

Rethinking Natural Gas

A Future for Natural Gas in the U.S. Economy

American Gas Association

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American Gas Association

The American Gas Association, founded in 1918, represents more than 200 local energy companies that deliver clean natural gas throughout the United States. There are more than 71 million residential, commercial and industrial natural gas customers in the U.S., of which 92 percent — more than 65 million customers — receive their gas from AGA members. AGA is an advocate for natural gas utility companies and their customers and provides a broad range of programs and services for member natural gas pipelines, marketers, gatherers, international natural gas companies and industry associates. Today, natural gas meets almost one-fourth of the United States' energy needs.

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Introduction

Today's natural gas industry delivers space and water heating, feedstock for chemical manufacturing and fertilizers, fuel for electricity generation and vehicles, and provides many other services to consumers throughout the U.S. economy. Natural gas contributes to reductions in greenhouse gas emissions, complements the intermittency of renewable electricity generation, fuels the fires of industrial production, adds value to our national economy, and is produced right here at home. The natural gas industry serves these requirements with an unparalleled commitment to safety, reliability and affordability.

The country will never realize the full potential of natural gas as a foundation fuel until it is more effectively used in energy applications across the economy.

Natural gas is the nation's *foundation fuel*, laying a base for energy security and reliability, emissions reductions, and consumer savings. However, this perspective is very different from views just ten years ago. At that time, concerns about declines in North American natural gas production contributed to an expectation of market uncertainty and price volatility. Today, market fundamentals support a vision of a future of affordable and

relatively stable-cost natural gas resources.

Recent changes and realizations within the natural gas landscape have shaped this view, including:

- new confidence in the U.S. resource base highlighted by the development of shale gas and the technologies that support its extraction;
- regulatory changes to local gas utility rate structures that enable commitments to energy efficiency;
- improvements in natural gas appliance efficiency;
- discernible environmental benefits attributed to natural gas compared to alternatives;
- the possibility of U.S. liquefied natural gas (LNG) exports; and
- a rallying of business, government, regulators, advocacy groups, and other stakeholders around the benefits of efficient and focused use of natural gas in the country's energy mix.

Because of these changes, there is more room for wise and efficient growth of natural gas consumption in today's domestic energy market. The days of fearfulness about price instability and resource constraints could be behind us. The current vision is one of a new market environment, supported by prudent regulation and policy making informed by science and facts, creating new opportunities to better optimize our nation's energy resources.

U.S. natural gas supply can respond efficiently and robustly to foreseeable and plausible demand growth scenarios at an affordable cost compared to other energy alternatives.

In this new environment, market issues will remain, of course. This view does not deny that gas prices cannot or will not rise. Additional market demand can lead to price increases. The question is how much? The American Gas Association's (AGA) view is that natural gas acquisition prices will remain affordable compared to other forms of domestic energy, even with an aggressive increase in natural gas consumption.

A set of fundamental points are key to understanding this vision. AGA's view for natural gas for the coming decade and beyond is predicated, at least in part, on the following conditions.

- 1. Resource Abundance** – technology has opened the door to efficient, affordable, and robust extraction of natural gas, oil, and other liquids in North America. The ultimate recovery potential is enormous and still likely underestimated. In short, the natural gas resource base in North America may be larger than is even acknowledged today.
- 2. Technological Progress** – further technological developments will advance resource extraction efficiency, mitigate some of the environmental and social impacts of natural gas production and distribution, and continue to make clean natural gas affordable to customers in homes, businesses, and industries across the country.
- 3. Responsible and Sustainable Resource Development** – the people of the United States expect that extraction, transmission, and distribution of natural gas to be carried out using the best available, most responsible, and sustainable engineering, social, and environmental practices. Appropriate regulatory frameworks will be essential.
- 4. Demand Pull** – the market today reflects the dynamics of demand constraint, not supply limitations, given recent strong natural gas production along with less-than-commensurate increases in levels of demand. There is significant potential to expand natural gas use for homes and businesses, electricity generation, industrial plants, liquefaction facilities, and vehicles. These applications can provide net benefits to the entire natural gas industry and the U.S. economy. The demand for natural gas, and not merely abundant supply, delivers market signals essential to the long-term health of our businesses and the country as a whole. AGA believes that the country will never realize the full potential of natural gas as a foundation fuel until it is more effectively used in energy applications across the economy.
- 5. Market and Price Stability** – the evolution from market uncertainty, instability, and resource scarcity ten years ago to the current environment of recognizing natural gas as a critical foundation fuel in the American economy has been transformational. The current price of natural gas of under \$3.00 per million British thermal units (MMBtu) may be a short-term phenomenon and a market response to excess supply. With that said, there is room to grow demand at reasonable and stable prices. Even significant increases in demand may be supported by this large, dynamic, robust and diverse North American natural gas resource base, coupled with expanding infrastructure and appropriate regulatory constructs, at acquisition

prices averaging slightly higher than \$5.50 per MMBtu during the next ten years and possibly beyond.

- 6. Regulatory and Legislative** – it is not only incumbent on the natural gas industry to recognize the critical potential for natural gas in our energy mix, but also necessary for regulators and policy makers to acknowledge this potential and make critical decisions based on the best available science and information.

Market Evaluation Methodology and Observations

This paper reviews key natural gas market drivers and conditions in order to understand better the landscape of the market for the next ten years. In particular, the paper examines critical supply and demand issues, including the drivers of natural gas consumption and the important factors that may shape demand. Understanding these supply components and demand drivers forms the basis for an examination of plausible yet aggressive scenarios of natural gas consumption and the resulting price rationalization during the decade ahead.

