THE NATURAL GAS REVOLUTION

America has a strategic advantage in the Natural Gas Revolution and stands to benefit from the forecasted increase in demand. But first, policy and transportation infrastructure must adapt to keep pace with the new demand. This white paper explores the Natural Gas Revolution, its benefits, and how the forecasted increase in demand affects the pipeline infrastructure.

September 2012

Snelson Companies, Inc.

U.S. Natural Gas Revolution
Getting the Infrastructure Ready

Domestic supply of natural gas is at an all-time high; prices are the lowest they've been in decades. Big oil players have heavily invested in natural gas hedging their bets on a long-term win when demand and infrastructure meet.

This white paper provides a background on the Natural Gas Revolution, why it is good for the consumer and the economy, and how it affects growth in infrastructure.

Executive Summary

The Natural Gas Revolution has begun and the global race to be first in the market and ready with supply is underway. America has the strategic advantage given it's shale resources, production capabilities, and current storage levels.

The Revolution will benefit those players who have properly invested in it. With an overabundance in liquid natural gas, forward thinkers such as T. Boone Pickens and corporations such as Shell are vying for position with early investments.

Natural gas, as a transportation fuel, is 50 percent cheaper than diesel. As heavy duty trucks begin to switch to natural gas, more supply stations will be needed, and transportation infrastructure will expand. A boom in the industry will lead to a boom for the suppliers in the market but the benefits won't stop there. Consumers will enjoy lower unemployment rates thanks to the jobs created, and lower cost of goods, thanks to reduced transportation costs.

Some have called the U.S. the Saudi Arabia of natural gas due to the relatively recent discovery of shale resources which increase domestic resources dramatically. This shift will change the way we use energy and reduce our dependency on foreign oil sources, also reducing imports, and keeping manufacturing facilities and jobs domestic.

In the coming years, the U.S. Government will handle critical decisions in the domestic energy policy as they work to set regulations, or not, in natural gas exports. Exporting our supply will aid international allies such as Japan, but it would increase prices domestically for consumers.

To meet the growing demand, infrastructure for transportation of the gas needs to be expanded, updated and maintained. Pipeline that was originally installed in rural areas is now located under residential areas as urban centers have continued to grow.

This paper will begin with a brief history on natural gas and the current state of the revolution. It will describe the benefits for the consumer, environment, and the economy; and then explore changes that need to take place in infractructure in order for the U.S. to come out as beneficiaries in the Natural Gas Revolution.

The Natural Gas Revolution

Origins of natural gas development

Commercial use of natural gas is traced back as (relatively) recently as 1000 B.C. in Greece where it seeped from the ground and produced a flame. At first, this was a great mystery and the Greeks believed it to be of divine origin. They built a temple and a priestess gave out prophecies inspired by the flame. Over time, more of these flames were discovered but no one was able to explain why.

It was in 500 B.C. that the Chinese began to make use of this flame. They built crude pipelines of bamboo to transport the gas and use it for heating and cooking.

In 1785, Britain began using natural gas to light homes and streets. In the U.S., Baltimore became the first city to light it's streets using natural gas and Philadelphia was the first to create a municipal natural gas distribution company.

In the 19th century, natural gas was used mostly for lighting. Commercial and other uses were limited because pipeline infrastructure did not yet exist. Also, Robert Bunsen had not yet invented the Bunsen burner opening the window to the opportunties natural gas can provide.

Pipeline construction began in the 20th century to transport natural gas nationwide and provide home heating and cooling, run appliances such as water heaters and oven ranges, supply manufacturing and processing facilities, and create boilers to generate electricity.

Recent History

According to the BP Statistical Review of World Energy, global gas demand increased 600 percent from 1965 to 2010.

Between 1990 and 2010, a major shift towards gas became evident with coal consumption declining nearly 50 percent from 460 million tons of oil equivalent (Mtoe) equivalent to 260 Mtoe.

In that timeframe, natural gas consumption increased from 290 to 430 Mtoe.

This shift in energy usage is credited to a couple of things:
- Abundant and cheap gas in the North Seas; and
- Increased awareness of environmentalism in the 1980s and the fact that coal and oil are not sustainable sources of energy.

Price volatility became an issue within that timeframe due to these factors and there were two notable price spikes: One in 2000-2001 and another in 2002-2003.

