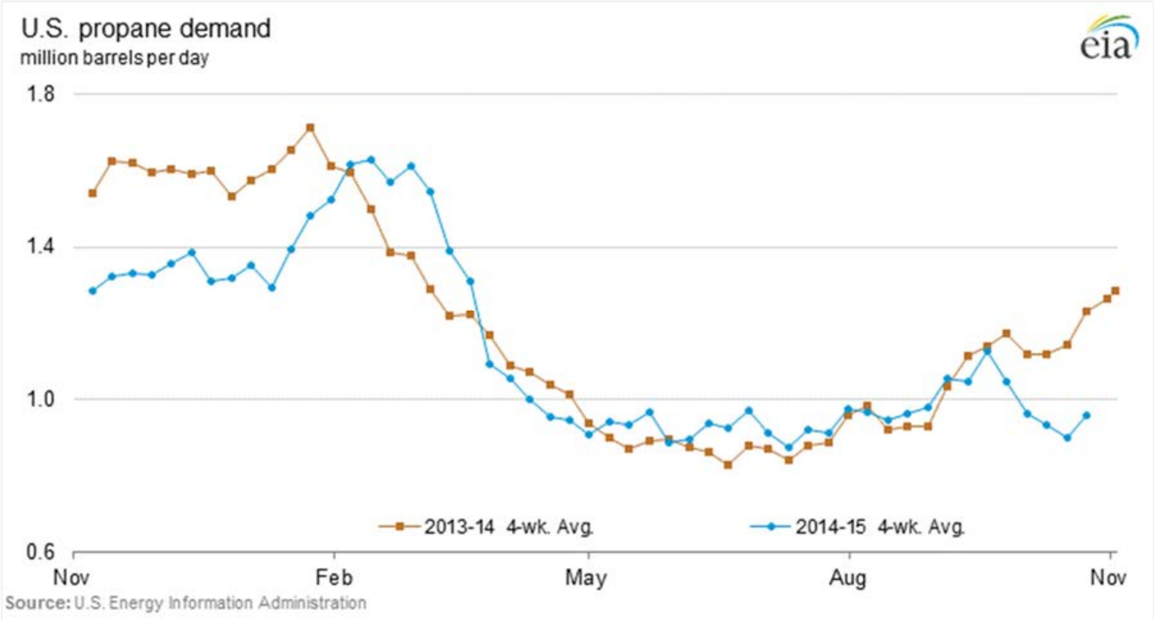

Figure 64 - U.S. Propane Demand 2013-2015 (U.S. Energy Information Administration)

Inventory levels at Conway and the other hubs started to rebuild and rise above historic averages (see Figure 65), with an increased focus on primary storage and the risks associated with rising exports and PDH demand.

