IHS CERA

Fueling the Future with Natural Gas:

Bringing It Home

Executive Summary

January 2014 ihs.com

Executive Summary

In Brief

- Unconventional technologies have dramatically altered the outlook for US natural gas over the past five years. Once considered to be in imminent danger of depletion, the US natural gas resource base is now widely agreed to be sufficient to last 100 years at current rates of consumption. Costs have also fallen, and the natural gas price is expected to grow very slowly over the next 20 years, remaining much lower than prices for many other fuels.
- The new outlook for natural gas cost and availability has created new possibilities for making progress toward national goals of energy efficiency, cost efficiency, environmental protection, and energy security. It is also contributing jobs and revenues to the economy at the national, state, and local levels.
- Gas local distribution companies (LDCs) face both opportunities and challenges in helping their communities take advantage of newly abundant supplies of natural gas. Specific opportunities will vary from one region to another and may require regulatory change, policy support, financial and technological innovation to be fully realized.
- Much prevailing natural gas regulation was developed in a time of perceived scarcity and should be reviewed to identify areas that may no longer be appropriate for today's and tomorrow's gas markets.
- State governments, PUCs, and gas LDCs should consider how natural gas can help improve total energy efficiency, reduce emissions and lower costs, using full fuel-cycle analysis for a more accurate assessment and comparison of various fuels and technologies.

It is called a revolution for a reason. In the span of less than five years, unconventional technologies for natural gas development have changed the outlook for US natural gas supply from scarcity to abundance, from high cost to moderate cost, from import dependence to self-sufficiency. Turning this revolution to best advantage requires both vision and understanding on the part of gas local distribution companies, their customers and regulators. Business models, fuel choices, regulation, and energy policy must be re-evaluated in light of the new opportunities presented by the unconventional natural gas revolution.

These opportunities are both immediate and far-reaching, as evidenced by the current natural gas surplus and the new understanding that the domestic natural gas resource base will be sufficient for domestic needs for many decades. A visionary response to these opportunities must therefore encompass both the near- and long-term perspectives. This report begins that process by evaluating the opportunities to leverage customer-based knowledge, critical infrastructure, regulatory and policy relationships, and the extraordinary natural gas resource availability to realize the benefits of natural gas for gas LDC customers and the nation as a whole:

- Technology, efficient applications and economic opportunity have dramatically altered the outlook for domestic natural gas for decades to come. Once considered in imminent danger of depletion, the US natural gas resource base is now widely accepted to be robust and recoverable at a lower cost than could have been imagined even five years ago.
- Extensive volumes of natural gas can be economically developed in the United States with prices of less than $4-5 per million British thermal units (MMBtu), making supply responses to demand increases highly elastic. Domestic and international oil prices are expected to remain three to four times higher than the British thermal units (Btu) equivalent price of natural gas for many years into the future. Also new high-efficiency natural gas technologies and a widening gap between retail prices of electricity and natural gas in many US regions give natural gas the competitive edge for many residential and commercial applications.
- This reality opens many doors for efficient use of natural gas resources and infrastructure in critical areas of the US economy and quality of life, including cleaner electricity generation and direct use in businesses, homes, transportation and manufacturing.
- Increased use of natural gas in the national energy economy will help achieve national goals of energy efficiency, environmental protection and energy security.
- Unconventional oil and gas activity and energy-related chemical manufacturing, directly or indirectly, are expected to contribute 3.9 million jobs, $533 billion (constant 2012 $) in value added to gross domestic product (GDP), and $138 billion (constant 2012 $) in government revenues by 2025.
- Growing natural gas use in the United States is not just about using more. The efficient use of natural gas and other forms of energy should continue to be a policy imperative. Cost-effectively increasing overall energy efficiency throughout the economy will require that energy policy, regulation, and consumer fuel choice be grounded in a full fuel-cycle analysis of energy requirements and costs. In many cases, increased use of natural gas to displace less efficient sources of energy may improve the overall energy efficiency of the economy.
- For many decades natural gas regulation was based on assumptions of resource scarcity. These regulations need to be re-evaluated in light of new realities. An opportunity now exists to redefine business models, regulatory policies, financial outreach and technology innovation from a position of strong supply and expectations of long-term market price stability.
- Significant regional diversity across US energy markets precludes a “one-size-fits-all” approach to energy policy, regulation, and business models. Opportunities to increase natural gas’ market share will vary by region and by state.
- Bringing the benefits of natural gas to new markets will require investment by gas LDCs and their customers. In some cases, significant up front costs may be required in order to realize fuel cost savings over many years into the future. New policies and regulations may be required to assure that gas LDCs recover their prudent investment costs and that high up front costs do not deter consumers from making prudent fuel choices.

Introduction

Recent advances in the technology of natural gas extraction have opened up new opportunities across the American economy. Technologies for producing natural gas from unconventional shale and tight sandstone formations have unlocked recoverable resources sufficient to last 100 years at current rates of consumption. Even the significant increase in demand that is expected over the next two decades can be supplied from low-cost resources without requiring a significant price increase, as these technologies have also lowered the cost of natural gas. IHS CERA estimates that about 900 trillion cubic feet (Tcf) of unconventional gas resources—more than one-third of the total recoverable resource base—can be produced economically at a Henry Hub price of $4 per thousand cubic feet (Mcf) or less in constant 2012 dollars.[1] As a result, we expect natural gas prices to remain in the $4-5 per MMBtu (constant 2012 $) on an annual average over the long-term, albeit with some short-term cyclicality.[2]

What does unconventional mean?

“Unconventional” oil and natural gas is exactly the same commodity as “conventional” oil and natural gas. The word “unconventional” is typically applied to major new advances in extraction technology in the oil and natural gas industry that allow access to resources not previously technically or economically recoverable. In recent years, “unconventionals” have included oil sands, extra-heavy oil extraction technologies and deepwater drilling technologies. In this report, we focus on unconventional natural gas that is produced from low-permeability source rock using a combination of horizontal drilling, which exposes more of the subsurface to the well, and hydraulic fracturing that creates pathways that allow the oil and natural gas to flow through the dense rock into that wellbore.

The new outlook for natural gas supply and price represents a sea change from the expectations of just a few years ago when North American natural gas was viewed as a scarce resource, heading for depletion, with ever-increasing prices required to maintain production or even to attract imports. As recently as 2008, the United States was expected to become a major importer of liquefied natural gas (LNG) by 2015, at prices linked in international markets to oil.[3]

The new opportunities resulting from the unconventional natural gas revolution have taken time to assess, and initially, large-scale investments faced hesitation and even skepticism that the new resource would prove durable. Skepticism has been replaced by confidence, as reflected in the commitments being made across the US economy. Industries are responding with multi-billion dollar investments in chemical, steel, and other gas-intensive processes. Power generators are planning more investments into gas-fired power plants as they phase out some coal capacity, while also integrating new renewable capacity into the generation fleet. Transportation companies are adding compressed natural gas (CNG) and LNG automobiles, vans, and trucks to their fleets, and considering the use of LNG in locomotives, barges, and ships. Proposals to liquefy and export US natural gas are moving through the permitting process and one

[1] For purposes of this report, 1 Mcf is assumed equivalent to 1 million British thermal units (MMBtu).

[2] Note that prices are projected to be somewhat higher than the lowest cost gas resources available, as higher cost resources are always a part of a supply mix owing to practical considerations such as producers’ acreage positions, adequacy of the service industry in new areas, infrastructure, market, and financial constraints.

[3] US Energy Information Administration’s *Annual Energy Outlook 2008* projected gross LNG imports of 5.8 Bcf per day in 2015. *Annual Energy Outlook 2013* projects gross LNG imports of 0.5 Bcf per day in 2015.

facility is under construction. Policy makers are incorporating natural gas into efforts to move the US energy mix in a less greenhouse gas (GHG)-intensive direction.

Gas LDCs as well are in the process of re-evaluating their opportunities to serve existing customers and to expand service to new customers in ways that make sense economically and that can be developed under the umbrella of state and local regulation. Much of the prevailing natural gas regulation was developed in a time of perceived scarcity. Thus, it may be reasonable to review regulations and identify hindrances to natural gas use that may no longer be appropriate for today's and tomorrow's natural gas markets.

There has already been a positive response to the new natural gas outlook in residential and commercial markets. Conversions from oil heat to natural gas heat have accelerated, particularly in the Northeast, in response to both cost considerations and government initiatives. For example, New York City is in the midst of a large-scale conversion from fuel oil use to natural gas use. In Maine, gas LDCs are expanding their systems to deliver natural gas into sparsely populated areas serving paper mills and, with the industrial demand providing a base level of support for the infrastructure, are also connecting residential and commercial customers along the way. New pipelines and other infrastructure projects are being constructed to eliminate pipeline bottlenecks and deliver natural gas from new supply basins into growing market areas.