Not only had demand increased from a general standpoint but:
- Severe weather put pressure on the power grid for heating and cooling; and
- The California electrical grid was over capacity, which put pressure on natural gas to fill the gap.

When supply can't meet demand, the price spikes and demand destruction starts to occur.

By the mid 2000s, prices had increased from $2 per million British thermal units (MMBtu) in the 90s to $3 per MMBtu. To moderate the price, drilling began and gas production began to rise. Simultaneously, demand fell off because of industries and businesses failing, relocating, or switching fuel sources due to lack of supply and/or price.

Mild weather kicked back in and prices in 2003 fell back closer to the $2 per MMBtu range. Storage was renewed.

Storage levels then reached an all-time high in 2002-2003, but that winter saw the largest inventory drawdown ever recorded: 2530 Bcf during the winter. In April 2003, natural gas was in short supply and the price spiked yet again.

The Current Situation

Today, natural gas is a critical source of energy for the United States and the world, because it is a cleaner and extremely abundant fuel source. America's supply translates to a significantly reduced dependency on foreign oil and OPEC.

- Natural gas supplies more than "one-half of the energy consumed by residential and commercial customers, and about 41 percent of the energy used by U.S. Industry."

- There are more than 900 U.S. public gas systems in the country, with Philadelphia Gas Works being the largest and longest operating.

- The life span of existing resources has been increased from 70 years to 300 years thanks to the shale gas revolution and techniques for extraction, hydraulic fracturing, and horizontal drilling.

Demand has not yet reached anticipated levels and prices are at an all-time low. But the major players in the oil industry are showing signs they know it will happen.

With natural gas prices at an all-time low and oil prices on the rise, major corporations are strategically positioning themselves to take advantage of the Natural Gas Revolution.

Shell, for example, at the writing of this paper, was seeking a location for it's plant near the Marcellus Shale in West Virginia, Pennsylvania, and Ohio and all three states are vying for their attention. What Shell is most interested in is the by-product of natural gas production - ethane, an important ingredient in plastics production which can be extracted from the natural gas liquids - thereby killing two birds with one stone and off-setting the (current) low commodity price of natural gas.

Exxon is another major player investing heavily in the Natural Gas Revolution. In December 2009, they placed a big bet on the future of natural gas when they acquired XTO Energy, Inc. Investors showed their displeasure and concern that Exxon overpaid. Their stock price plummeted accordingly. The price of natural gas fell further, but Exxon stands by it's decision waiting for the long-term payoff.

Both corporations are hedging their bets as stock increased only slightly since then, at about 17 percent, and higher oil prices have helped absorb that investment.

In late 2011, the U.S. Energy Department reduced it's estimates of the amount of gas in the Marcellus Shale formation by 66 percent. This, in turn led the price of natural gas to increase due to a reduced supply.

How Price is Affected

Price volatility is affected by a number of factors.

- **Weather**: Severe weather has price implications on natural gas. Winter consumption can be up to double that of summer consumption. An even colder winter can dramatically increase that demand causing prices to increase accordingly. Hot summers put pressue on air-conditioning and electricity, increasing demand for gas-fired elecricity and having the same price effect.
- **Drought**: Most of the Western U.S. and Canada rely heavily on hydroelectric generation. Drought years result in reduction of capacity and put pressure on natural gas-fired generating facilities to make up for the deficit, affecting the natural gas price upwards.
- **Low snowpack:** High winter snowpacks create a reserve of water for the hydroelectrcity system. Low snow packs create a similar effect as drought.

- **Climate change** is expected to slowly reduce snowpack over the long-term putting further strain on the hydroelectricity system and thereby more pressure on natural gas to fill the gap.
- **Storage**: Gas storage levels fluctuate depending on season and consumption. Drawing down on storage helps to moderate the cost and also reduces interruptions to the consumer. Buyers and sellers watch the storage levels closely keeping an eye on the rate at which it is added to or drawn down. Abnormal changes will affect the price accordingly.
- **Oil prices**: Most industries and utilities have the ability to switch fuel sources. Higher oil prices cause a shift to natural gas which, in turn, increases that cost. In the 2000s, fuel switching has been reduced because of stringent air quality regulations.