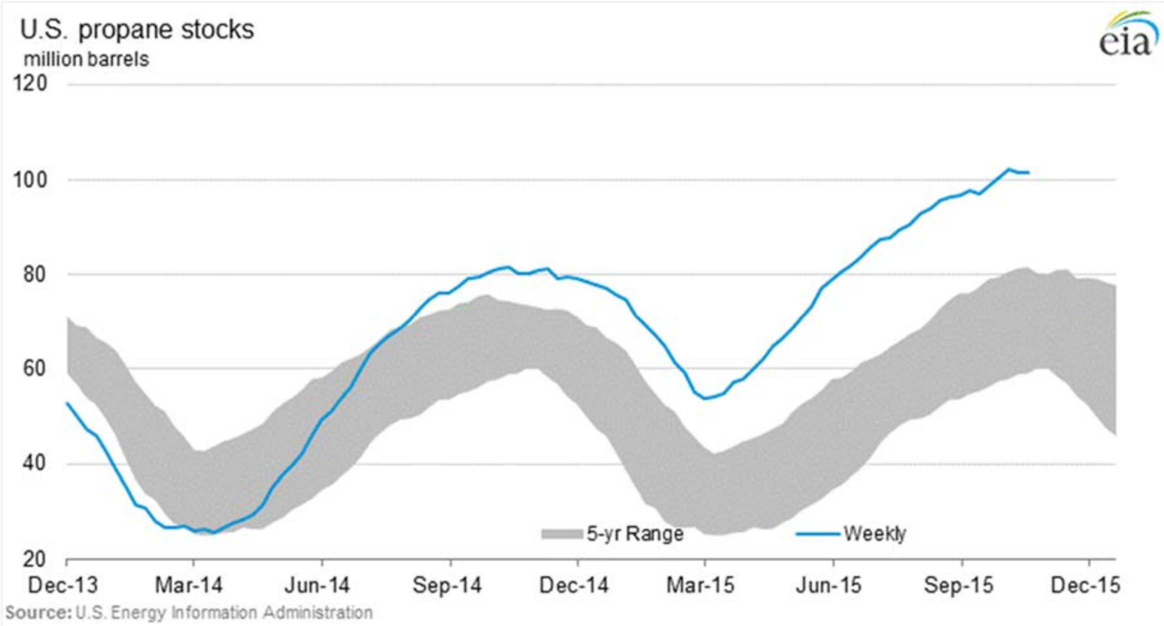

Figure 65 - U.S. Propane Stocks 2013-2015 (U.S. Energy Information Administration)

Based on developments in the oil and natural gas markets[110], there was a **dramatic fall in propane prices**, reaching 13-year lows. The focus has shifted from mitigating the risk of rising propane prices, through sourcing and risk management practices, to timing inventory purchases to take advantage of the low prices.

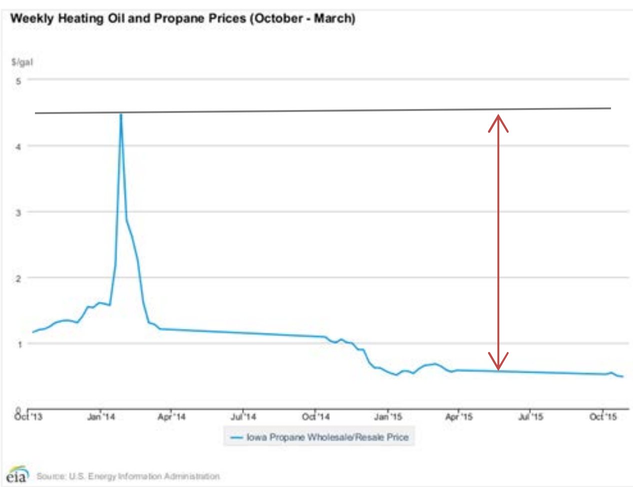

Figure 66 - Weekly Iowa Propane Wholesale/Resale Price (U.S. Energy Information Administration)

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110 "Propane is produced from both natural gas and crude oil—in 2013, about 60% of propane was from natural gas processing, while 40% was from refinery crude oil processing. Because of this split, the price of propane is related to the prices of both commodities. Since 2012, propane prices have tracked between crude oil and natural gas prices on an energy-equivalent basis. Recent falling crude oil prices have narrowed the spread between crude oil and natural gas, and, combined with inventory builds in the Midwest and Gulf Coast, led to decreases in propane spot prices at both the Conway and Mont Belvieu price hubs." (U.S. Energy Information Administration, 2015)

The market situation was in sharp contrast to the shortage of the prior year. However, even though issues of the same magnitude did not emerge in 2014-2015, the **supply chain risks still persist**. The natural tendency may be to reduce diligence and put less emphasis on best practices that build supply chain capacity.

But the reality is that **demand is volatile**. Demand levels fluctuate up and down, year-over-year, based on the factors discussed in Section 3. Demand levels in 2014-2015 did not stress the capacity of the network. But the demand situation in 2015-2016 may be very different. Industry participants need to have contingency strategies to deal with future demand extremes.

Investments are being made by wholesalers to **add rail terminals**[111] within Midwest states affected by the Cochin reversal, in order to compensate for the pipeline's loss and bring additional contingency supply into the Midwest. However, with lower demand levels, the adequacy of these investments to provide additional contingency capacity has not been tested.