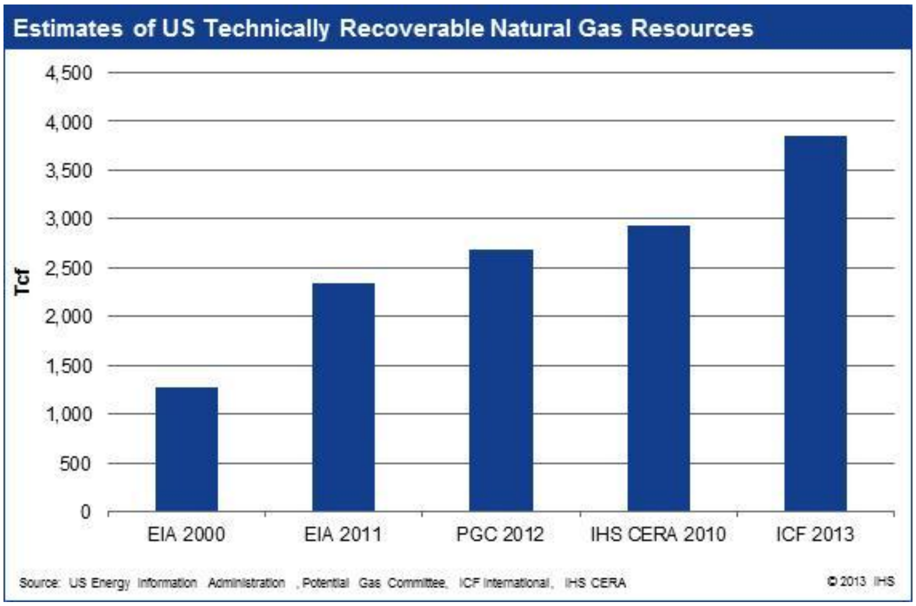
Gas LDCs face both opportunities and challenges in helping their communities take advantage of newly abundant supplies of natural gas. Natural gas provides opportunities to increase the overall efficiency of energy use, to reduce air emissions, to reduce energy costs, and to promote local economic development. Challenges include recovering the often high up front costs of investments by gas LDCs and consumers, conflicting federal, state, and local policy objectives, regulations grounded in outdated assumptions regarding natural gas supply and cost, and developing a consensus as to the new realities of the natural gas market. Specific opportunities will vary from one region to another and may require regulatory change, policy support, and financial and technological innovation to be fully realized. Similarly, challenges to achieving these goals may vary regionally and may require regulatory, policy, financial, or technological measures if they are to be overcome.

This study is intended to serve as a resource for gas LDCs, their customers, regulators, legislators and other policy makers, industry, and the general public to use in adjusting to the new realities of the natural gas market. It describes the unconventional natural gas revolution (also known as the "Shale Gale") and how it has upended long-held notions of natural gas supply and cost. It discusses the actual and potential contributions of natural gas to certain national goals such as energy efficiency, environmental benefits, economic growth and energy security. The study evaluates the potential benefits of natural gas use in the residential and commercial sectors that constitute the core markets for gas LDCs. It identifies factors that encourage as well as inhibit greater use of natural gas, with a particular emphasis on gas LDC systems and their core residential and commercial markets. It also describes how natural gas use in the power sector, the industrial sector, and even the transportation sector is evolving and how gas LDCs may be able to participate in such market growth.

The unconventional natural gas revolution

Over the past five years, it has become evident that unconventional technologies have made a vast new natural gas resource accessible to development. In recent years, estimates of the technically recoverable resource base have ranged from 2,300–3,800 Tcf, enough to supply current consumption for 88–154 years (see Figure ES.1).[4]

FIGURE ES.1



Unconventional natural gas production, driven by shale gas resources, has increased rapidly. Total shale gas production in 2000 was only 1 billion cubic feet (Bcf) per day, roughly 2% of total US lower-48 production (see Figure ES.2). By 2012, shale gas accounted for 39% of US lower-48 production and IHS CERA expects that it will account for 58% of total productive capacity by 2035. Unconventional gas from all sources (shale, tight sands, coal bed methane, and associated gas from unconventional oil plays) is expected to provide 90% of total natural gas productive capacity by 2035 (see Figure ES.3).[5]

[4] ICF resource estimate from testimony of Harry Vidas before the Subcommittee of Energy & Power of the US House of Representatives Committee on Energy and Commerce, February 5, 2013.

[5] Productive capacity is the volume of gas that could be produced without infrastructure or market constraints.

FIGURE ES.2

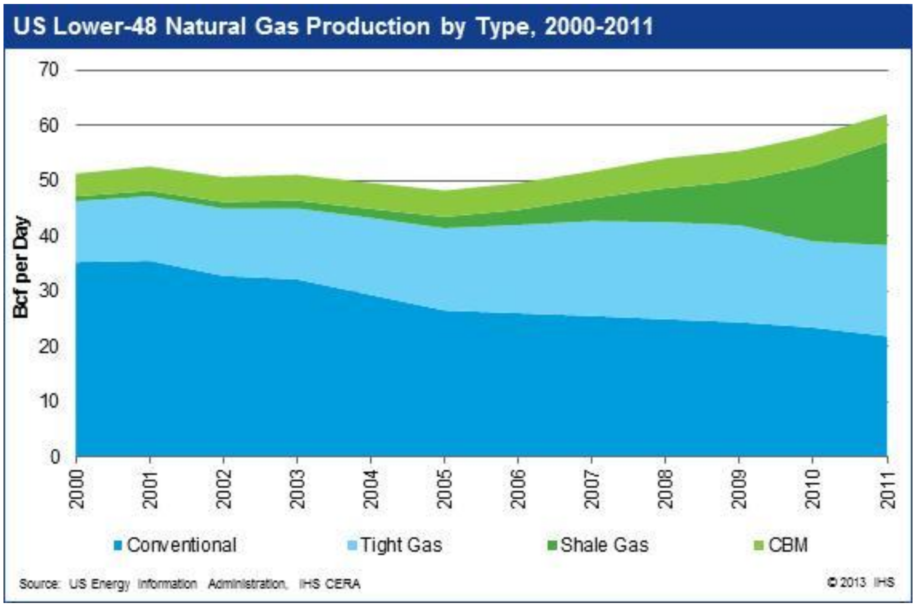
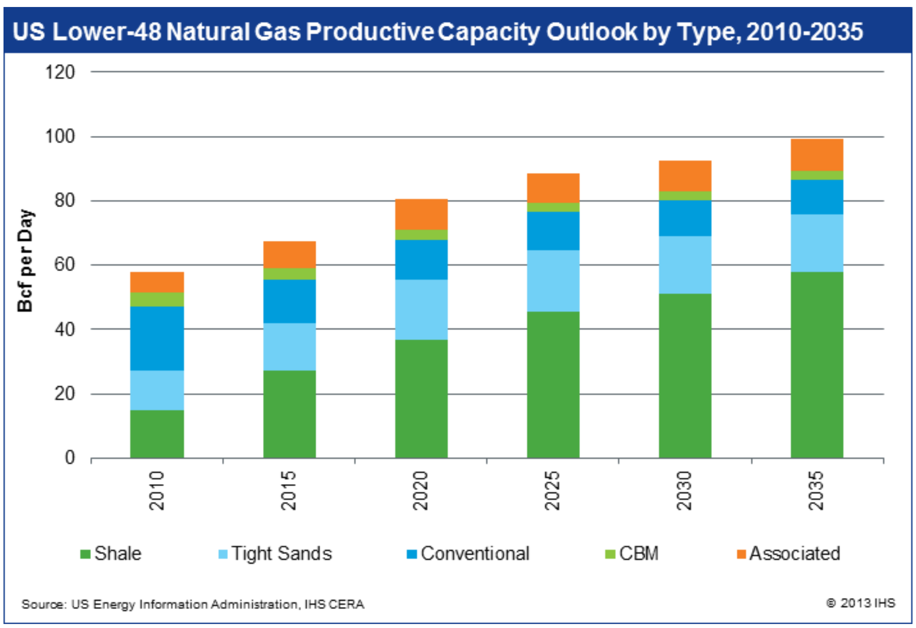