The Future

The United States is well-positioned to benefit significantly when the demand inevitably increases because of the abundant supply. Thanks to the low cost and economic efficiencies in relation to alternative fuel sources, industrial demand is forecasted to increase and overtake coal by 2025.

Simmons & Co. Reports that supply continues to exceed demand by 1.2 billion cubic feet per day (bcfd) thanks, in large part, to over-capitalization of organizations and increased efficiency in drilling. This will result in full storage and will slow down production in order to balance the market. The growth in demand, forecasted at 1.7 bcfd is driven by industrial, not consumer demand.

Given the current state, prices are at a level that make it uneconomic to drill except on the Marcellus Shale. Production companies will cut back and by 2013, the market will begin to balance with a correction in price.

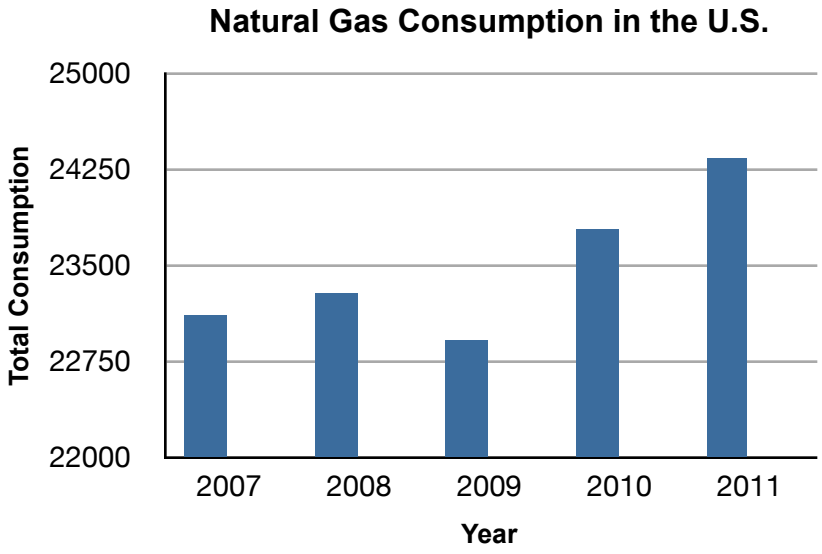
This turn of events paves the way for industries who use natural gas, such as fertilizer manufacturers who suffered 10 to 15 years ago during the period of demand destruction. It has ramifications for liquid natural gas stations and transportation vehicles who see significant opportunity to meet new demands.

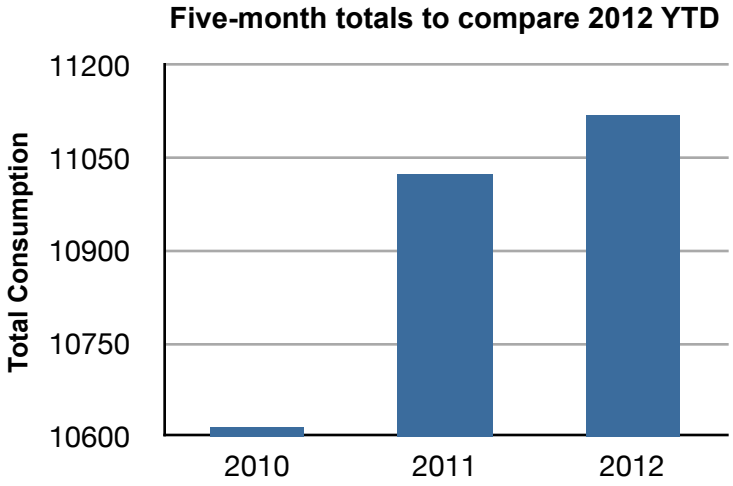
The economic benefits will be discussed in more detail in the Economic Effects (on pages 8-9) section of this paper.

In addition to domestic demand, the country and the U.S. Administration will need to come to terms with how much will be kept domestically, and how much will be exported to markets such as Europe, China, and Japan.

China’s demand for natural gas and other cheap energy sources will continue to increase. Japan imports 98 percent of it’s energy supply, and Europe, finding itself far behind in terms of capacity to transport natural gas, is grappling with fixing cross-border shipping and market rules to ready itself to take advantage of the low-cost, abundant energy source.

