Making the
Statistical Case
What makes a winter heating season unusual?

Generally, the answer to this question is deviations from the norm. Using this simple criterion, the 2013-14 winter was extraordinary, testing a natural gas value chain that had been in many ways untested for a decade.

During this past winter, the second coldest on record in twenty-nine years, the U.S. consumed greater volumes of natural gas than it ever has before. January in particular was marked as having the highest daily, weekly, and monthly requirements for natural gas ever. Residential and commercial heating demand was the principal driver, but the gas system responded to requirements much broader than those for the residential and commercial sectors.

Electricity demand also rose sharply as a result of the cold. Natural gas requirements to power generation grew accordingly, though not just as a result of the cold but also because of a longer-term structural shift in the natural gas-fired electricity market—a trend which emerged during the past few years and which is expected to continue.

Industrial demand remained strong throughout the winter as well—a function of both structural requirements and weather-sensitive heating demand. In all, the natural gas system responded to economy-wide draws to meet the nation’s energy needs this past winter.

The major driver of gas demand this past winter—or in other words, the event that fully tested the natural gas system—was the extraordinary cold brought on by the Polar Vortex. The winter heating season from November 2013 to March 2014 began with early periods of cold confined to specific geographic areas. As winter deepened, sustained periods of below normal temperatures persisted over wide swaths of the country, creating conditions requiring the deployment of all industry assets designed to meet peak day and peak month natural gas demand. This deployment presumes that such assets are functioning, flexible, and ultimately reliable. The U.S. natural gas system in fact did meet these criteria and the challenge presented during the 2013-14 winter.

Local gas utilities plan for contingencies each winter with strategies developed by understanding past events and system performance, all the while preparing for variable weather-sensitive consumption in the short-term as well as for the entire winter season. This analysis examines the conditions of this past winter and how the natural gas system responded, using metrics that governed the 2013-14 winter, such as heating degree days across the country, overall natural gas...
consumption, home heating loads, demand by power producers, and critical supply components, including underground storage. This paper also reviews changes in industry metrics during the ten-year period leading up to this past winter. As noted, compared to recent history the 2013-14 winter posed an exceptional challenge.

- During 2013 and into 2014 the U.S. natural gas market balanced supply and consumption somewhere north of 70 Bcf per day on average. However, requirements for natural gas by consumers—especially during the winter heating season—were not average.

- During the period of November 1, 2013 through March 31, 2014, total U.S. consumption of natural gas (including net exports to Mexico) ranged from less than 70 Bcf per day on a warm March day to 139 Bcf on the highest consumption winter day in January—a huge swing in observed daily winter heating season demand.¹

- The residential and commercial market segments were primarily responsible for the dramatic swings in customer requirements—R&C consumption having ranged from 78 Bcf on the highest consumption day in January to a season low of 27 Bcf per day in late March.

- The power generation sector also impacted natural gas requirements: natural gas flow to power generation on the coldest days of the year has become a key driver in the natural gas market and in price rationalization, both regionally and nationally.

- To meet such requirements, production and market area storage played a key role in the efficient management of local gas utility supply and transportation portfolios. It should be noted that storage practices are no longer solely dictated by local utility requirements to serve winter peaking loads but also support natural gas parking, loaning, balancing, commercial arbitrage opportunities at market hubs and city gates, and even fueling power generation to serve summer cooling loads.

Before identifying specific statistics related to the 2013-14 winter heating season, it is worthwhile to understand at a high level the evolution of the US natural gas system during 2003 - 2013 period. In fact, by the time the polar vortex impacted temperature and weather patterns in the first quarter of 2014, ten years of customer and infrastructure growth had already significantly transformed the natural gas industry.

**Metrics Measuring the Evolution of the Natural Gas Market: 2003 - 2013**

**Customer Growth**

- For the period of 2003 - 2013, total natural gas customers in the United States grew by more than five million. Most of this growth occurred in the residential sector, although a small increase took place in the commercial sector as well.

- While the number of customers in the industrial sector shrank from 205,000 in 2003 to about 192,000 in 2013, natural gas consumption actually increased by 4.3 percent.