FIGURE ES.3



Lower long-term costs

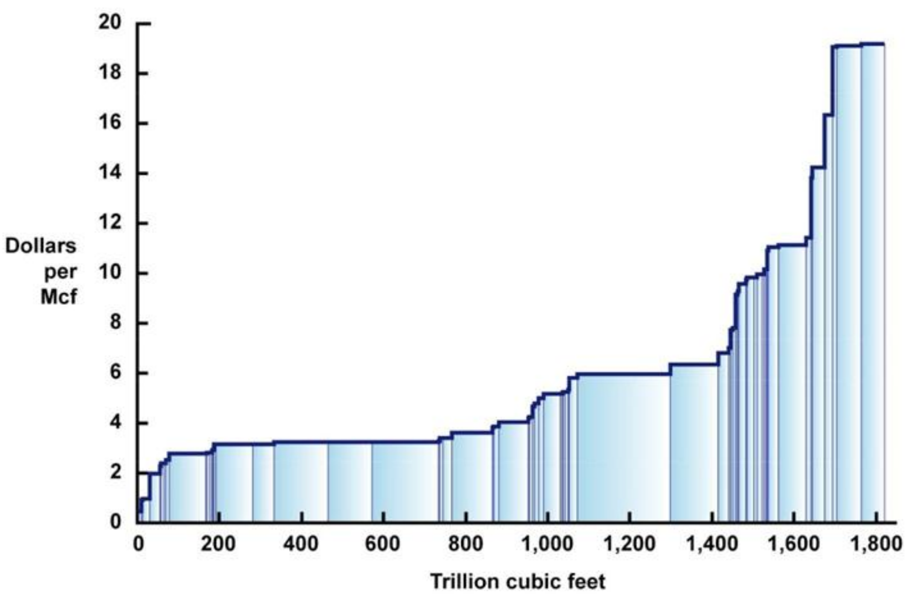
Unconventional technology is also steadily improving gas production economics. Because unconventional production techniques such as horizontal drilling and hydraulic fracturing allow greater access to the reservoir, the productivity of unconventional gas wells is much higher on average than that of conventional gas wells. As a result, although a typical unconventional gas well can cost more to drill and complete than a conventional well, the cost per unit of gas produced is usually much lower for unconventional wells than for the large majority of conventional wells—as much as 50% lower for wells drilled in 2011.

In its study *Fueling North America's Energy Future*, IHS CERA estimated that approximately 900 Tcf of the North American unconventional gas resource base from the 17 plays evaluated in that study (including two shale plays in Canada) could be produced economically if Henry Hub prices were $4 per Mcf or less (see Figure ES.4). Costs can be even lower in plays with high proportions of valuable natural gas liquids and in oil wells that produce associated gas, as revenues from the sale of liquids offset some or even all of the costs of drilling and completing the wells.

Because so much unconventional gas resource is now available at a cost in the $4 per Mcf range, the supply curve for natural gas has become highly elastic. In other words, the US natural gas resource base can now accommodate significant increases in demand without requiring a significantly higher price to elicit new supply. Other recent estimates of the gas resource base are even larger than IHS CERA's which reinforces our outlook as conservative.

FIGURE ES.4

Full Cycle Breakeven Price for 17 Unconventional Gas Plays in North America



Source: IHS CERA.
Note: Includes proved, probable, and possible resources.
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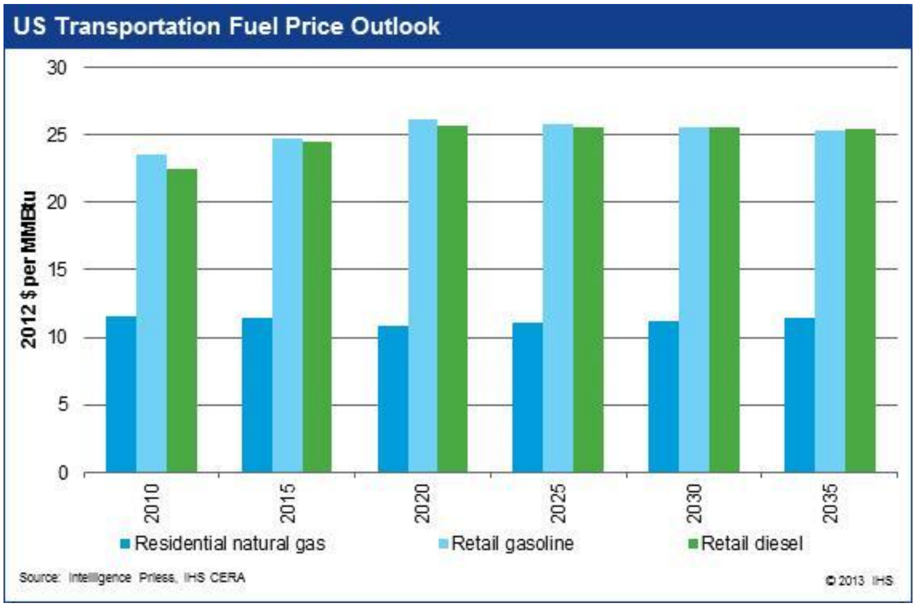
The natural gas price advantage

With a long-term elastic supply curve allowing new demand to be met for many years from supplies costing about $4 per Mcf, IHS CERA expects the Henry Hub price of natural gas to remain in the $4-5 per MMBtu range (constant 2012 $) on an annual average through 2035. (Projected prices are somewhat higher than the lowest cost resources as higher cost resources are always a part of the gas supply mix.)

In contrast, the price of crude oil is projected to remain around $90 per barrel (constant 2012 $), or almost $16 per MMBtu, over this period. This implies that oil prices, in Btu terms, will be three to four times higher than natural gas prices for decades to come.[6] This oil/gas price relationship will extend to the retail level. IHS CERA expects that residential natural gas prices (which include the cost of gas plus the costs of transmission and distribution) will remain below $11 per MMBtu (constant 2012 $) on average for 2012-2035. The projected retail costs of gasoline and diesel fuel will be approximately twice the natural gas price on a Btu-equivalent basis (see Figure ES.5). Such a sustained price differential will help to increase the attractiveness of natural gas as a transportation fuel.

FIGURE ES.5



Similarly, delivered prices for home heating oil (a fuel chemically similar to diesel) are expected to be more than twice as high as rates for residential natural gas service, encouraging the ongoing process of replacing fuel oil with natural gas for home heating. Residential electricity rates are also expected to increase in the future, reflecting the costs of investments in generation and electric transmission/distribution, as well as policy-driven investments in pollution controls, energy efficiency and renewable power. On a Btu-equivalent basis, residential electricity rates are expected to average 3.5 times as expensive as residential natural gas rates on a national average (see Figure ES.6). Similar trends are expected for energy prices in the commercial sector.

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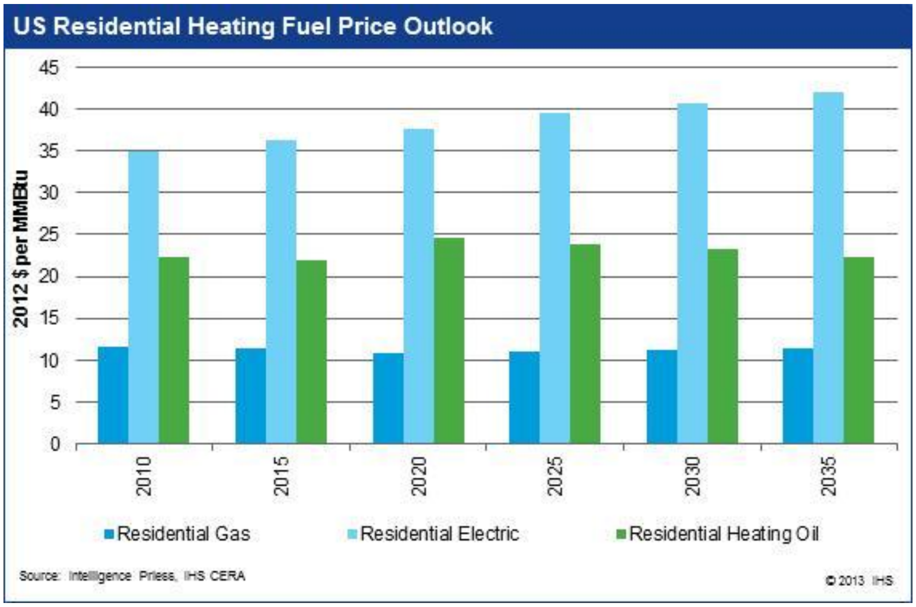
[6] This stands in sharp contrast to the recent past. From 2000-2008, oil prices were never more than twice the natural gas price (on a Btu-equivalent basis); in 2003 the oil price was roughly equal to the natural gas price.