The following tables show the growth in natural gas consumption in the U.S. between 2007 and 2012.





The next two sections will discuss the economic benefits of the Natural Gas Revolution to the consumer, the environment, and the national economy.

The Economic Effects of the Natural Gas Revolution

How the Natural Gas Revolution Benefits Consumer and Industry

Economy
Greater natural gas production, transportation, and consumption will lead the country's economic recovery because it will help to keep manufacturing domestic, create more jobs, and reduce fuel costs which will, in turn, reduce cost of goods.

Environment
According to The U.S. Energy Information Administration, natural gas burns 50 percent cleaner than coal and about 30 percent cleaner than oil. Its lower carbon content and fewer impurities mean it produces less sulfur dioxide, a primary contributor to acid rain. It is already used widely for personal and industrial consumption.

As the world refines and improves the technology for wind and solar energy, many organizations such as Greenpeace and experts such as T. Boone Pickens see natural gas as an ideal transition fuel. There is enough supply now to displace coal plants and meet aggressive energy goals set in international energy agreements.

Consumers
- Cooking: Chefs prefer it because they are able to better control the heat levels than with electric. As well, it keeps pots and equipment cleaner.
- Heating and lighting: Natural gas is cleaner because of the levels of hydrogen (the higher the hydrogen content, the cleaner the fuel), and is less expensive.

Industry
- Natural gas is used to produce cosmetics, medicine, light bulbs, home flooring, batteries, and more.
- Other products that rely on natural gas in their manufacturing process include sunscreen, sunglasses, and bathing suits.
- It is critical to growing food by heating dairy and poultry farms; and hot houses.
- It can fuel transportation vehicles.

Job creation
The natural gas industry supports nearly three million jobs and adds about $385 billion to the national economy**.**

In Texas and Pennsylvania, for example, more than 200,000 jobs were created in the last year as a result of the Natural Gas Revolution. For Texas, that translated to approximately $13.7 billion in additional economic output in 2008, alone. In Pennsylvania, 62 jobs are created for each well, equalling about $5.46 million in new output.

Jobs associated with this industry pay higher than average salaries. They also contribute to state and local tax revenues. North Dakota now has the lowest unemployment rate in the nation, attributed almost exclusively to oil and gas development.

Changes the way we use energy
Natural gas can reduce our dependency on foreign oil sources and reduce imports. T. Boone Pickens cites its big benefits not as an energy fuel, but as a transportation fuel.

The Pickens Plan calls to shift America's eight million heavy duty trucks from imported diesel, which is $1 per gallon more expensive, to domestic natural gas. Approximately 15 percent of the oil America consumes is used by 18-wheelers transporting goods throughout the U.S. A shift in fuel would reduce reliance on Organization of the Petroleum Exporting Countries (OPEC) by 70 percent, thereby removing support of unstable countries whose decisions and policies do not align with that of the U.S.

This shift has begun to happen and will have positive effects on the entire commerce network as shipping costs to retailers will drop and that reduction in price will be passed on to consumers.

As well, major utilities are switching to power generated by natural gas rather than coal.

Keeps manufacturing domestic.
Growth in availability of natural gas means we can again manufacture fertilizer, chemicals, and pharmaceuticals in the U.S., creating more jobs and exporting more goods.

Manufacturers who rely heavily on energy can now keep their facilities and jobs in the U.S., thanks to more affordable and stable gas prices. This helps to resolve the demand destruction issue we discussed in the *Recent History* section (on page 4), where facilities were either failing or relocating due to lack of availability of affordable fuel sources.

Overall, a boom in the energy sector, coupled with a slow recovery in domestic manufacturing, could raise gross domestic product by two to more than three percent by 2020, according to a recent analysis by Citigroup.

Opportunity for Exports
This year (2012) is a critical year for the future of American domestic energy policy. While domestic production of natural gas is beneficial to the U.S., a dilemma is presented to the Presidential administration. Should we export natural gas to countries where the price is higher and, if so, how much?

Other countries, such as Japan who imports 90 percent of its energy in the form of oil and gas, will be eager to import. Because they are more efficient in what they do, it is noteworthy their consumption has not risen since 1975. China's demand is forecasted to increase and Europe's production is not meeting their demand.