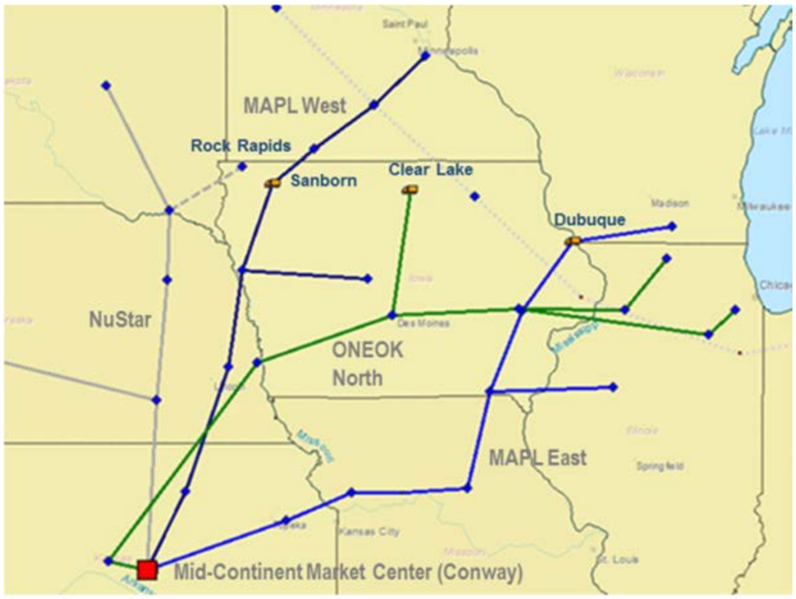

Figure 67 - Current State of Iowa Regional Pipelines

NuStar also recently announced the **expansion of its pipeline network** to include propane service at its Rock Rapids, Iowa terminal. This investment will increase pipeline capacity for propane flowing into Iowa. It will help reduce the dependency on more expensive contingency supply sources/alternate modes. And it will likely relieve some of the pressure from out of state marketers filling at other Northern Iowa terminals, including Sanborn, Clear Lake and Dubuque.

The development also brings a fourth pipeline directly into Iowa, which helps to reduce the impact of an outage in the Iowa pipeline terminal network. However, it still sources from Conway, so it doesn't mitigate the risk of a disruption at the market hub itself. It also does not take advantage of rising propane inventory levels in Western Canada.

The actions taken to avoid repeating the experience of 2013-2014 helps in many ways, but also **puts stress on different parts of the supply chain**. Building inventory to meet demand levels has increased the reserves of propane. However, it also has reduced the available inventory capacity.

With inventory levels up at Conway and in the region, there is less need in the Midwest for contingency supply from Western Canada. And without the Cochin pipeline to transport propane to the U.S. cost effectively, the **propane inventories in Edmonton are increasing significantly**, where the capacity constraint on primary storage in the region has become an issue (see Figure 68).

[111] CHS, a propane wholesaler and large farmer-owned cooperative, added propane rail service and/or expanded service at propane rail terminals in Hannaford, ND, Fairmont, ND, Glenwood, MN and Rockville, MN (Pates, 2014), as well as Hixton, WI, connected to CPRS, BNSF and CN rail lines. Another energy company added propane rail service at the Iowa Northern Railway terminal in Manly, IA, connected to the UP line.