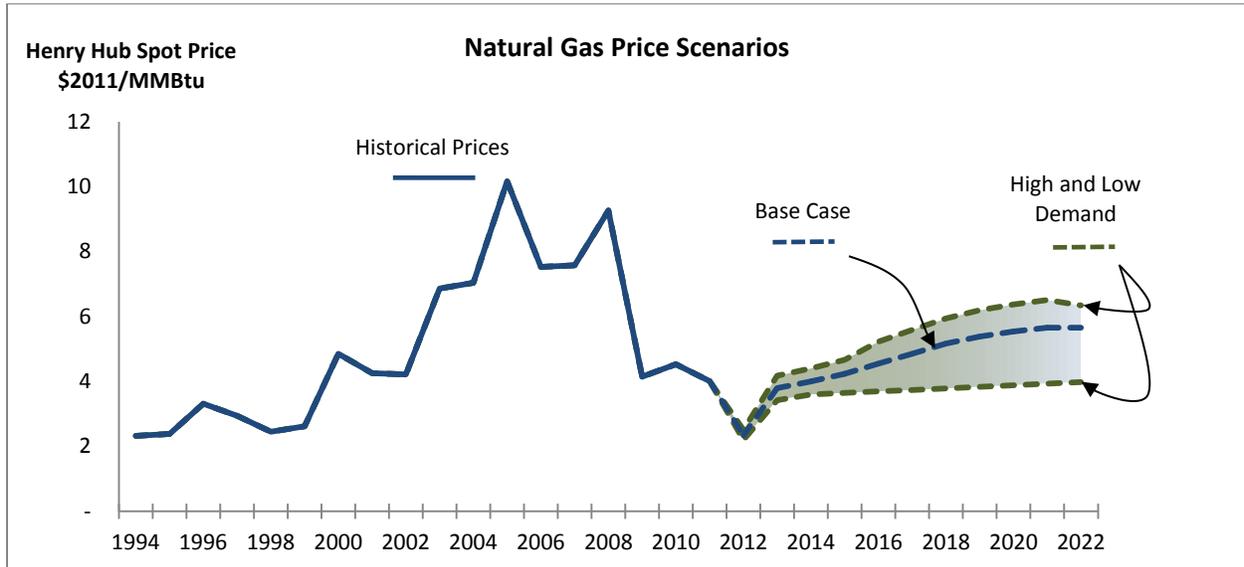
This exercise is based on research and analysis by AGA staff and comprehensive energy modeling and data from the U.S. Energy Information Administration (EIA) and Wood Mackenzie, a consulting firm with expertise in global and domestic energy markets. AGA, EIA and Wood Mackenzie do not endorse any long term views or projections discussed here as a prediction of the future. Instead, AGA staff incorporated a fundamental understanding of natural gas resources in North America, infrastructure, economic conditions, federal and state policy knowledge and available market information to shape the forward-looking vision and statements in this paper. The robust and thorough nature of the Wood Mackenzie base case model provided AGA staff the opportunity to evaluate more aggressive demand scenarios and resulting price trends compared with the EIA Annual Energy Outlook. The Wood Mackenzie work underlies some of the discussion about potential resources and possible future price trends, but the demand-side assessment and all conclusions are those of AGA.

The results of this analysis are a range of demand expectations, supply responses, and market balancing prices based on a variety of assumptions. In these scenarios, a balanced market is observed with a stable range of affordable prices. In other words, natural gas market growth is accomplished within the bounds of a relatively stable market environment.

What does the new market environment entail for natural gas acquisition prices during the next decade? The projected prices in Figure 1, depicted with dashed lines from the years 2012 to 2022, are based on modeling of high and low demand cases, some details of which are noted later in this paper. These scenarios show a range of natural gas acquisition prices based on plausible levels of foreseeable consumption for the next ten years. These prices range from roughly \$4.00 to \$6.50 per MMBtu. In the high demand case, higher prices support a very aggressive 45 percent increase in natural gas demand. Many factors contribute to this scenario. New supplies, better technology, evolving regulatory

frameworks, greater efficiency, and other factors all contribute to a vision of increased natural gas demand served by a robust resource base at affordable prices.

Figure 1
Range of plausible price scenarios point to lower costs and stability compared to history.



Source: Wood Mackenzie, Spring 2012

Increased North American natural gas production has alleviated resource-related constraints on supply, which means that new demand requirements from increased natural gas consumption can be met at affordable prices. In AGA's view, given the robust domestic supply portfolio, which includes Canadian import and seasonal storage, prices are more likely to materialize in the range of cases reflected here. In fact, acquisition prices may trend on the lower side if additional natural gas consumption does not materialize.

This view does imply the end of short-term changes in natural gas prices. Weather, limitations on pipeline capacity, and various uncontrollable events can lead to localized, temporary increases in the price of natural gas. To believe otherwise ignores reality. However, a longer-term trend toward greater affordability and reliability supported by robust supply portfolio helps mitigate these short-term events.

It is not possible to correctly predict every moment in the market life of a dynamic commodity such as natural gas. Furthermore, models and outlooks are inherently incorrect because there are factors that cannot be fully captured and incorporated into the modeling assumptions. Nevertheless, such exercises are useful because the analysis and discussion of key market drivers lead to deeper insights into the market dynamics, implications for prices, and reasonable expectations for the coming decade. In

addition to the observed economic modeling outputs, this paper offers observations of the vagaries of future market conditions, but that are tempered by realistic expectations of likely future scenarios.

The remainder of this paper details findings regarding supply and demand outlook and the resulting implications for the natural gas market. The AGA team examined each natural gas demand sector in order to understand the drivers of consumption, both retrospectively and looking forward, to develop views on what might be plausible levels of natural gas demand for the next decade. In addition, the team established a high-demand case to understand how greater volumes of natural gas consumption might affect natural gas prices. For each demand sector, the team evaluated ranges of plausible yet less probable levels of natural gas consumption.

U.S. Natural Gas Supply Findings

The foundation for a sustainable view of future natural gas market stability goes directly to observations of a large, diverse, reliable, accessible, and ultimately affordable natural gas resource base in the United States. Technology has opened the door to this possibility, by making economic unconventional sources of natural gas such as shale. Natural gas production has grown considerably in recent years. So much so that in 2012, natural gas from shale accounted for a third of domestic production – a spectacular increase in the past five years. Sustainable and responsible production and delivery practices will keep the door open only if national and state policies, regulatory constructs, and stakeholder engagement support rather than impede the opportunity.