Exporting our supply will aid international allies such as Japan, but it would increase prices domestically for consumers. The dilemma pits the idea of free-trade against protecting the U.S. economy. It's a political hot potato because natural gas producers and the national economy stand to benefit from exports but it will, at the same time, increase prices affecting large energy-dependent manufacturers and shippers.

Democrats, often critical of the oil and gas sector, are wary of getting out in front of an issue that divides even the manufacturers benefitting from low gas prices. Republicans, who favor free trade and support fossil fuel development, are leery of being accused of raising costs for consumers and industry.

The issue currently lies on the docket for a unit of the Energy Department, the Office of Natural Gas Regulatory Activities to resolve.

Regardless of the outcome, the forecasted increase in demands will have major effects on the infrastructure of the natural gas transportation system.

The next section will explore how natural gas is transported and distributed, safety issues it must contend with, and how the infrastructure needs to be modified to meet new market demand.

Infrastructure Growth:
Filling the gap between supply and demand.

To reap the benefits of the opportunities the Natural Gas Revolution offers, transportation networks need to be updated, expanded, and maintained. This section describes how gas is transported to the consumer, how it is distributed, safety considerations in the network, and how the infrastructure needs to be expanded.

Getting the natural gas to the consumer
The U.S. natural gas pipeline network is an integrated transmission and distribution grid that can transport natural gas to and from nearly any location in the lower 48 States.

The natural gas pipeline grid comprises:
- More than 210 natural gas pipeline systems.
- More than 300,000 miles of interstate and intrastate transmission pipelines (see mileage table).
- More than 1,400 compressor stations that maintain pressure on the natural gas pipeline network and assure continuous forward movement of supplies (see map).
- More than 11,000 delivery points, 5,000 receipt points, and 1,400 interconnection points that provide for the transfer of natural gas throughout the United States.
- Twenty-four hubs or market centers that provide additional interconnections (see map).
- Four hundred underground natural gas storage facilities (see map).
- Forty-nine locations where natural gas can be imported and/or exported by way of pipelines (see map).
- Eight LNG (liquefied natural gas) import facilities and 100 LNG peaking facilities (see map).

The Transportation Process

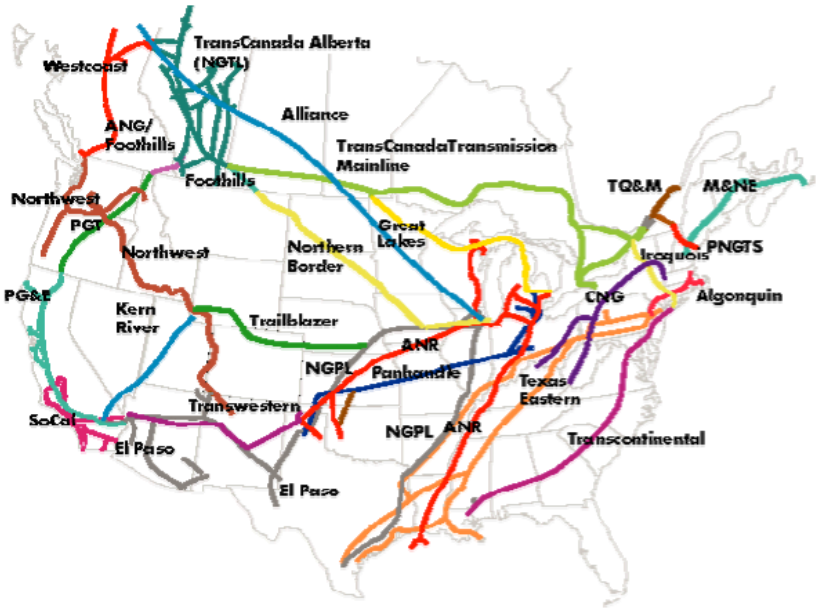


Figure 7.2 Major North American Pipelines
Source: National Energy Board of Canada - website: http://www.neb.gc.ca/energy/images/gasmap_e.gif

Note: Since this map was created the name of PG&E Pipeline has changed to National Energy & Gas Transmission Gas Transmission Northwest (GTN).

Natural gas transportation begins at the drilling site and ends at the consumer or industrial use. In the process, it goes through transfers and processing steps.