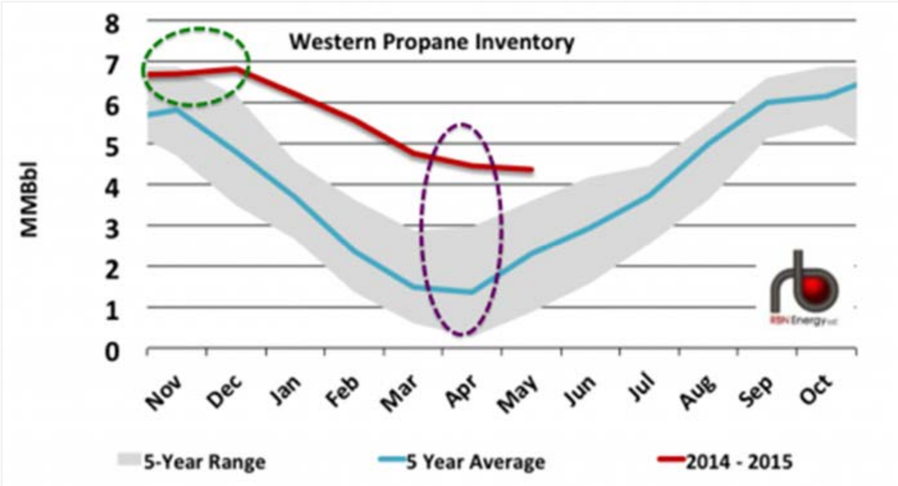

Figure 68 - Propane Inventory Levels in Western Canada (National Energy Board)

With the ongoing growth in natural gas production in Western Canada, propane output is at record levels as a result, without a readily available export market to absorb the supply. With constrained primary storage capacity, the issue has risen to such a level that the price of propane in Edmonton is now negative (see Figure 69). Since propane is a by-product, there is no control over production levels. Producers are in the position where they must pay others to take the inventory, until investments can be made to increase underground storage capacity in Edmonton.

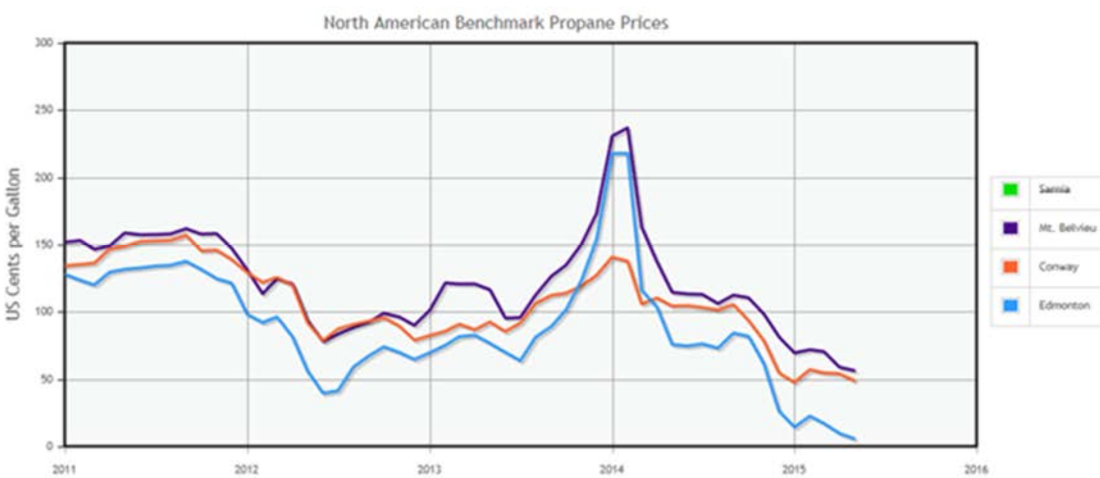

Figure 69 - Propane Price Trends in Edmonton Market Hub (National Energy Board)

These events reinforce both the volatility of the market and the interrelationships between supply chain participants. There is no one-time fix that will eliminate the risk of a shortage. And the constantly changing nature of the supply chain increases or decreases the risks, as well as determines what constraints drive current market challenges. Thus, a continued emphasis and ongoing momentum is required to re-evaluate the current situation and implement actions to optimize the supply chain and mitigate its risks.

Ultimately, it is a long-term effort for Iowa to be able to objectively analyze potential supply chain risks and opportunities, to be better informed when demand for propane reaches critical levels and Iowa faces potential shortages, as well as to better manage extreme fluctuations and disruptions in propane supply and the corresponding economic consequences in the future.