FIGURE ES.6



Natural gas costs and prices in perspective

With so much natural gas supply expected to be cost-effective to produce at Henry Hub prices of about $4 per MMBtu, the new outlook for natural gas is said to be one of abundance and low cost. In this context, "low cost" does not suggest that natural gas will cost less than all other fuels—the price of coal is expected to remain significantly below that of natural gas on an energy-equivalent basis.[7] Nor does it indicate that natural gas costs and prices will be lower than they have ever been--historically natural gas wellhead prices have remained below $4 per MMBtu (in constant 2012 $) except for two periods: 1981-1985 and 2000-2008. Nor does it mean that volatility has been eliminated—daily, monthly, and seasonal volatility will continue to reflect unexpected events and temporary misalignment of physical demand and supply, often caused by variations in weather.

Rather, "low cost" natural gas in the context of the unconventional natural gas revolution indicates that:

- Natural gas prices will not have to increase materially to elicit additional supplies, owing to the extensive resource base that is available at a full-cycle breakeven price of about $4 per Mcf;
- Natural gas prices will remain significantly lower than had been expected prior to the Shale Gale;
- Retail natural gas prices are expected to remain lower over the long-term, on a Btu-equivalent basis, than refined oil products or electricity.

[7] From early 2009 through mid-2013, the dispatch costs of many gas generation units have been lower than those of many coal generation units even though natural gas prices have been higher than coal prices on a Btu-equivalent basis at times; the price disadvantage has been more than offset by gas generation's efficiency (or heat rate) advantage.

Natural gas and national energy objectives: security, economic growth, environment, efficiency

US energy policy has traditionally focused on several objectives. These include price moderation, energy efficiency, cost efficiency, environmental protection, and energy security. The new outlook for natural gas cost and availability has created new possibilities for progressing toward these goals. In addition, the development and extraction of unconventional natural gas and oil is contributing jobs and revenues to the economy.

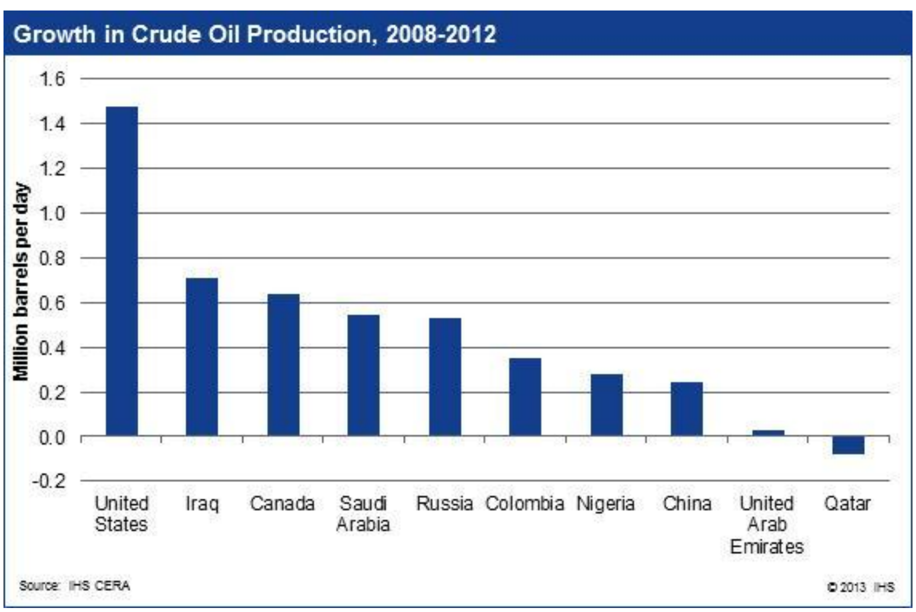
Improving energy security

The United States is essentially self-sufficient in natural gas, producing 92% of its total supply and importing the rest from Canada. Before the Shale Gale, increasing dependence on LNG imports had been envisioned. Instead, the United States is poised to become a natural gas exporter via LNG within several years.

Moreover, the transfer of unconventional natural gas technology to oil plays has unlocked a new crude oil resource base that had previously been uneconomic. Since 2008, the United States has led the world in the growth of new supplies of crude oil (see Figure ES.7). Production of unconventional “tight” oil has increased from 100,000 barrels per day in 2003 to an estimated 2 million barrels per day (mbd) in 2012. This provided a noticeable proportion of the total supply of petroleum in the United States, which was 18.5 mbd in 2012. Because of the growth in domestic production, net US oil imports have declined to only one-third of total demand, down from 60% in 2005.

By the end of this decade, tight oil production is expected to reach nearly 4.5 mbd, representing nearly two-thirds of domestic crude oil and condensate production. Such growth will continue to reduce US oil imports in the years ahead. The rapid increase in tight oil production has also led to a substantial increase in natural gas that is associated with the primary oil production.

FIGURE ES.7



Contributing to economic growth

The growth in US oil and natural gas production is fueled by capital spending on exploration and development, which exceeded $87 billion in 2012. Since the majority of the technology, tools, and know-how are home grown, an overwhelming majority of every dollar spent through this supply chain remains in the United States and supports domestic jobs. Extensive supply chains—across many states, including states that do not directly produce unconventional oil and natural gas—reach into multiple facets of the American economy.

As the production of unconventional oil and natural gas expands over the next 25 years, the industry's economic contribution will also expand. IHS CERA projects that upstream capital expenditures will average some $200 billion (nominal $) per year during 2012-2035 for a total expenditure of more than $5 trillion over this period.[8] Unconventional oil and gas activity and energy-related chemical manufacturing, directly or indirectly, were responsible also for 2.1 million jobs, nearly $284 billion in value added to GDP and more than $74 billion in government tax revenues in 2012. By 2025, these contributions are expected to grow to 3.9 million jobs, $533 billion (constant 2012 $) in value added to GDP, and $138 billion (constant 2012 $) in government revenues.

In addition to the significant industry contributions defined above, affordable and abundant natural gas has ushered in an era of substantially lower prices than they otherwise would have been without the unconventional revolution. These lower prices are currently providing a short term economic stimulus to disposable income, GDP and employment—a positive force during a period of continued economic uncertainty and slow growth. These other economic contributions are attributable to the unconventional energy revolution and include:

- Increases in real GDP ranging from 2.0% to 3.2% per year and translating into an increase in GDP of $500 - $600 billion.

- A total net trade improvement increasing steadily until a plateau of about $180 billion per year (constant 2012 $) is reached in the early 2020s, compared to a hypothetical US trade regime in which there is no unconventional oil and gas development.

- An increase in real disposable income per household of approximately $1,200 in 2012 will steadily increase to $2,000 (constant 2012 $) in 2015 and more than $3,500 (constant 2012 $) by 2025.[9]

Regarding the last point, household income increases as a result of: (1) lower costs for natural gas used for space and water heat, (2) lower costs of various consumer goods resulting from the lower cost of natural gas used in manufacturing and in electricity generation, and (3) higher wages as the manufacturing renaissance increases industrial activity.

[8] IHS Inc., *America's New Energy Future: The Unconventional Oil and Gas Revolution and the US Economy; Volume 1: National Economic Contributions, October 2012*.

[9] IHS Inc., *America's New Energy Future: The Unconventional Oil and Gas Revolution and the US Economy; Volume 3: A Manufacturing Renaissance, September 2013.*

Environmental considerations

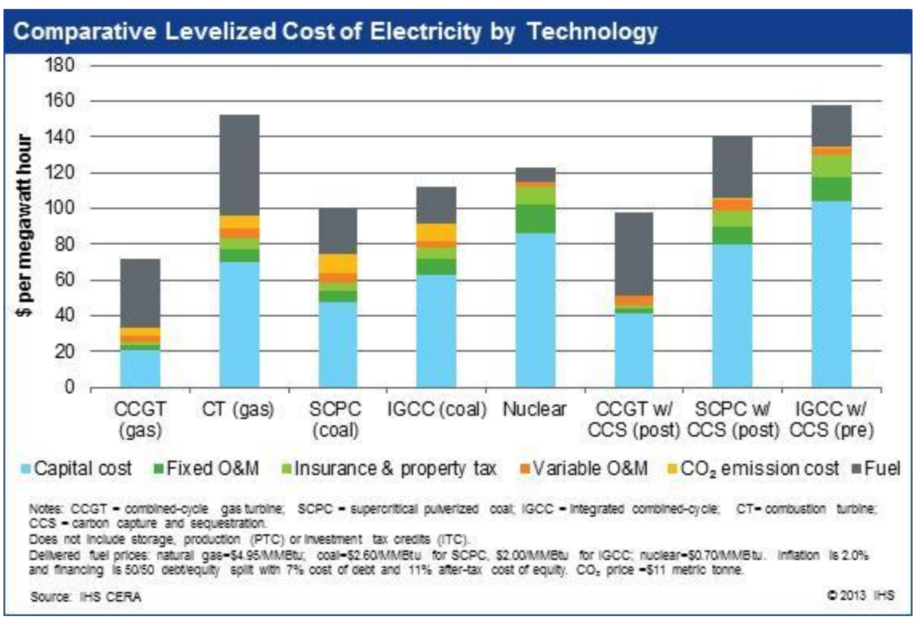
Two of the greatest attractions of natural gas from an environmental perspective are (1) that it results in the lowest carbon dioxide (CO_2) emissions of any fossil fuel and (2) efficiency increases when natural gas is used directly in homes and businesses in place of electric heat and hot water.