A quick glossary of transportation terms:

- **Wet natural gas**: Gas exiting the production field that contains significant amount of hydrocarbon liquids and other impurities.
- **Gathering Lines**: Small-diameter pipelines move natural gas from the well head to the natural gas processing plant or to an interconnection with a larger mainline pipeline.
- **Processing Plant**: Extracts natural gas liquids and impurities from the natural gas stream.
- **Mainline Transmission Systems**: Wide-diameter, long-distance pipelines that transport natural gas from the producing to market areas.
- **Market Hubs/Centers**: Pipelines intersect and flows are transferred.
- **Underground Storage Facilities**: Natural gas is stored in depleted oil and gas reservoirs, aquifers, and salt caverns for future use.

From the well, natural gas goes into a pipeline gathering system where it is directed either to the natural gas processing plant if water and other impurities need to be extracted, or submitted directly to the mainline transmission grid.

At the processing plant, the gas is processed into pipeline-quality natural gas. The gas is then pressurized and moved through transmission lines, sometimes for thousands of miles. Along the route, some is diverted off for consumers, business, and industry.

To transport natural gas globally, the gas is chilled to liquid form and put on one of the four U.S. transport terminals to be shipped overseas. It is then brought back to vapor form and transported through that destination's pipeline network.

Distribution to the Consumer or End User
Local utilities will transport natural gas from distribution points on the transmission pipelines to businesses and households.

The delivery point to the utility is often called the 'city gate,' where the utilities take ownership of the gas and deliver it to the customer's meter. This is done through a network of small diameter pipe. The U.S. Department of Transportation reports there is more than two million miles of distribution piping in the United States.

Gas distribution to the consumer is very much like the transportation process, the difference is gas is moved in much smaller volumes than that at much lower pressures over shorter distances. The installation of distribution piping is similar to larger pipelines involving excavation and trenching for the pipe, and welding and fusing as required.

Safety Considerations of Natural Gas Distribution
Safety is the most important consideration throughout transportation and distribution process. Every aspect from production to distribution has to meet strict standards set by local and national agencies. For an in-depth review of these standards, visit the U.S. Department of Transportation site.

Pipeline networks come with a great deal of safety ramifications. Pipeline construction companies, such as Snelson Co., take the lead in proactively identifying any potential environmental and safety health concerns. Large-diameter pipeline is typically buried and is constructed far from metropolitan areas. Smaller-diameter pipeline is used to distribute the gas to the consumer because it is lower volume and lower pressure, reducing the safety risks.

Pipeline Expansion

The pipeline infrastructure has several critical functions. Not only is it the essential link from the production field to the residential, commercial, or industrial consumer, but it also serves another crucial function; that of adding storage and buffering demand spikes. This reduces, and in most cases eliminates, the need to provide for storage close to the point of consumption.

In anticipation of the forecasted increase in demand, additional pipeline will be needed for a few reasons. Production areas have changed geographically meaning the network doesn't serve the current demand well, and an aging infrastructure won't have the capacity soon.

When pipelines were constructed centuries ago, they were put in far from population centers, for safety reasons. If a water main ruptures, the pressure drops immediately and the problem can be fixed. When a pressurized gas pipeline ruptures it takes hours or days for the pressure inside the pipe to equalize with the outside air. By keeping the pipes away, everyone is safer.

In recent decades, as urban sprawl has continued to expand, many people are now living over pipelines. These networks need to be moved further out and modified accordingly.

By running the pipeline in rural areas and then bringing it into population centers in smaller volumes, with smaller diameter pipe, the infrastructure can be safely updated and maintained.

Lastly, aging infrastructure must be updated. Most consider 1859 to be the beginning of the natural gas industry in America. At that time a 2" diameter pipeline, 5.5 miles long was built from the well to the village of Titusville, PA.

One of the first significant pipelines constructed in 1891, was 120 miles long carrying gas for the city of Chicago. However, it would be the 1920s before any significant pipeline infrastructure began to be put in place. Further, it wasn't until after World War II that the 'pipelining process', i.e. welding techniques, metallurgical advancements, and pipe manufacturing, would be advanced enough to allow the construction of reliable pipeline infrastructure.

This surge in pipeline construction lasted into the 1960s and put many thousands of miles of pipeline infrastructure in place in the United States.