9 Bibliography

Abendroth, R. E. (2010, September 28). *In-Field Drydown Rates and Harvest*. Retrieved from Iowa State University, Extension and Outreach, Department of Agronomy: http://www.extension.iastate.edu

Ceresana. (2014). *Market Study, Polypropylene.*

Ceresana. (2014). *Market Study: Propylene.*

Energy and Environmental Analysis, Inc. (2005, June). *Good Practices for the Care and Custody of Propane in the Supply Chain*. Retrieved from Propane Education & Research Council: http://www.propanecouncil.org

Fattouh, B. (2014, July). *The US Shale Revolution and the changes in LPG Trading Dynamics: A Threat to the GCC?* Retrieved from The Oxford Institute for Energy Studies: http://www.oxfordenergy.org/wpcms/wp-content/uploads/2014/07/The-US-Shale-Revolution-and-the-changes-in-LPG-Trading-Dynamics-A-Threat-to-the-GCC.pdf

Federal Energy Regulatory Commission. (2012, October 22). *Docket No. OR12-22-000, Order on Petition for Declaratory Order, Kinder Morgan Cochin LLC*. Retrieved from FERC: www.ferc.gov

Federal Energy Regulatory Commission. (n.d.). *eTariff Viewer*. Retrieved September 2014, from Federal Energy Regulatory Commission: http://etariff.ferc.gov

Federal Motor Carrier Safety Administration. (n.d.). *Regulations*. Retrieved June 2015, from FMCSA: http://www.fmcsa.dot.gov/regulations

Ford, G. (2013, November 11). *Propane Shortage in Iowa Weighs on Remaining Corn Harvest.* Retrieved from The Gazette: http://thegazette.com

GasTec. (2014, March). *GasTec Propane Tank Chart*. Retrieved from Slide Share: http://www.slideshare.net

Hall, K. G. (2014, July 13). *US considers a strategic propane reserve.* Retrieved from Duluth News Tribune: http://www.duluthnewstribune.com

Hamilton, T. M. (2014, October 8). *Winter 2014-15: Propane Supply & Infrastructure*. Retrieved from U.S. Energy Information Administration: http://www.eia.gov

ICF International. (2013, April). *Propane Supply Sources and Trends 2013.* Retrieved from National Propane Gas Association: http://www.npga.org

ICF International. (2014, June). *Impact of Cochin Pipeline Reversal on Propane Markets and Marketers in the Midwest*. Retrieved from Midwest Governors Association: http://www.midwesterngovernors.org

Iowa Department of Human Rights. (n.d.). *Bureau of Energy Assistance.* Retrieved from Iowa Department of Human Rights: http://www.dcaa.iowa.gov

Iowa Department of Public Safety, State Fire Marshal Division. (2009-2014). LP Plan Reviews.

Iowa Department of Public Safety, State Fire Marshal Division. (n.d.). *Flammable & Combustible Liquids Section*. Retrieved June 2014, from Iowa Department of Public Safety: http://www.dps.state.ia.us

Iowa Department of Public Safety, State Fire Marshal Division. (n.d.). *Liquid Propane Informational guide to submitting plans*. Retrieved June 2014, from Iowa Department of Public Safety: http://www.dps.state.ia.us

Iowa Department of Transportation. (n.d.). *Freight Advisory Council*. Retrieved June 2015, from Iowa DOT: http://www.iowadot.gov/systems_planning/freight/advisory_council.html

Iowa Economic Development Authority. (2015, May). Iowa Energy Data Profile.

Iowa Legislature. (n.d.). *661 Iowa Administrative Code, Chapter 226, Liquefied Petroleum Gas*. Retrieved June 2015, from Iowa Legislature: https://www.legis.iowa.gov/

Iowa Legislature. (n.d.). *Iowa Code 321.449 Motor Carrier Safety Rules*. Retrieved from Iowa Legislature: https://www.legis.iowa.gov/

Iowa Pipeline Association. (n.d.). *Operator Profiles*. Retrieved June 2014, from Iowa Pipeline Association: http://www.iowapipelinesafety.com

Iowa Propane Gas Association. (n.d.). Retrieved from Iowa Propane Gas Association: http://www.iapropane.org/

Kinder Morgan Energy Partners, L.P. (2013, May). *Cochin Reversal Project Fact Sheet.* Retrieved from Kinder Morgan: http://www.kindermorgan.com