For the purposes of this analysis of natural gas markets, it is assumed that insurmountable impediments to responsible and sustainable resource development do not occur during the next ten years; that environmental and other stakeholder concerns are addressed; and that the cost of those remediated strategies are built into the economic balance of the industry and, more particularly, built into this modeling and evaluation effort.

Natural gas production during the last decade was generally lower than it is today, and the expectation is of increasing production going forward. Dry natural gas production averaged 53.3 Bcf per day from 2000 to 2010, with a notable uptick in production toward the later end given new natural gas supplies coming to market. By year-end 2012, dry natural gas production (after processing and liquids removal) will likely total about 64 Bcf per day, an increase of 20 percent above the prior decade’s average and a historical high. What about the next decade?

Table 1 summarizes an estimate of domestic natural gas production in 2012 and additional outlooks ten years forward. Also represented are projected prices associated at those levels, according to EIA and Wood Mackenzie. The modeled projections reveal greater natural gas production is expected to come online during the next ten years given recent trends and accelerated development of the North American resource base, if production is supported by adequate natural gas acquisition prices and a demand for the product.

Table 1 - U.S. Daily Natural Gas Supply Potential

	2012	EIA AEO Ref 2022	Wood Mackenzie Low Demand 2022	Wood Mackenzie Base Case 2022	Wood Mackenzie High Demand 2022
Bcf per day					
U.S. Production	63.9	70.3	81.4	81.5	85.9
Imports from Canada	5.4	0.4	6.6	7.7	8.0
<i>Price (2011 \$/MMBtu)</i>	<i>\$2.85</i>	<i>\$5.43</i>	<i>\$3.98</i>	<i>\$5.65</i>	<i>\$6.34</i>

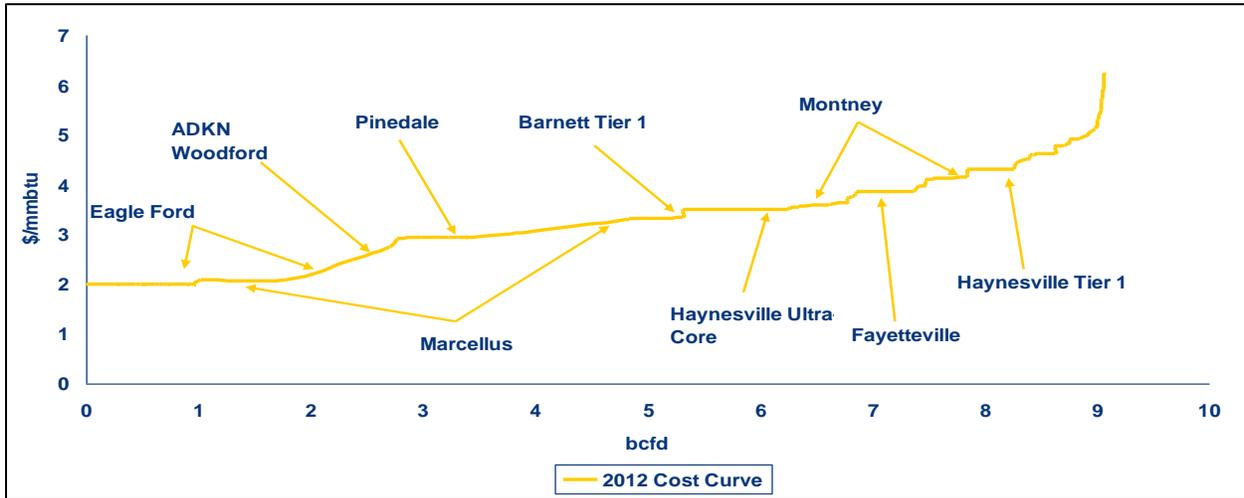
Sources: Energy Information Administration; Wood Mackenzie, Spring 2012

Wood Mackenzie, which takes a much more bullish view of potential natural gas production in 2022 than the Energy Information Administration, projects the possibility of over 80 Bcf per day of natural gas production in both its low demand high demand and base cases, if required by commensurate demand. This production outlook is supported by additional U.S natural gas supply brought on when domestic acquisition prices grow to \$5.00 per MMBtu and more. EIA currently projects less development with dry gas production at about 70 Bcf per day, however, considerably less market demand. In both cases natural gas production is expected to grow. Growth in shale production is expected to meet new demand requirements.

Whatever the modeling outlook for the ultimate supply and demand balance of the marketplace, natural gas supplies are made available to the market priced from \$4.00 to \$6.50 per MMBtu at Henry Hub during the next decade. If there is a risk to the analysis and acquisition pricing band assigned these volumes, it is more likely to be one of lower cost on average (AGA's view), not more. AGA concludes that *U.S. natural gas supply fundamentals can respond efficiently and robustly to foreseeable and plausible domestic demand growth at an affordable cost compared to other energy alternatives.*

The most straight forward way to define the future of U.S. gas supply is to understand what may be required to meet domestic natural gas consumption requirements in the time period 2012-2022. Growing domestic natural gas production requires that a certain market pricing signal elicit a production response from gas producers. The chart on the next page (Figure 2) illustrates the critical tie between natural gas market prices and the future development of emerging unconventional resource plays. In short, many identified shale gas resource plays become economically available to the market at a development cost of about \$6 per MMBtu. This is precisely the foundation that accounts for the possibility of greater domestic natural gas production during the next ten years.

Figure 2
Shale Gas Supply Curve points to potential incremental 2012 additions of 9 Bcf per day natural gas production at below \$6 per MMBtu.