¹ Daily demand data reported by Bentek Energy, LLC.
**Distribution Pipeline Infrastructure Expansion: Capacity and Miles**

- The natural gas distribution system also expanded during the 2003 - 2013 period. Distribution mains increased by about 170,000 miles from nearly 1.1 million to more than 1.27 million miles during this ten-year period. Likewise, capacity increased.

**U.S. MILES OF GAS MAIN AND STATE OUTFLOW CAPACITY 2003-2014**

Source: DOT 7100, PHMSA, Annual Report Data from Gas Gathering, Gas Transmission, Hazardous Liquids and LNG Operations
This infrastructure growth is reflected in recent increases in construction costs. For all parts of the natural gas value chain, construction expenditures were consistently higher during the three-year period of 2011-2013 compared with 2003.

**U.S. Natural Gas Industry Construction Expenditures**

- General Construction Expense
- Distribution Construction Expense
- Underground Storage Construction Expense
- Transmission Construction Expense
- Production Construction Expense

Source: American Gas Association, *Gas Facts*

**Natural Gas Production**

- Dry natural gas production grew from less than 20 Tcf annually to nearly 25 Tcf during the 2003 - 2013 period. Domestic production is expected to continue to grow as additional unconventional and conventional resources are developed and as demand requirements continue to pull on a growing gas market.

**U.S. Dry Natural Gas Production (Tcf)**

Source: Energy Information Administration 2002-2013
### Domestic Natural Gas Reserves

- As with production, natural gas reserves have grown steadily during the past decade. Underpinning domestic production capability, natural gas reserves have grown from less than 200 Tcf in 2003 to over 330 Tcf in 2013.
Underground Storage Capacity

- Working gas in storage provides about 15 to 20 percent of total winter heating season gas supply (November 1 through March 31).

- The share of storage working gas in the supply asset pie has grown in the past decade: according to the Energy Information Administration, design working gas capacity in America’s underground storage system grew by about 1,000 Bcf in the past 10 years.

- During the 2013-14 winter heating season, storage played a critical role as a supply source providing additional deliverability during peak load periods.

**Underground Working Gas Capacity -- Continued Growth**

[Graph showing weekly storage stocks and max demonstrated capacity from April 2006 to April 2013]

Source: Energy Information Administration, US Department of Energy

Natural Gas Emissions Profile

The entire natural gas value chain accounts for a very small portion of total greenhouse gas (GHG) emissions in the United States—only about two percent.

- Furthermore, natural gas emissions from the distribution system, owned and maintained by local gas utilities, is considerably smaller—accounting for less than 0.3 percent of the nation’s greenhouse gas footprint.

- Additionally, the emissions trend line for the natural gas distribution system shows a downward slope despite significant growth in installed distribution main. This can be attributed to the accelerating rate in which natural gas utilities have been replacing older pipe in their distribution systems.
Efficiency Gains and Average Use per Residential and Commercial Customer

The natural gas residential customer has shown substantial gains in energy efficiency. In 2003 the average customer used 84.1 Mcf on a weather normalized basis. A decade later the average annual use for a gas home was 63.2 Mcf, roughly a 25 percent decline. Technology improvement was the prevalent factor behind this trend: customers replaced their older gas appliances—particularly some space heating units—with more efficient models. Additionally, new homes were built to higher standards and featured better insulation, windows, and doors.

Also contributing to this sector’s enhanced efficiency were utility and government programs that support energy efficiency and conservation. Through these programs, utilities offered consumers financial incentives to upgrade equipment and retrofit home shells, while the government offered tax deductions to citizens that made home energy efficiency investments. Such programs accelerated the energy efficiency gains in homes.