When used to generate electricity, natural gas emits as much as 50% less CO_2 than coal. In addition, natural gas use results in negligible emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x), mercury (Hg), and particulates compared with other fuels. Increasing the use of natural gas in place of other fossil fuels can therefore have both global benefits in terms of reduced GHG emissions and local benefits in terms of lower emissions of SO_2, NO_x, mercury, and particulates in the United States.

Already, substituting natural gas for coal in power generation is tempering the growth of US power sector CO_2 emissions. The decline in the spread between natural gas and coal prices that began in the spring of 2009 altered the competitive position of natural gas-fired power generators in many US markets, and caused a significant amount of coal generation to be displaced by lower-CO_2 emitting gas generation. In 2012, US power sector CO_2 emissions were the lowest that they have been since 1995, and 16% below emissions in 2005 (an often used baseline year).

Natural gas is not emissions-free. If natural gas is to be used to help manage atmospheric concentrations of GHGs, technologies must ultimately be developed to economically remove CO_2 from the natural gas combustion process. A variety of carbon capture and storage (CCS) technologies are under development for use with either coal-fired or natural gas-fired power generation, but significant challenges remain. CCS will make generation more costly, but gas with CCS is expected to be less costly than coal with CCS (see Figure ES.8).

FIGURE ES.8



Most forms of energy development—including natural gas, oil, wind, and solar—result in land disturbances, dust, noise, vehicle traffic, and water impacts; many of which are temporary. The process of natural gas development specifically involves site preparation, drilling, well completion, production, and the construction of infrastructure to connect new gas supplies to markets; all for which best practices should be applied. Also best practices for water use and the safe disposal of waste water are being addressed to help diminish concerns about hydraulic fracturing.

Natural gas does possess one potential disadvantage from an environmental perspective, however. Natural gas is about 95% methane; methane has about 28 times the global warming potential of CO_2 when it is emitted into the atmosphere rather than combusted.[10] Direct emissions of methane into the atmosphere—whether from upstream operations, leaks in the pipeline and distribution systems, or accidents anywhere within the natural gas system—have environmental consequences. Minimizing methane emissions from natural gas production, processing, transmission, and distribution is an important factor in realizing the climatic benefit of fuel switching from other fossils fuels to natural gas.

The precise level of methane emissions is unknown and efforts are underway to collect better data, particularly through direct measurement at well sites and other locations. As a remediation action, a US Environmental Protection Agency (EPA) regulation that takes effect on January 1, 2015 will require reduced methane emission completions on all wells drilled after that date. Such systems are already widely used throughout the United States and are mandated by several states.

A framework of regulation is emerging at the state level that seeks to mitigate safety and environmental concerns associated with well construction and completion practices. The incremental rules put into place over the past few years have not slowed growth in drilling and production, supporting the view that reasonable regulations are not likely to materially inhibit hydrocarbon supply in North America.[11]

Gas LDCs also have a role to play in reducing methane emissions. EPA data indicate that natural gas distribution activities account for about 16% of total GHG emissions from the natural gas sector. Programs designed to replace aging pipe, safety priorities, and the fundamental economics of serving customers dictate the gas LDC interest in improving this important environmental metric.

Energy efficiency and cost efficiency

Since the 1970s, increasing the efficiency of energy use has been a priority of national energy policy. Major gains have been achieved by appliance energy standards, stricter building codes and site energy efficiency programs. These programs all focus on improving energy efficiency at the point of consumption and were developed in era when natural gas was considered a scarce and expensive resource. For example, appliance energy efficiency labels report site energy efficiency (efficiency at the point of operation—electricity or gas input to the appliance versus useful energy produced by the appliance). The use of site energy efficiency is limiting in that it does not take into account energy necessary produce and deliver energy to a site. A more relevant measure is the "full fuel-cycle" efficiency or "primary energy" efficiency, which includes the energy required to produce and deliver gas or electricity to the appliance versus useful energy produced by the appliance.

Because natural gas uses the equivalent of about 8% of its energy to make the trip from wellhead to burner tip, a natural gas appliance will have a full fuel-cycle efficiency that is about 92% of its site efficiency. The loss is much greater for electricity. Although there is a wide variation across regions, on a national average in 2012 electric generation used 60% of its energy input to produce and deliver fuel to the power plant, to generate electricity, and to deliver it to end users. As a result, an electric appliance will have a full fuel-cycle efficiency that is only about 40% of its site efficiency.

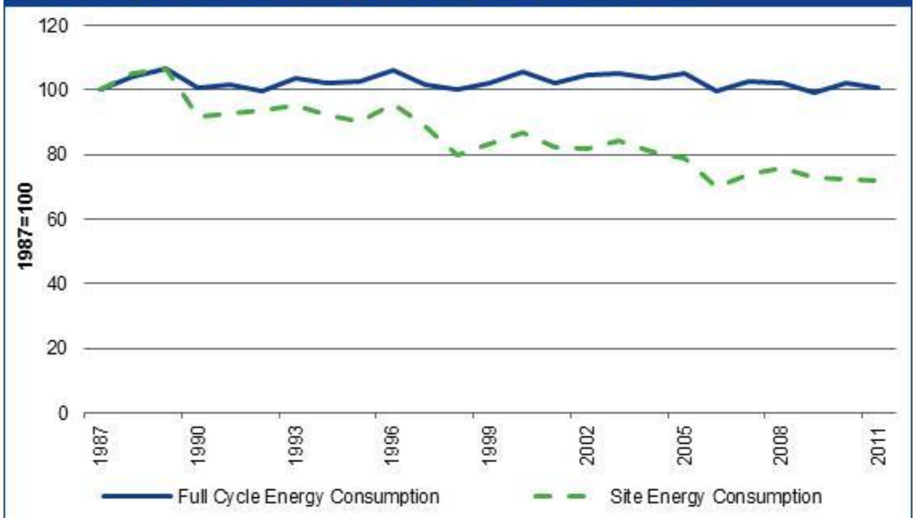
[10] The global warming potential (GWP) for a particular greenhouse gas is the ratio of heat trapped by one unit of mass of the greenhouse gas to that of one unit of mass of CO_2 over a specified time period, in this case 100 years. Methane also has a relatively short atmospheric lifetime of 12 years, meaning that its GWP is higher over shorter time frames than the 100 years typically used in climate analysis. *Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)*, Geneva, Switzerland, 2013.

[11] IHS Inc., *Prudent Oil and Gas Development and the Evolution of US Regulations,* April 2013.

The residential sector has achieved significant energy efficiency gains when site energy consumption per household is considered. Site energy consumption per household was 28% lower in 2011 than it had been in 1987 (see Figure ES.9). When the losses associated with generating electricity are taken into account, however, overall primary energy consumption per household in 2011 was almost identical to its level in 1987, illustrating the importance of evaluation using full fuel-cycle energy consumption.