Source: Wood Mackenzie, Spring 2012

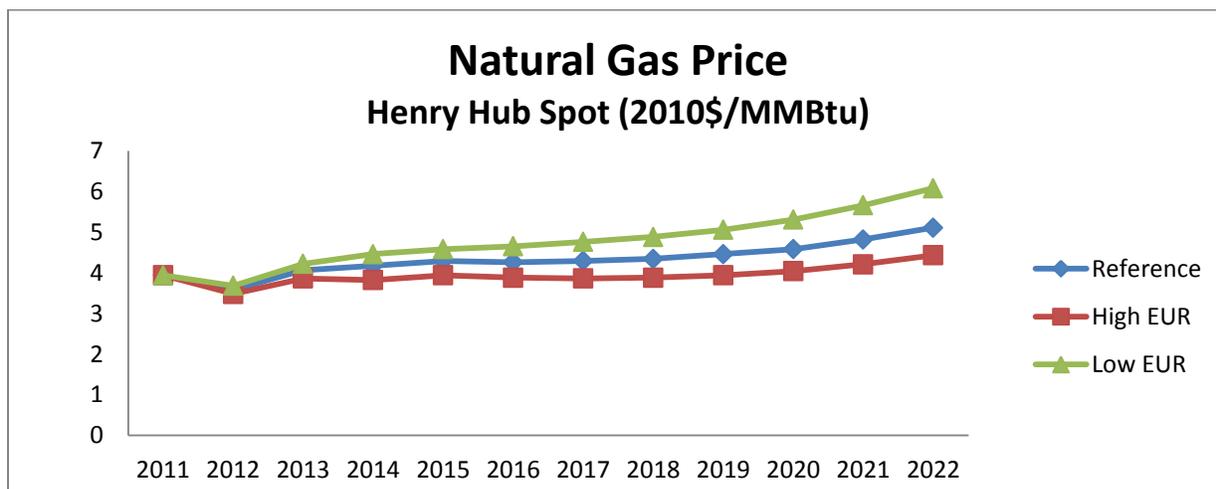
In this view, only a small percentage of incremental new gas production is economic at wellhead prices of \$2.50 per MMBtu or less. Therefore, the recent prices of \$3.00 per MMBtu at Henry Hub (and below) may be unsustainable in the long term, but would be sustained within the previously identified range of \$4.50 to \$6.00 per MMBtu. In the short term, natural gas acquisitions prices may rise from the relatively low levels of 2012 as additional gas is demanded and natural gas production is grown or sustained. Over the long term, domestic production has the potential to grow significantly, with a commensurate yet moderate increase in natural gas prices as well. In the base case scenario, an increase of natural gas demand from 64 Bcf per day to more than 80 Bcf per day by 2022 could be supported by existing resources at a reasonable price level. Given the robust resource base, shale gas production would more than double to meet this demand.

What if the natural gas resource base proves more or less robust than currently projected? A primary unknown of possible future shale gas production is whether current growth trends are being supported by drilling of “sweet spots”, which by definition would be used up in time and not be replaced, or whether better well results will be supported by continued technological improvement and producers just being smarter, which is the key to long-term production. *AGA’s conclusion is the latter is more descriptive of the domestic unconventional resource base, which may be under-estimated compared with the base case and reference cases used in this analysis.*

To gauge how natural gas resources may shape the future price of natural gas, AGA examined different scenarios where shale gas well production was higher or lower than today and how that affects natural gas prices. Figure 3 demonstrates the increase and decrease in natural gas price based upon assumptions of the Estimated Ultimate Recovery (EUR) of shale gas wells for new, undrilled wells from the EIA Annual Energy Outlook 2012. The Low EUR case assumes 50 percent lower EUR per shale gas

well than in the Reference case (AEO 2012). The High EUR case assumes 50 percent higher EUR per shale gas well compared with the reference. Production in the Low EUR case is 7 percent lower in 2022, but still has an acquisition price of \$6 per MMBtu (2010\$). Even assuming a dramatic *decrease* in natural gas resources, the projected price in this case is well within the *stable, affordable* band identified. Note that the 2012 baseline from which the AEO 2012 projections stem from is higher than the acquisition prices that have actually materialized for 2012, indicating the prices projected in 2022 in all cases *may be on the high side*.

Figure 3
Projections of Natural Gas Prices based on Estimated Ultimate Recovery per shale gas well for new, undrilled wells.



Source: U.S. Department of Energy, Energy Information Administration.

Regarding other sources of natural gas for domestic customers, pipeline imports from Canada have historically provided a significant portion of annual natural gas demand and helped to balance demand requirements during peak winter months. Canadian imports are likely to remain a sustained supplier of natural gas to the United States in the range of 5-8 Bcf per day during the next decade. Additional supply from Canada helps enhance the durability of the U.S. supply portfolio and therefore lends itself to greater supply security.

Production comprises only one key component of supply. Pipeline imports from Canada and the LNG import-export balance, as well as increases in storage capacity, may shape the future supply portfolio to meet demand requirements. Liquefied natural gas (LNG) imports currently add less than 1 Bcf per day to daily supply, but there is potential for much more natural gas from imports. That said, LNG import-export trade is expected to turn to net exports with the start up of Sabine Pass liquefaction capacity on the Louisiana gulf coast and the continued moderation decline of LNG imports associated with other terminals.

The supply findings noted above support a foundation of future market stability. The resource base and the components of domestic supply, including natural gas production, imports, and storage, are viewed as a robust partner in meeting a range of domestic demand requirements at affordable costs.

U.S Natural Gas Demand Findings and Expectations for the Next Decade

Underlying AGA's vision of market stability is recognition that the North American supply portfolio should be able to meet substantial growth of new natural gas demand at affordable prices. Critical to this understanding is not only the underlying supply components, but how demand will be shaped for the years to come. Economics, regulations, and policy all play a role.

This section reviews a number of plausible futures for natural gas demand for the next ten years influenced by various modeled scenarios. These cases are used to develop a view of what the possible effects on acquisition prices are given different levels of plausible natural gas demand. In addition, demand chapters explore the specific drivers of natural gas consumption in broad sectors of the economy.

Based on an internal review of the drivers of natural gas consumption, the following summarizes AGA's high-level views of plausible demand going forward.