Although the industry has steadily upgraded pipelines, added capacity, and replaced older systems nearing the end of life, the growth of natural gas as one of the most important, readily available energy sources has led to the need to add significant transportation infrastructure to what's already existing.

Even with the steady growth in pipeline capacity, it is estimated the U.S. and Canada will need between roughly 30,000 to 60,000 additional miles of pipeline through 2030. This added capacity will not just move natural gas long distances between regions, but will also serve growing demands.

Underground pipelines are the safest, most reliable, cost effective way to transport natural gas. The need for clean, dependable, cost efficient energy sources such as natural gas is growing exponentially. Clearly, the need for natural gas pipelines, and the companies that put them in will remain strong for the future.

Conclusion

The U.S. will need to move quickly to remain a frontrunner in the global gas market as the European Union and Asian markets race to position themselves as dominant players.

It may not yet be the bottom of the market for natural gas. However, there is a huge advantage to those who have invested in it for the long-term.

The environmental and economic benefits of natural gas, and the trend away from coal all point to an explosion in demand for this abundant and inexpensive source of energy.

Ideally, with U.S. support of production, balanced with moderate exports to allow the price to self-correct, without drawing down heavily on reserves, demand will increase as transportation vehicles and other energy dependent manufacturers switch fuels.

Infrastructure investment and expansion will need to continue at rapid pace, to meet the rising need and avoid a replay of the early 2000s and demand destruction.

The New York City water transportation system was designed more than 100 years ago as a series of three tunnels. Those who were part of its development were so far-sighted in thinking, they are still constructing the third tunnel in the infrastructure.

Once that third tunnel is complete, the first two, finished in 1914 and 1935 respectively, will close down for planned maintenance and upkeep.

If the natural gas industry is going to continue to meet demands in the future, long-range planning of this scale needs to occur. This isn't something that is reflected on a balance sheet. It's something that has to occur with the next century and future generations in mind.

About Snelson Companies, Inc.

Snelson was founded as a small plumbing and heating business in 1946 by Frank Snelson. In 1957, his youngest son Bill took over for his father and quickly took Snelson from a small, family business to a diversified mechanical, pipeline, and utility contractor.

Throughout its expansion, the Snelson pipeline company continued to stay true to its roots – maintaining integrity, giving back to the community, and providing quality employment. In fact, many of the employees who were hired by Snelson during the expansion in the 1970s have stayed with the company – forming the main group that continues to be the heart of Snelson's family today.

In the mid-1990s, Snelson focused to specialize in the key services they had been providing for more than 40 years – pipeline construction and maintenance, gas distribution services, facility installations, and pipe and structural fabrication.

Now partnered with Power Line Services, Snelson Companies continues to move the business into the future with the same vision as Bill Snelson – delivering quality craftsmanship by experienced people, serving their community with pride and fusing long-term relationships with clients and their employees.

Snelson continues to play a significant role in building the infrastructure required for the Natural Gas Revolution.

Resources

Brief history: http://www.apga.org/i4a/pages/index.cfm?pageid=3329

American Public Gas Association, A brief history: http://www.apga.org/i4a/pages/index.cfm?pageid=3329

Natural Gas Drives Economy, Jobs, Votes: http://energy.nationaljournal.com/2012/01/whats-ahead-for-natural-gas.php

The Pickens Plan: http://www.pickensplan.com/theplan

Reuters report: INSIGHT-As Congress looks away, U.S. tiptoes toward exporting a gas bounty http://www.reuters.com/article/2012/06/27/usa-lng-exports-idUSL2E8HP7F620120627

About the U.S. Pipelines: According to the U.S. Energy Information Administration, http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/index.html

Exxon/Mobil White Paper: http://www.exxonmobil.com/Corporate/files/news_pub_eo.pdf The Outlook for Energy: A View to 2040

Getting Natural Gas to the Consumer, U.S. Energy Information Administration: http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/index.html

Safety standards for Natural Gas Transportation and Distribution, U.S. Department of Transportation: http://primis.phmsa.dot.gov/comm/pipelinebasics.htm?nocache=7202

How to Cash in on America's Natural Gas Highway, Steve Sjuggerud: http://www.stansberryresearch.com/pub/reports/SDW_highway.html

Call Before you Dig, U.S. Department of Transportation: http://primis.phmsa.dot.gov/comm/CBYD.htm?nocache=4506