FIGURE ES.9

Full Fuel-cycle and Site Energy Consumption per Household



Source: US Energy Information Administration, IHS CERA

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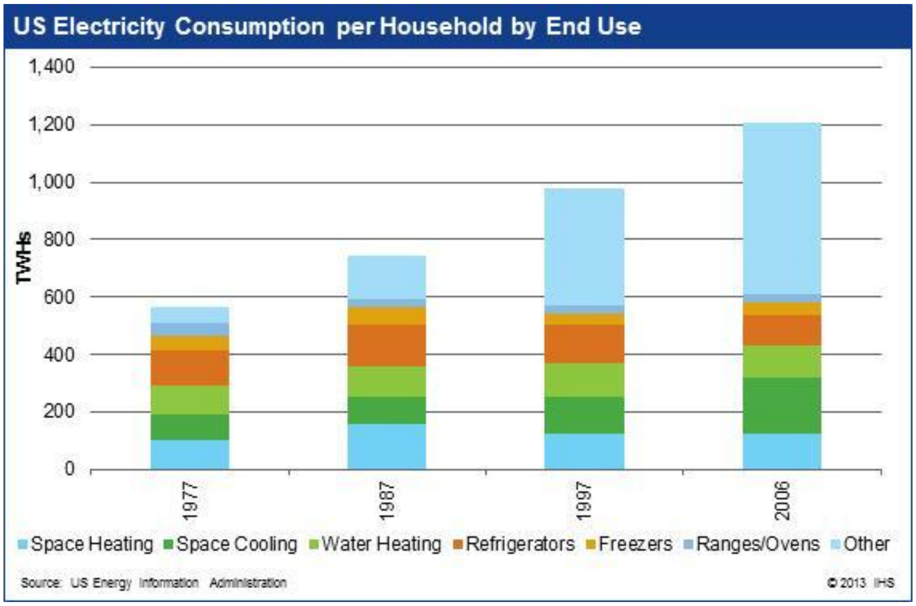
This result is due primarily to the increased share of electricity in total household fuel consumption. Although electricity consumption has declined for almost all applications that were available in 1977, owing to energy efficiency improvements for cooking, lighting, refrigeration, water heating, and space heating and cooling, total electricity consumption per household has grown significantly as other uses of electricity have been devised, such as computers, cell phones, and high-definition televisions (see Figure ES.10). EIA has remarked that “the number of [new] devices per household have offset efficiency gains in residential electricity use.”[12]

[12] US Energy Information Administration, Two perspectives on household electricity use, Today in Energy, March 6, 2013, http://www.eia.gov/todayinenergy/detail.cfm?id=10251&src=email.

FIGURE ES.10



Because of the energy losses incurred in the generation of electricity it may be possible to achieve significant energy efficiency gains and GHG emissions reductions by substituting natural gas consumption for electricity consumption for uses—such as space heat, water heat, or cooking—that can be served by either energy form.

But energy efficiency does not necessarily equate to cost efficiency, which depends not only on the energy efficiency of the appliance but also on fuel costs and capital costs. With the prospect that natural gas prices will be significantly lower than electricity prices in many regions over the long-term, the life-cycle cost of natural gas appliances can be lower than that of their electric counterparts. However, the up front capital and installation costs of natural gas appliances may be higher than that of electric appliances. The natural gas advantage is realized over time as lower fuel costs gradually overcome the higher initial costs, but payback periods may be longer than consumers are willing to accept. Cost-reducing technologies and financial incentives or other measures that help reduce payback times may be required if natural gas is to gain market share.

State governments and PUCs should consider adopting policies that are underpinned by full fuel-cycle energy efficiency analyses, full fuel-cycle emissions analyses, and life cycle cost analyses. Such analyses may in many instances be supportive of expanding natural gas use by existing customers and extending natural gas service to new customers.

Growth of LDC systems and natural gas markets

The US natural gas distribution system is one of the foundations of the American economy and life. It serves more than 65 million households, more than five million commercial customers, and over 190,000 industrial and power generation customers. Almost all residential and commercial gas users rely on gas LDCs for their gas purchases and/or deliveries. Perhaps surprisingly, 95% of all industrial gas customers and nearly 70% of all power generation customers also depend on gas LDCs for their gas deliveries, although in terms of volumes only about half of the gas used in the industrial sector and only about onequarter of gas used for power generation go through a gas LDC system. Very large gas-using industrial and power facilities are often not served by gas LDCs, but instead are directly connected to wholesale pipelines.

Gas LDCs are a diverse group. There are over 1,200 gas LDCs in the United States that are investor-owned, municipally-owned or owned by co-operatives. Gas LDCs range from very small to very large in terms of number of customers, throughput and geographic area served. Climate conditions of markets served also vary significantly. Market characteristics, operating parameters, rates, and tariffs are diverse. Some LDCs own wholesale gas storage facilities and high pressure gas pipelines. This structural diversity makes it difficult to generalize about gas LDCs.

Gas LDC services, rates and facilities are regulated by 49 PUCs or by their municipal or co-operative owners. Some PUCs have appointed commissioners, while some have elected commissioners, but all are subject to political and ratepayer pressures. The policy objectives of PUCs are usually set by legislation and those policy objectives vary across states and time.

Now that unconventional gas development has eased long-standing concerns about the adequacy and cost of natural gas supplies, many of these PUCs may choose to encourage gas consumption or remove policies that discourage gas consumption within their states.

Growth from the gas LDC perspective

Gas LDCs primarily grow revenues and earnings by increasing the rate base on which they are allowed to earn a return. In addition, gas LDCs have the ability to grow earnings between rate cases by adding customers and/or throughput that exceeds the amount considered in the development of existing rates. An individual gas LDC's strategy for growth will be heavily influenced by its rate structure, tariffs, PUC policies, and state laws.

Gas LDC rates are set by regulators at a level intended to recover their costs of distribution, including a "just and reasonable" rate of return on invested capital (or rate base). Gas LDCs are not allowed to mark up the cost of the gas that they deliver through their system—and in some cases the gas itself has been purchased by the customer from a third-party.[13] Most gas LDCs have two-part rate structures that allocate costs to a fixed monthly customer charge and a volumetric or usage charge. The usage charge includes the cost of the gas and the variable costs that the gas LDC incurs in delivering the gas to the customer. The LDC's fixed costs are usually split between the customer charge and the usage charge in proportions that differ from one gas LDC to another.

Generally speaking, a gas LDC with a high proportion of its fixed costs in the usage charge will recover more of its costs if it delivers more gas to consumers and risks under-recovering its costs when deliveries decline. For such gas LDCs, increasing deliveries to existing customers—such as customers with gas water heaters who choose to replace an oil furnace with a natural gas furnace—would add to the volume of gas delivered by the gas LDC, but it would not necessarily add to the gas LDC's rate base unless new facilities were required to serve the higher load. Gas LDCs whose fixed costs and rate of return are partly allocated to the commodity charge will see higher fixed cost recovery and earnings from delivering greater volumes of gas to existing customers. These benefits are likely to be temporary if in the gas LDC's next rate proceeding throughput units for rate design purposes include the incremental volumes.

[13] According to the US Energy Information Administration, for 2012 LDCs supplied 96%, 65%, and 17% of the gas delivered to residential, commercial and industrial customers, respectively. The balance of the gas was supplied by third parties.

For gas LDCs to increase their rate base, and thereby increase profits, they must add new customers and/or expand their system into new service areas. Rate base and gas LDC earnings can also be increased if the gas LDCs have to invest in new or replacement facilities to maintain operational integrity and reliability, but such investments could increase customer rates unless the customer base also grows.

Gas LDCs whose rates are subject to decoupling adjustments are largely indifferent in the short run to the volumes delivered on their system, but they too stand to benefit from system expansions. However, in the long run, the gas LDC value proposition with the customer should be favorably impacted by increasing the number of natural gas applications used in the home or building and how those applications meet the needs of the customer.

Opportunities in core gas LDC markets

A clear opportunity exists to expand natural gas service to more residential and commercial customers who constitute the core markets for gas LDCs. The possibilities include:

- A near-term and on-going opportunity to displace heating oil in the Northeast
- An opportunity to increase gas market share in space heating and other uses, taking advantage of a growing divergence between gas and electricity prices and a greater full fuel-cycle efficiency of some gas appliances in some regions
- An opportunity to work within gas LDC service areas to use natural gas to promote economic development, attract industrial, power, or large commercial gas-using facilities to serve as anchor tenants around which a gas distribution system can be extended to smaller residential and commercial customers in the area
- Over a longer time frame, developing and improving natural gas technologies, including lower-cost high-efficiency appliances, natural gas heat pumps, small-scale generation, cogeneration applications, and fueling facilities for natural gas vehicles, whether commercial or home-based

Ideally, gas LDCs may be able to expand their networks to serve a variety of customers, balancing complementary load profiles and optimizing distribution costs across the customer base.

Growth in other sectors

The 5% of industrial gas users that were not connected to gas LDC systems used almost half of industrial gas volumes in 2011, and the 31% of power sector customers that were not served by gas LDCs accounted for nearly three-quarters of power sector gas consumption. Nevertheless, prospects exist for higher gas demand from these sectors and expansions of gas LDC systems may be required to facilitate their growth. Gas-using industrial and power facilities can also serve as anchor tenants for gas LDC system expansions and as engines for local economic development. Natural gas is also poised to increase its share of a heretofore minuscule market—transportation. Gas LDCs may play a role in building and supplying residential and commercial refueling stations.