- **Residential and commercial** demand has been level since 1970 as demand from new customers has been counterbalanced by consumer conservation and improvements in energy efficiency. While many factors indicate this flat-line trajectory may be likely to continue, growth in residential and commercial consumption is possible if certain market drivers take hold, including the adoption of new technologies, an accelerated economic recovery that drives new housing and building construction, greater conversions from alternative energy sources including distillate fuel oil, continued price advantages for natural gas, and the recognition of emissions and other environmental benefits.
- **Electricity generation** from natural gas is likely to be the largest driver of new natural gas consumption during the decade ahead. Short-term price advantages for natural gas relative to coal have driven large increases in consumption already. Long-term migration from coal to natural gas may be driven by sustained coal to natural gas price differentials, new environmental regulations on coal-fired power generation, and economic growth.
- **Industrial** use of natural gas for heat, power, and chemical feedstock will likely be shaped by the fortunes of the U.S. economy and the strength of global GDP growth. Underlying trends toward greater industrial energy efficiency will be compounded by a general shift toward less-energy intensive, high-value products. New demand is expected from new manufacturing capacity, driven in part by lower natural gas prices as well as an expanding economy. Growth in global petrochemical demand, new investments in combined heat and power technologies, and greater use of natural gas as a compliance solution for environmental regulations may contribute to these positive growth trends.

- **Vehicular** use of natural gas faces challenges over the next decade to improve fueling infrastructure, however, the idea and tangible results of alternative vehicle strategies are gaining momentum. Sizable advances may be made within specific vehicle markets including fleets and long-haul trucks, which require large mileage and central refueling infrastructure that may help project economics. The spread between natural gas and global oil prices will remain an important driver, however. If the spread is maintained or increases, so will the natural gas vehicle value proposition.
- **LNG exports** are likely to materialize as North American natural gas prices enable arbitrage value to European and Asian markets compared with other exporting countries. The range of new demand will be constrained, at least somewhat, based on regulatory hurdles and capital requirements for new plants.

Deriving views of plausible natural gas demand for the next decade is only the first step. Stress testing the supply base with plausible but aggressive demand scenarios offers the opportunity to explore a wide range of consumption scenarios can be supported by the gas supply component. Table 2 below presents a number of cases of possible future demand, including the EIA 2012 Reference case, Wood Mackenzie Spring 2012 base case, and high and low demand cases.

Table 2
U.S. Natural Gas Demand 2012 and Forecasts for 2022

	2012	EIA AEO Ref 2022	Wood Mackenzie Low Demand 2022	Wood Mackenzie Base Case 2022	Wood Mackenzie High Demand 2022
Bcf per day					
Res/Com	20.5	22.5	23.2	23.7	24.5
Power Gen	23.4	21.3	25.9	25.9	28.6
Industrial	18.6	19.6	21.9	22.7	23.3
LNG Exports	0.06	1.8	5.2	5.2	8.0
Exports to Mexico	1.4	1	3.3	3.3	3.3
NGVs	0.2	0.3	0.8	1.3	2.1
Total US Sector Demand (w/other)	64.1	66.5	83.7	85.6	93.9
Price (2011 \$/MMBtu)	\$2.85	\$5.43	\$3.98	\$5.65	\$6.34

Sources: EIA; Wood Mackenzie, Spring 2012

The results point a plausible and realistic future of natural gas demand where U.S. consumption grows from 64 Bcf per day currently to nearly 80 Bcf per day by 2022. New demand would be spread across all sectors, though not equally. Much of the new demand will likely come from the power generation, industrial, and LNG export sectors. New industrial capacity and LNG export investments, in particular, are capital and time intensive, so many may not materialize until 2015 or later. Additionally, there is still

significant potential for demand in residential, commercial, and natural gas vehicle sectors over the long-term.

Key to this view of possible natural gas consumption is that new requirements across all sectors can be met at affordable prices. The price range across the scenarios analyzed point to a range between \$4.00 and \$6.50 per MMBtu. *These price levels are well below peak acquisition prices seen during the past decade and indicate a new market environment going forward.*

The following insights and observations of natural gas demand help to define the potential for natural gas demand in U.S. markets during the next ten years.

Residential-Commercial Sector

Natural gas demand in the residential and commercial sector has not grown for four decades as declining natural gas use per customer has largely offset demand requirements of new customers. Despite the addition of 28 million new residential customers and 700,000 commercial customers since 1970 and new natural gas load associated with these hook-ups, residential natural gas consumption has remained essentially flat and commercial sector growth has been minimal. Most of the annual variation in consumption is attributable to weather. Improvements in appliance and building shell efficiency, customer conservation, periods of higher natural gas prices than seen today, lack of new natural gas appliances available to consumers, and conversions away from natural gas have all contributed to the decline in natural gas use per customer.

Over the last decade, these dynamics were accelerated by the collapse of the new construction market which is still restricting market growth. In terms of the residential sector, not only has the number of homes declined, but natural gas market share has fallen during that time as well.

When the new home market collapsed, many utilities turned to conversions of homes from oil or electricity as a strategy for adding customers. Traditionally, about 15 percent of new customers come from conversions. In 2010, that average increased to 25 percent. But conversions to natural gas have not made up for the lost growth from new construction, and some of the best candidates have been converted, making it harder to grow the market through traditional conversions, alone.

Despite challenges, there is potential for upside in natural gas consumption in both sectors including:

- increasing the number of burner tips per household or building;
- Improved market share of new construction;
- overall growth in the construction market;
- population growth;
- price advantages of natural gas compared with other energy sources; and
- recognizing emissions benefits of natural gas compared with other energy sources.

Given these factors, growing demand from both residential and commercial sectors may be achieved. This view anticipates net growth in the residential and commercial sectors after years of stagnant demand, based on:

- residential-commercial demand growth on the back of strong conversion preferences for natural gas and increased market shares in new construction;
- reversal of historical trends that demand from customer growth can be offset through continued efficiency gains;
- increased growth associated with recovering economic conditions; and
- potential for market growth enhanced by new products introduced to the commercial sector, including those for cooling and humidity control, water heaters, and boilers. Some of the larger commercial customers can utilize combined heat and power units, also.

Industrial Sector

Natural gas is used in the industrial sector primarily as a fuel for heat and power, and to a lesser extent as a petrochemical feedstock for chemical manufacturing and primary metal fabrication. The Great Recession added to a decline in 2009 of industrial gas consumption as demand fell to 16.9 Bcf per day. As the recession has turned gradually back to growth, renewed industrial production has brought gas demand back to about 18 Bcf per day in the sector. For 2012, the EIA *Annual Energy Outlook* projects 18.6 Bcf per day of likely industrial natural gas demand; of this, 92 percent will be used for heat and power in refining and industrial applications and 8 percent will serve as a chemical feedstock.