Mark Hanna, S. S. (2014, October). *Energy consumption during grain drying*. Retrieved from Iowa State University Extension and Outreach: http://www.extension.iastate.edu

Mid-Continent Fractionation and Storage, LLC. (2012). *Underground LPG Storage Guide, Public Awarenss Safety Information.* Retrieved from The Williams Companies: http://co.williams.com/

Minnesota Department of Agriculture. (2011, April 1). *Minnesota's Supply and Demand for Propane and Anhydrous Ammonia*. Retrieved from Minnesota State Legislature: http://www.leg.state.mn.us

National Association of State Energy Officials. (2012, October). *Guidance for States on Relief from Federal Motor Carrier Safety Regulations in an Energy Emergency*. Retrieved from National Association of State Energy Officials: https://www.naseo.org

National Energy Board and Competition Bureau. (2014, April). *Propane Market Review*. Retrieved from Government of Canada National Energy Board: http://www.neb-one.gc.ca

National Energy Board. (n.d.). *Statistics and Analysis*. Retrieved 2015, from Government of Canada, National Energy Board: http://www.neb-one.gc.ca

National Oceanic and Atmospheric Administration. (n.d.). *Climate Prediction Center*. Retrieved 2015, from National Weather Service: http://www.cpc.ncep.noaa.gov/

National Propane Gas Association. (2014, May 28). *Issue Brief: Congress Should Adopt Policies That Enhance Transparency and Resilience of the Propane Supply and Distribution System*. Retrieved from National Propane Gas Association: https://www.npga.org

National Propane Gas Association. (2014, May). *Recommendations from the Industry/Marketer Education Working Group of the NPGA Supply and Infrastructure Task Force*. Retrieved from Midwest Governors Assocation: http://www.midwesterngovernors.org

National Propane Gas Association. (2014, January 22). *Statement on Propane Supply, Demand, and Distribution.* Retrieved from National Propane Gas Association: http://www.npga.org

National Propane Gas Association. (n.d.). *Facts About Propane*. Retrieved June 2014, from National Propane Gas Association: http://www.npga.org

National Propane Gas Association. (n.d.). *State Governmental Affairs: Why Propane Should Not Be Regulated as a Utility?* Retrieved June 2015, from National Propane Gas Association: http://www.npga.org

National Weather Service. (n.d.). Retrieved June 2015, from National Oceanic and Atmospheric Administration: http://www.weather.gov

Nielsen, R. (. (2013, September). *Field Drydown of Mature Corn Grain*. Retrieved from Purdue University, Department of Agronomy: https://www.agry.purdue.edu

Office of the Governor, Wisconsin. (2014, June 18). *Press Releases*. Retrieved from Office of the Governor Scott Walker: http://www.wisgov.state.wi.us

Oil and Energy Online. (2014, October 9). *How Salt Cavern Storage Works*. Retrieved from Oil and Energy Online: http://oilandenergyonline.com/how-salt-cavern-storage-works/

Oil Price Information Service (OPIS). (n.d.). Retrieved 2014, from Oil Price Information Service: http://www.opisnet.com

Pates, M. (2014, April 14). *CHS builds rail terminal to help compensate for Cochin Pipeline loss*. Retrieved from AgWeek: http://www.agweek.com

Pipeline and Hazardous Materials Safety Administration, U.S. Department of Transportation. (n.d.). Retrieved from National Pipeline Mapping System: https://www.npms.phmsa.dot.gov/

Propane Education & Research Council. (2007). *Bobtail Equipment and Systems.* Retrieved from Propane Education & Research Council: http://www.propanecouncil.org

Propane Education & Research Council. (2014, January 22). *Statement on Propane Transportation Issues.* Retrieved from Propane Education & Research Council: http://www.propanecouncil.org

Propane Education and Research Council. (n.d.). *Propane Emergency Training Scenarios*. Retrieved June 2015, from Propane Education and Research Council: http://www.propanecouncil.org

(2014, August). *Propane Supply Chain Survey of Iowa Marketers.* Quetica, LLC.