Industrial sector

Natural gas use in the industrial sector is accelerating as many gas-intensive industries are expanding their US operations in response to the new availability of low-cost natural gas and natural gas liquids. Such expansion is particularly evident in the petrochemical industry, which is investing billions of dollars in reviving mothballed facilities, relocating plants from overseas, or expanding domestic operations. Other industries are also participating in the revival, including iron and steel. Gas LDCs can play an important role in local economic development efforts by helping to attract industries into their market areas. This would not only contribute to the local economy in terms of jobs and tax revenues from industrial expansion but could also help to optimize the development of the LDC system by spreading costs across a broader customer base to the extent that the gas LDCs participate in delivering the incremental industrial demand.

Power sector

The largest projected growth in gas demand will occur in the power sector as gas generation fills the gap left by retiring coal units and also serves new electric load. Only about 25% of the gas volumes delivered to power plants go through gas LDCs suggesting that these are small volume users. Therefore, there is the potential for gas LDCs to increase their throughput and possibly add new power sector customers. In addition, some gas LDCs may be uniquely suited to offer services to power companies, such as storage, balancing, or real-time fuel deliveries as these companies increase their use of natural gas. Rate structures may have to be modified to encourage gas LDC diversification into such services. Also new power plants might also serve as anchor tenants for expanding a gas LDC system.

Combined heat and power (CHP)

When a power generation unit is combined with a heat recovery system, it becomes a CHP plant, producing electricity and heat from a single source at the site of use. Natural gas is the fuel of choice for existing CHP plants, with 71% of capacity consuming 3.4 Bcf per day of gas.

One of the biggest advantages of CHP includes the higher electrical efficiency that comes first from the cogeneration of heat and power on-site and second from the avoidance of the losses associated with the transmission and distribution of moving power from a central generating unit to an end user site. For this reason, a number of states allow CHP to be counted in their Renewable Portfolio Standards. However, high costs (equipment, installation and maintenance costs) and the need for constant thermal loads are the two most significant barriers to more widespread acceptance of medium- and small-scale CHP in the United States.

For CHP to grow, regulatory and policy changes are likely to be necessary, particularly at the state level. Some, but not all, states include gas CHP in energy efficiency and renewable portfolio standard programs. It is important for all policy makers to recognize that they may be biasing outcomes against gas-fired CHP and in favor of renewables or other technologies, perhaps in an unintended manner. Attempting to include quantification of the benefits from intangible items into the return on investment metric may also help push the odds toward an outcome that favors CHP if concepts such as independence from the grid, greenhouse gas reductions, petroleum displacement, economic development, or energy efficiency are purposely included. New business models are likely to be required that better align the interests of customers, regulators, energy suppliers, and manufacturers of CHP technology.

Transportation sector

In the transportation sector, the long-term prospects for a sustained disconnect between natural gas and oil prices (as illustrated in Figure ES.5) provide an opportunity for natural gas to progress from a niche fuel to key contributor. Mature technologies exist for natural gas use in light-duty, medium-duty, and heavy-duty vehicles—both as CNG and LNG. Although up front costs are higher for natural gas vehicles (NGVs) than for conventional vehicles, fuel savings over the life of the vehicle can pay back the higher capital costs over a period of years, depending on how much the vehicle is used. Payback periods are much shorter for heavy-duty trucks than for personal automobiles owing to the much higher vehicle miles traveled by the trucks. Natural gas-fueled personal automobiles will also have to compete not only with gasoline-fueled automobiles, but also with vehicles propelled by much more efficient electric motors.

However, NGVs have decided advantages in terms of fuel costs and tailpipe emissions compared to a gasoline-powered automobile, which has 17% higher emissions than a comparable NGV on a well-to-wheels basis.

The market potential for NGVs is quite large. All of the light-, medium-, and heavy-duty vehicles on the road today used the energy-equivalent of more than 55 Bcf per day of natural gas, primarily in the form of gasoline or diesel fuel. However, the actual market penetration of natural gas into the transportation market is very small at present. Of the 230 million light-duty vehicles (LDVs) on the road in 2012, only an estimated 100,000 were fueled with natural gas. And vehicle use of natural gas was only 0.2% of total energy consumption in the transportation sector in 2012.

A number of challenges face natural gas in penetrating the LDV market. These include high up front costs, limited refueling facilities, limited driving range, uncertain vehicle resale value, limited consumer awareness, limited manufacturer supplier base, rapidly increasing fuel efficiency standards for new vehicles, and an absence of policy support. Perhaps the greatest policy challenge holding back NGVs is the lack of a level playing field in terms of federal government incentives. These challenges can be addressed by measures such as design changes to increase driving range, cost reductions from economies of scale as more NGVs are manufactured, tax credits for NGVs comparable to those that exist for electric vehicles, technology to reduce the cost of refueling infrastructure, and coordination and education across the commercial refueling industry.

Prospects are brighter for natural gas penetration of the heavy-duty vehicle (HDV) market, where the high vehicle-miles traveled reduces payback times to three years or less given the expected lower cost of LNG fuel as compared to diesel fuel costs. Although still a challenge, fueling infrastructure is less problematic for HDVs than for other vehicle types. LNG fueling infrastructure is in its infancy with 66 stations providing LNG across the country and only 28 serving the public (as of February 2013), however these numbers are expected to double or even triple by the end of 2013 and grow thereafter. IHS CERA estimates that fewer than 250 fueling stations would be needed to blanket the US lower 48's entire interstate system at 300 mile intervals. This represents a required investment of $250-$375 million, at a cost between $1.0-1.5 million per station (minimum). By locating stations where interstates cross, this investment could be considerably lower.

IHS CERA estimates that HDV consumption of natural gas in the United States could grow to more than 4 Bcf per day by 2035.

Natural gas use in marine vessels and in railway locomotives also has potential, and pilot projects are underway in these markets.

Overcoming regulatory challenges to growth

Gas distribution systems typically are expanded only when they satisfy certain economic tests such as providing an expected net present value that is greater than zero, providing an internal rate of return that exceeds the gas LDC's cost of capital, or having a payback period that is shorter than some predetermined number of years. The application of those tests varies among jurisdictions, and often poses obstacles to system expansions that are in fact economic. A combination of gas LDC initiatives, regulatory support, and government policy could remove these obstacles, promote economic use of gas, and serve the public interest in full-cycle energy efficiency.

Gas LDCs themselves have developed strategies to encourage conversions to natural gas and system expansions. Information and outreach programs to educate consumers on the benefits of natural gas are particularly useful when energy consumers are unaware of their options. Gas LDCs can also offer loans and other financial assistance to new customers, including payment plans that stretch high up front service line and main costs over several years and loans for up front customer installation costs that can be repaid from fuel savings. They can also secure commitments for a system expansion from large anchor customers such as an industrial customer, a housing development or subdivision, a hospital, or power plant. Such commitments provide a secure base load that reduces the required contribution from other new customers. Another option is to adopt the "open season" approach used by interstate pipelines to gauge customer interest in a system expansion. If a sufficient number of commitments were gathered during the open-season period to make a system expansion economic, the gas LDC would be able to proceed with reasonable assurance of cost recovery.

Regulatory support for system expansion will also be required. PUCs can encourage these measures in several ways:

- Pre-approving system investments whose economic returns are supported by strong and credible growth projections. Pre-approval lowers the gas LDC's investment risk and makes it more likely to explore and develop system expansion opportunities.
- Endorsing economic tests that account for revenues over the useful life of the investment.
- Encouraging gas LDC financing for customer contribution in aid of construction through such devices as the free-feet mechanism.
- Permitting gas LDC or LDC-affiliate financing of conversion to gas appliances.
- Promulgating uniform standards that provide gas LDCs a clear and predictable framework for planning and evaluating potential system expansions.

The public benefits of using natural gas instead of typical alternative fuel sources may justify measures that go beyond removing economic barriers, and that actually promote the use of natural gas. Active promotion of gas at the expense of alternatives lies beyond the mandates of most PUCs, but state and local governments are entitled to make such policy choices, and can promote gas system expansion as part of an overall energy and/or economic strategy. In pursuit of such a strategy, governments should consider:

- Authorizing the PUC to allow system expansion costs to be recovered through general tariffs applied to existing as well as new customers.
- Providing explicit subsidies for expansion of gas networks to unserved areas that meet established density criteria. These subsidies could take the form of economic development grants or state-backed bonds.
- Promoting fuel conversion through information dissemination.