Natural gas industrial sector demand growth is tethered to domestic and global economic growth which drives industrial production, the biggest driver of new natural gas demand. Aggregate demand for industrial products in North America and overseas drives industrial output, which in turn requires additional demand for natural gas. As the fortunes of the global economy go, so will industrial natural gas consumption.

However, any growth in industrial energy consumption is likely to be moderated by a shift in the mix of output as energy intensive manufacturing grows less quickly than high value, less-energy intensive industries. In contrast, a resurgence of energy-intensive manufacturing could result in quicker natural gas demand.

Other factors contributing to new industrial demand include:

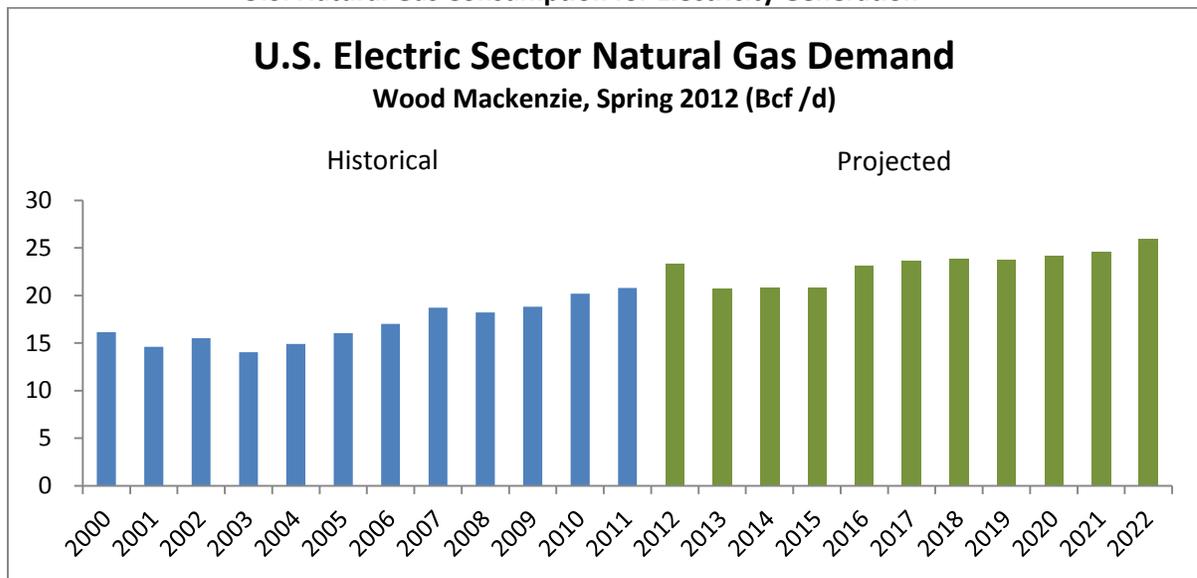
- investments in new manufacturing capacity;
- petrochemical demand for natural gas and natural gas liquids;
- new combined heat and power capacity; and
- natural gas utilized as a solution to environmental regulations (for example, EPA boiler MACT).

All told, the potential range in industrial sector natural gas demand is likely somewhere between 1 Bcf to 4 Bcf per day during the next ten years. Generally, upside potential exists if a further drop in natural gas prices spurs additional industrial demand, and if economic growth exceeds expectation. This is reflected in the various scenarios analyzed.

Power Generation Sector

Natural gas has long been a fuel for electricity generation and remains an important component of the electricity fuel mix. Today, the electric sector uses natural gas for a quarter of all electricity generation and the electricity generation sector comprises about one third of the all natural gas delivered to consumers. Recently, declines in natural gas prices relative to coal have led to an increase in natural gas use for power generation. In addition, in coming years natural gas is seen as a compliance solution for a number of environmental regulations.

Figure 4
U.S. Natural Gas Consumption for Electricity Generation



Sources: Wood Mackenzie, Spring 2012

In 1998, natural gas was used as fuel for 15 percent of all electricity generation. Over the ensuing years, natural gas-fired electric generation capacity more than doubled, up from 180 GW in 1998 to over 400 GW in 2009. Many of the new capacity additions were natural gas-fired combined cycle units, which are generally more economic to operate compared with the single cycle turbines or steam generators. But new gas demand and declining domestic production strained the market and natural gas prices subsequently rose, making many of the new natural gas-fired power plants more costly to run. As a result, much of the new gas capacity was not fully utilized. Natural gas combined cycle plants were run at less than 40 percent capacity on average between 2003 and 2007.

As natural gas prices dropped toward the end of the decade, natural gas requirements for electricity generation began to rise. By 2011, natural gas fueled 25 percent of net electricity generation, up 10 percentage points from a decade prior. Projections show this share could increase.

The electric sector is likely to be a significant driver of natural gas demand in the coming years. A number of interrelated factors are likely to drive demand for natural gas. Economic growth, coal and gas competition in electricity dispatch, new environmental regulations on coal-fired power plants, and infrastructural requirements to meet intermittent renewable power will all play a role in shaping future gas demand in the power sector.

A natural question is then, to what extent do these factors play in driving new gas demand, and what is the potential for significant growth?

- Economic growth is likely to be the primary driver of new natural gas demand as new electric load draws upon increased gas-fired generation.
- The price difference between coal and natural gas, which will shape the economic order that electricity operators dispatch coal and natural gas-fired power plants.
- Upcoming EPA regulations, the size and extent of which may drive coal-fired generation closures and lead to greater use of natural gas generation to meet demand. This, in turn, will have a feedback effect on natural gas and coal prices.
- Counterbalancing these issues will be the role energy efficiency policy plays to shape electricity demand and supply choices.

Transportation Sector

During the past 40 years efforts have been made to promote natural gas as a vehicle fuel, with limited success in the United States. The momentum to do so once more, however, is increasing. The best near-term opportunities in this market seem to be in fleets, most of which have high mileage vehicles that return often to central location. Recently, a couple of developments have increased optimism for this market:

- the price of natural gas has fallen significantly, as the price of oil increased with little long-term relief expected; and
- a number of new players, in particular natural gas producers, have joined in efforts to develop the natural gas vehicle market, adding significant resources that will aid in infrastructure development.