Reuters. (2014, June 6). *Canada's surprise light oil boom delights oil sands producers seeking diluent*. Retrieved from Reuters: http://www.reuters.com

S.C. Whitley, R. G. (2011). *U.S. Propane Industry Infrastructure and Deliverability Study.* Purvin & Gertz, Inc.

Shawn Shouse, M. H. (2012, May). *Energy considerations for low-temperature grain drying*. Retrieved from Iowa State University Extension and Outreach: http://www.extension.iastate.edu

Sloan, M. (2014, Feburary 3). *Reviewing the 2013 - 2014 Propane Markets: A Look at the Numbers – and a Look at the Future*. Retrieved from Slide Share: http://www.slideshare.net

State of Texas, O. o. (2014, January 23). Retrieved from Office of the Governor of Iowa: https://governor.iowa.gov/

U.S. Census Bureau. (2012). *American Community Survey*. Retrieved from U.S. Census Bureau: http://www.census.gov/

U.S. Department of Agriculture. (2014). *2014 Annual Statistical Bulletin, Statistics by State, Iowa*. Retrieved from USDA National Agricultural Statistics Service: http://www.nass.usda.gov

U.S. Energy Information Administration. (2011, July 8). *Review of Emerging Resources: U.S. Shale Gas and Shale Oil Plays*. Retrieved from U.S. Energy Information Administration: http://www.eia.gov

U.S. Energy Information Administration. (2012, February 7). *PADD regions enable regional analysis of petroleum product supply and movements*. Retrieved from U.S. Energy Information Administration: http://www.eia.gov

U.S. Energy Information Administration. (2014, November 13). *Rail shipments of oil and petroleum products through October up 13% over year-ago period*. Retrieved from EIA: http://www.eia.gov

U.S. Energy Information Administration. (2015, April). *Annual Energy Outlook 2015*. Retrieved from U.S. Energy Information Administration: http://www.eia.gov

U.S. Energy Information Administration. (2015, February 6). *Midwest propane market more balanced than a year ago*. Retrieved from EIA: http://www.eia.gov

U.S. Energy Information Administration. (2015, April 17). *New maps highlight geologic characteristics of U.S. tight oil, shale plays*. Retrieved from U.S. Energy Information Administration: http://www.eia.gov

U.S. Energy Information Administration. (n.d.). *Heating Oil and Propane Update*. Retrieved from U.S. Energy Information Administration: http://www.eia.gov

U.S. Energy Information Administration. (n.d.). *Petroleum & Other Liquids Data*. Retrieved from U.S. Energy Information Administration: http://www.eia.gov

U.S. Energy Information Administration. (n.d.). *Propane Explained*. Retrieved June 2015, from U.S. Energy Information Administration: http://www.eia.gov

U.S. Energy Information Administration. (n.d.). *State Profile and Energy Estimates: Iowa*. Retrieved from U.S. Energy Information Administration: http://www.eia.gov

U.S. Energy Information Administration. (n.d.). *This Week in Petroleum: Propane*. Retrieved from U.S. Energy Information Administration: http://www.eia.gov

United States Department of Agriculture. (2012). *Census of Agriculture*. Retrieved from United States Department of Agriculture: http://www.agcensus.usda.gov

United States Department of Agriculture. (2014). *National Agricultural Statistics Service (NASS)*. Retrieved from United States Department of Agriculture: http://www.nass.usda.gov/

Warren Wilczewski, M. S. (2014, November). *Odorized Propane Impact on Iowa Economy*. Retrieved from National Propane Gas Association: https://www.npga.org/

Wilczewski, W. (2012, November). *Introduction to the Propane Database and Forecasting Model*. Retrieved from Propane Marketer Research Catalog: http://www.propanemarc.com

Yanik, K. (2013, October). *Cochin reversal project creates pipeline pressures*. Retrieved from LP Gas Magazine: http://www.lpgasmagazine.com

Yanik, K. (2015, May 20). *NuStar, CHS to bring more propane to Upper Midwest.* Retrieved from LP Gas Magazine: http://www.lpgasmagazine.com