Implications for gas LDCs

The evolution that is now underway in natural gas markets presents a number of opportunities for gas LDCs, their customers, regulators, and policy makers. This study has identified a number of areas in which gas LDCs can work with their customers, regulators and other stakeholders to take advantage of these opportunities for mutual benefit.

Residential/commercial demand growth

Gas LDCs can grow their core residential and commercial markets by:

- Working with customers and PUCs to increase access to natural gas, help existing customers to increase their use of natural gas as desired, and extend LDC systems to serve new customers.

- Working with state governments and PUCs to change any legislation or regulatory policies that discourage the servicing of new gas load, especially if that load would improve overall energy efficiency, reduce emissions, and is economical.

- Working with PUCs, community leaders, financial institutions, and appliance manufacturers to develop mechanisms to reduce the impact of high up front costs to both gas LDC and consumer which can deter customers from converting to natural gas, while avoiding adverse effects on existing gas LDC customers.

- Working with PUCs and developers of multi-family buildings to reduce the initial first cost of installing natural gas space and water heating systems, while educating potential buyers or renters on the operating cost advantage of natural gas versus electric space and water heating.

- Overcoming approaches in many efficiency rulemakings which discourage inter-fuel comparisons and result in promoting inefficient technologies, backed originally by site energy efficiency analysis. PUCs will need to assure that there is a level competitive playing field for all energies, but especially between gas and electricity.

As for the future, most forecasters, including IHS CERA, expect little, if any, growth in residential natural gas demand as growth in customers (which is a function of population growth) is offset by continued improvements in energy efficiency. However, if natural gas can increase its share of residential fuel through:

- Conversions from fuel oil or electricity for both single family and multi-family households

- Improvement in the competitiveness of natural gas furnaces versus electric heat pumps

- Significant installation of home refueling units for natural gas vehicles

- Transformational breakthroughs in fuel cells or micro CHP units

then, residential natural gas demand could be higher. Realizing these opportunities will be quite challenging and may require a rethinking of policies and programs by policy makers, PUCs and gas LDCs.

Promoting US energy efficiency

Gas LDCs can work with PUCs, policy makers, and other stakeholders to:

- Adopt full fuel-cycle analysis in all energy savings and energy efficiency comparisons.
- Identify new opportunities for natural gas to increase overall energy efficiency in a cost-effective manner. Given the expected growing disparity between retail natural gas prices and the retail prices of electricity and oil, it may be possible to increase overall energy efficiency by increasing natural gas use and decreasing the use of more expensive and less energy efficient sources of energy.
- Overcome approaches in many energy efficiency rulemakings which discourage inter-fuel comparisons and result in promoting inefficient technologies, backed originally by site energy efficiency analysis. PUCs will need to assure that there is a level competitive playing field for all energies, but especially between gas and electricity.
- Work with builders, local governments and other stakeholders to encourage builders to base their appliance decisions not on lowest first cost that tend not to be the most energy efficient option, but on full fuel-cycle and life cycle cost analyses.
- Explore the challenge of maintaining the cost-effectiveness, and therefore viability, of natural gas efficiency programs in the present environment of lower natural gas prices. Regulators and gas LDCs will need to review current and best practices in applying cost-effectiveness tests and potentially explore new approaches to evaluating the programs to ensure the full value of these programs are captured. Regulatory support for recognizing societal benefits of increased energy efficiency or reduced emissions will allow gas LDCs to seamlessly deliver efficiency programs to customers well into the future.
- Educate prospective converting and new customers on the economic and environmental benefits of using natural gas. Since most prospective customers are unlikely to convert until their existing furnace or water heater needs replacing, a successful program needs to be targeted at potential converting customers well before they need to replace their furnace or water heater.
- Revisit, and if necessary, update the terms of cost recovery mechanisms such as decoupling, if current mechanisms would act as an impediment to moving to a full fuel-cycle energy efficiency paradigm.
- Support efforts to set energy efficiency standards on a full fuel-cycle basis. Currently, most existing building codes and appliance standards are based on site-efficiency and ignore the losses associated with producing and delivering natural gas or electricity to the site. One exception is the EPA's EnergyStar building programs that allow comparisons of building energy use based on full fuel-cycle concepts. And in August 2013, DOE announced that it would use full fuel-cycle measures in future energy efficiency standards rulemakings.[14]

Growth in other sectors

Gas LDCs can benefit from growth opportunities in the industrial, power, and transportation sectors.

[14] *Federal Register*, Vol. 77 No. 160, Friday, August 17. 2012, page 49701.

- The fact that the majority of the number of industrial customers are served by gas LDCs presents a growth opportunity in that sector. Gas LDCs can devise strategies to maintain or increase their share of industrial gas deliveries. They can work with local communities and business development districts to attract gas-intensive industries to serve as anchor tenants and reduce the costs of system expansion. There may be opportunities to work with regulators to diversify energy efficiency offerings to industrial customers.

- The power sector has the largest potential increase in gas throughput, but gas-fired generation has a complex gas demand profile and new plants tend to connect directly to interstate pipelines. In order for LDCs to be meaningful participants in this sector, they must provide continued value to power producers – such as helping to balance short term changes in power loads, providing storage, and constructing laterals. LDCs have an opportunity to participate actively in managing real-time delivery of natural gas, given their pre-existing portfolios of gas, working with PUCs for the appropriate regulatory modifications. From a climate change perspective, replacing coal-fired power generation with gas-fired is beneficial in reducing emissions. LDCs should be important participants in this dialogue.

- Gas LDCs can be at the leading edge of the transportation sector by supporting consumer education to grow vehicle demand which will increase production of vehicles to bring down costs, supporting policies that level the playing field for all alternate fuel vehicles, providing fuel and fuel-related services that allow the buildout of refueling infrastructure, and supporting sustained R&D that will advance storage and compression technologies that reduce costs.

Combined heat and power

- For microCHP, look for ways to support research and development aimed at driving down manufacturing costs and facilitating wider distribution and installation of product.

- Support initiatives that facilitate easier, faster, and less costly ways to permit new CHP sites and drive interconnection standards towards uniformity.

- For microCHP, support common data standards, monitoring, collection and centralization from existing CHP sites for further analysis and outreach/educational programs.

- Work with regulators to expand the number of states that count CHP in Renewable or Energy Efficiency Portfolio Standards on the basis of efficiency gains.

- Work with state regulators to create equitable standby provisions, charges, and policies for CHP and help level policy playing fields for sale of power/heat/steam into wholesale and retail markets from CHP by gaining remuneration based on capacity value and voided costs of actual technologies.

Adapting regulation to support gas LDC system expansion

Traditional tests and policies relating to expanding gas distribution systems pose unnecessary and uneconomic obstacles. Gas LDCs need to take a leading role in promoting a more receptive environment for system expansion, but they cannot accomplish that task on their own. Regulatory and legislative support is also required.

- With concerns subsiding about natural gas availability and price, there is a clear justification for PUC policies that support distribution system expansion.
- State governments and PUCs should adopt policies that not only promote site energy efficiency, but also promote use of full fuel-cycle energy efficiency analysis, full fuel-cycle emissions standards and full cycle cost analysis.
- PUCs should review whether long standing rules are incompatible with current regulatory objectives and conditions in the natural gas sector, and if so, build partnerships between customers, builders, utilities, economic development agencies to work through the challenges.
- PUCs and gas LDCs should re-examine economic tests used for evaluating line expansion investments.
- PUCs and gas LDCs should review options that may ease the burden of high up front costs on prospective customers while protecting both existing customers and competing fuel suppliers.

Conclusions

The unconventional natural gas revolution has radically changed the outlook for the US natural gas market. Natural gas resources are expected to be available to meet demand for decades to come at prices much lower than were expected just a few years ago. On a Btu-equivalent basis, the wide gap between US natural gas prices and oil prices is expected to remain. And the gap between natural gas prices and electricity prices is expected to widen in many regions of the country. This presents new opportunities to reduce consumer energy costs, increase the efficiency of overall US energy use, reduce emissions of SO_2, NOx, mercury, particulates, ash, CO_2 and other GHGs, revitalize industries, increase US energy security, and promote local economic development through the increased use of natural gas. Energy policy, legislation, regulation, corporate strategy, and household decision-making will continue to adjust to the new realities, challenges, and opportunities of the natural gas market. However, obtaining potential benefits from the reinvigorated natural gas market could be jump-started by a review of PUC and gas LDC policies and practices.