Potential market growth may ultimately be influenced by factors such as those listed below.

- Increased fleet use – there is significant opportunity, particularly for large fleets and/or fleets with larger/heavy duty vehicles to use natural gas as a primary fuel. Utility fleets are generally

run on gasoline and diesel fuels, however, they are key candidates for alternative fuel use based on the beneficial economics of central refueling.

- Personal car market – expanded home refueling options and CNG storage vessels.
- Favorable value proposition for long-haul trucks (LNG) – good energy return on investment per vehicles (100,000 miles per year).
- Emission standards – more stringent vehicle emission standards could make the NGV choice more attractive to government, fleet operators and consumers.
- Infrastructure – public stations in states such as Utah have developed along key travel corridors. While private fleet stations are helpful for developing the NGV market, public stations can serve several fleets and individuals.
- More OEM products – many of the light- and medium-duty NGVs are aftermarket conversions while most heavy-duty engines are designed by the original equipment manufacturers. Increasing the number of automakers willing to build NGVs will help the market develop.

LNG and Pipeline Exports

Significant growth in domestic natural gas production is altering the energy landscape in the United States. Domestic gas production and the potential for future sustainable growth has attracted attention from natural gas marketers and producers envisioning the United States as an exporter of liquefied natural gas (LNG) to markets in Europe, the Caribbean, South America and Asia. Momentum is building for the development of infrastructure to support LNG exports from the U.S. gulf coast and west coast of Canada.

U.S. Department of Energy and Federal Energy Regulatory Commission (FERC) approval of export licenses and project planning are setting the stage. In fact, the first FERC approval of a facility for construction and operation was given on April 16, 2012 for the Sabine Pass, LA proposal offered by Cheniere Energy Inc. AGA's view of the deployment of domestic export capacity is supported by the following key acknowledgements.

- LNG exports may reach 5 Bcf per day from United States by 2022. The range of expectations runs from 2 to 10 Bcf per day from numerous prognosticators with the highest likelihood of occurrence in the 2 to 7 Bcf per day range based on regulatory hurdles and capital requirements.
- Nuclear power generation capacity in Japan is only now coming back on line since Fukushima and other countries (Taiwan, for example) are re-examining nuclear power strategies. This makes Asian markets targets for U.S. gulf coast and eastern LNG export proposals, as well as those in western Canada.
- Asian capacity holders have been identified and linked to export proposals from Gulf coast facilities Sabine Pass, Freeport, and Cameron LNG.

- As of April 2012, the Department of Energy Fossil Energy Office had slowed the progressive review of LNG export facility applications, waiting for the completion of a third party study of the potential impacts of LNG exports on domestic macroeconomic metrics.
- Facilities construction is expensive even in the case of brown field options. For example, Cheniere expects to spend at least \$4 billion in construction costs and up to \$2 billion in finance charges to construct two liquefaction trains (about .7 Bcf per day each) on the existing Sabine Pass, LA import facility footprint.
- Current proposals for U.S. LNG Export Terminal Projects include among others:
 - Cheniere (Sabine Pass, TX) 2.2 Bcf per day at existing regas facility;
 - Freeport LNG (Freeport, TX) 2.8 Bcf per day at existing regas;
 - Semptra (Cameron, LA) 1.7 Bcf per day at existing regas facility;
 - Jordan Cove (Oregon) proposed 1.2 Bcf per day bi-directional greenfield facility;
 - LNG Development Company (Oregon) 1.3 Bcf per day greenfield facility;
 - Cheniere (Corpus Christi, TX) proposed 1.8 Bcf per day greenfield facility;
 - Gulf Coast LNG (Brownsville, TX) proposed 2.8 Bcf per day greenfield facility;
 - Dominion (Cove Point, MD) 1.0 Bcf per day at existing regas facility;and
 - BG and Energy Transfer (Lake Charles, LA) 2.0 Bcf per day at existing regas facility.

EIA projects that net LNG exports may begin as early as 2016; reach about 2.5 Bcf per day by 2020 and sustain that level of exports through the forecast period (2035) of the *Annual Energy Outlook*.

In addition to LNG exports, pipeline exports to Mexico may average as much as 3.3 Bcf per day in the 2012-2021 period. Overall, the United States may become a net natural gas exporter (net of pipeline and LNG) by 2020.

Conclusions Regarding U.S. Natural Gas Market Pricing Findings and Macro-Expectations 2012-2022

Stable is not how one would have described the natural gas market during the period 2000-2010. After years of relative market calm, the beginning of the twenty-first century brought not only much higher prices, but major fluctuations in those prices. In the 1980s and 90s, the average monthly variation in price from high to low was less than \$0.50 per Mcf, even during the initial years of price decontrol. Compare that to a range of \$3.33 per Mcf during the 2000-2008 timeframe (see Figure 5). Those fluctuations played havoc in the marketplace by stifling demand, creating customer fears and contributing to the economic recession.

Many factors contributed to this period of instability including a decrease in gas well productivity, weather incidents that impacted supply or demand, and a perception among industry analysts that demand growth would exhaust domestic production to the point where the U.S. would need to import additional supplies in the form of LNG. Spurred by higher prices, gas producers not only increased efforts to extract supplies in traditional ways, they also experimented with a variety of untraditional methods to access supplies previously deemed uneconomic. These efforts paid off, and coupled with refinements on established drilling techniques allowed producers to develop economic gas wells in shale formations. As a result, shale throughout North America is supporting resource potential that many supply analysts believe can last into the next century.

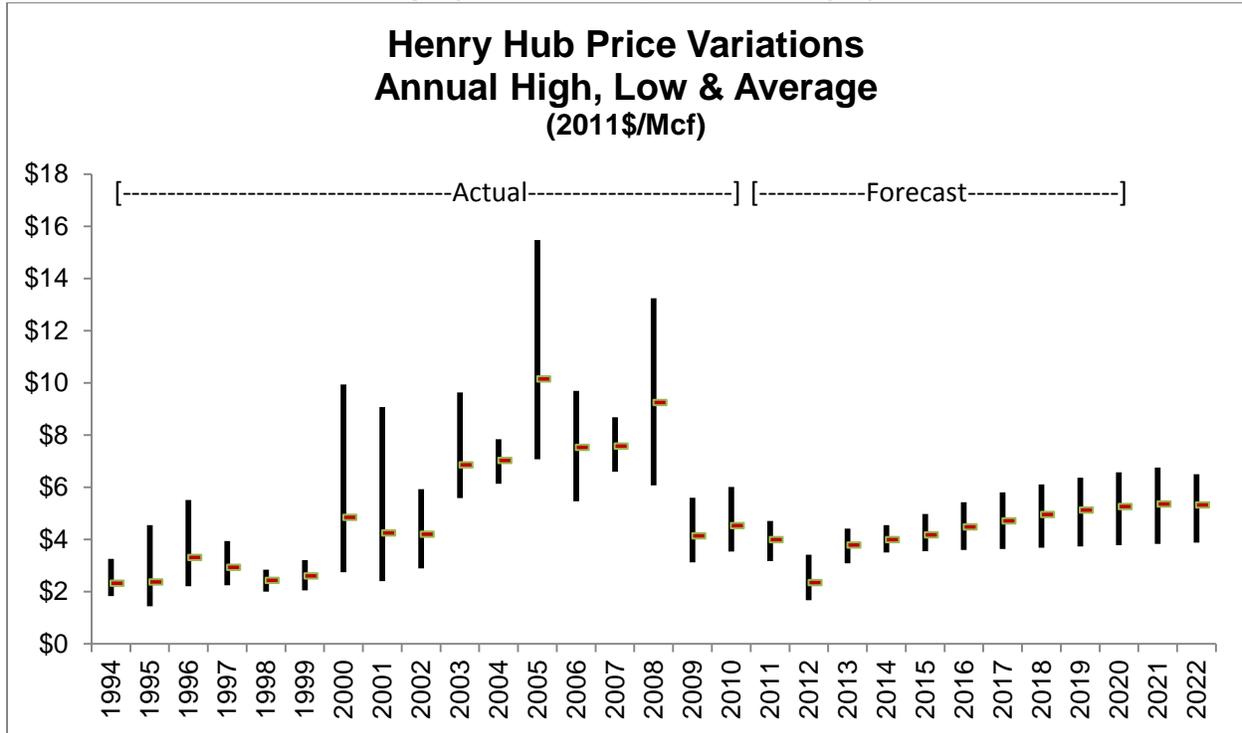
As the realization that supplies are more than ample for domestic demand, gas prices have fallen from highs in 2008. Ironically, demand did not immediately respond to these lower prices. Warm winter weather, near-full storage fields, a housing market that would not rebound, and economic recession contributed to gas prices falling to levels not seen since the mid 1990's. With that said, many forecasters expect natural gas demand to grow during the next few years, with increases in gas acquisition prices. The question is, will the natural gas industry go through another boom and bust cycle, with substantial changes in prices?

AGA's view is that such an expectation is less likely to occur, today, than in the past. At least for the next ten years, gas supplies are anticipated to be so robust that the market can supply not only the demand scenarios forecasted by most models but also those demand profiles that exceed the expectations of many analysts. And the market can deliver that natural gas at prices well below those encountered at the pricing peaks during the last decade. The model runs and analysis support the following conclusions:

- natural gas Henry Hub Base Case price of \$4.00 to \$6.50 which may support about 81 Bcf of domestic natural gas production by 2022;
- base case U.S. GDP growth of 2.4%, which is below the 1980-2011 growth of 2.6%; and

- a growth expectation risk focused dependent on GDP and environmental rationalizations. That is; lower GDP tends to take focus off environmental overlays, while spurts in GDP exceeding expectations often lead to renewed focus on environmental intervention.

Figure 5
Natural gas price variations, historical and projected



Source: Wood Mackenzie, Spring 2012

AGA sees that a fundamental shift in the natural gas marketplace has taken place. For now and the foreseeable future, natural gas supply will be able to satisfy and meet even aggressive natural gas demand estimates affordably and reliably.

Of course, one issue with comparing the actual prices to the forecasted range is that the forward-looking price projections do not account for unforeseen constraints on the gas market that caused previous price spikes. Certainly, the possibility of regionalized, short-term spikes in prices is in play. Underlying this possibility is a more robust supply portfolio and shifts in production, however. For example, less natural gas is being produced offshore, which is susceptible to weather-related events like hurricanes, therefore these events will have proportionally less impact on domestic natural gas production in the future. What the stronger supply position and changing dynamics of production portend is a mitigation of these spike events compared with history.

The most straight forward way to define the future of U.S. natural gas supply is to acknowledge that domestic natural gas demand growth during 2012-2022 is needed to establish price levels that elicit a

production response from gas producers. In short (and in time) many of the identified shale gas resource plays and more traditional production models become economically available to the market at a development cost of \$5-6 per MMBtu. This is precisely the foundation that accounts for an *additional* 11 to 34 percent increase in domestic natural gas production during the next ten years.

To conclude, the American Gas Association (AGA) envisions that natural gas as a foundation fuel is poised to provide:

- an **affordable**, relatively **stable**-energy resource, that delivers value to all customer, as well as a viable solution for helping to achieve the environmental objectives of our country;
- a vision that includes capitalizing on stable market influences in each demand sector;
- a catalyst for job growth in the U.S. economy, an improved international trade balance;
- an efficient and optimized energy profile for the country as a whole; and
- critical contributions to increased national security.

This vision has implications on the future opportunities and challenges for natural gas. But to properly capitalize on the opportunities, and to sufficiently address the challenges, requires a realistic view of the critical elements shaped by science and facts. The supply and demand fundamentals explored in this report are a large part of this puzzle. But just as important are the regulatory frameworks under which natural gas is produced and consumed, and recognition of natural gas as a component of a larger, all-of-the-above approach to energy policy and environmental concerns going into the next decade and beyond.