The heating portion of a commercial customer’s natural gas usage is typically lower than that for a residential customer, which could imply that conservation has a lesser impact for business customers. However, these businesses also demonstrated a usage reduction that averaged 25 percent—from 322 Mcf per customer in 2003 to 243 Mcf in 2013. Impacts of such efficiency gains are discussed later in this paper.
Efficiency-Directed Local Gas Utility Investments

As mentioned earlier, utility programs played a role in efficiency gains and reduced costs to customers. A number of these programs have existed for decades; however, the pace of utility investments in efficiency programs has accelerated in recent years—having more than tripled, from 2007 $320 million in 2007 to $1.1 billion in 2012. Energy savings more than doubled as a result of these investments—from 48.4 trillion Btu of saved energy in 2008 to 135.9 trillion Btu in 2012. Also for 2013, Utilities budgeted nearly $1.5 billion (projecting a 30 percent increase in spending). This helped residential program participants save 16 percent of household gas usage on average or about 112 Therm per year, averaging $117 in cost saving on their annual energy bill.

![NATURAL GAS EFFICIENCY PROGRAM EXPENDITURES UNITED STATES](chart)

Source: AGA Natural Gas Efficiency programs Survey – 2008 through 2013

The measures described above focus on the structural changes that have impacted the natural gas system—i.e., changes that have redefined the role natural gas plays in our energy economy. They do not encompass all the changes that affected our natural gas industry in the past decade—such as changes in regulatory structures, which are critical to the success of the natural gas utility business; in financial markets, which today support gas futures contracts aimed at hedging gas prices and maintaining market stability; and in end-use technologies, which provide efficient and economic applications for industry, businesses and homes.
NATURAL GAS MARKET CONDITIONS DURING THE 2013-2014 WINTER HEATING SEASON

2013-14 WHS Heating Degree Days

The 2013-14 winter heating season (WHS) was exceptional not only for the Polar Vortex phenomenon but also for the degree of temperature deviations from normal and for the wide geographic coverage. Also low temperature conditions persisted for long stretches of the coldest months.

• The United States compiled 4,217 heating degree days (HDD) over the five month period of November 2013-March 2014. This HDD total is 8 percent higher than the past 29 winter heating seasons (from 1985-86 to the present). The 2013-14 WHS was second coldest for the nation as a whole during this 29 year period.

• The East North Central portion of the country (essentially the upper Midwest) experienced 15.5 percent more HDDs than normal and as such recorded the coldest winter in 29 years.

• The East South Central region recorded 12.7 more HDDs and was the second coldest by that measure in the 29 year period.

• The Middle Atlantic region experienced its third coldest winter in 29 years and was 19.4 percent colder than normal based on HDD totals.

• Likewise, New England was the third coldest it has been in 29 years with a HDD total 8.0 percent above the norm.

• The South Atlantic region completed the east coast trifecta with temperatures resulting in 8.2 percent more heating degree days than normal—the second coldest winter in 29 years.

• Further west, it was also cold with the West North Central and West South Central regions 12.4 percent and 15.9 percent colder than normal, respectively, as measured by HDDs. For the WNC region it was the coldest in 29 years and for the WSC the second coldest.

• Only until you look at the Mountain West and Pacific Coast do you see more normal or even warmer conditions for the just past winter. The Mountain and Pacific regions were the clear exception for the country as the polar vortex that settled over the mid-continent and East Coast actually pulled the jet stream further north in the Pacific and Mountain regions bringing dry and warmer conditions. The Mountain region was 7.5 percent warmer and it was only its twenty-third coldest winter in 29 years. The Pacific region registered 19.3 percent fewer heating degree days and was thus warmer than normal this winter. It was actually the second warmest winter heating season for the Pacific Coast in 29 years, according to data from the National Oceanographic and Atmospheric Administration (NOAA).
2013-14 WHS Natural Gas Consumption

As shown in the figures that follow, natural gas consumption during the 2013-14 WHS significantly exceeded the demand levels of the recent past. Understanding the scale of this variance from past winters underscores the reliability and resilience of the natural gas value chain in meeting weather-induced challenges. It also puts into context the key supply components, such as underground storage, domestic flowing gas, and marginal supplies, as well as the pricing environment, which prevailed for much of this past winter.

- Total natural gas consumption in January 2014 reached 3.2 trillion cubic feet (Tcf) – the strongest gas demand month ever for any time of year, according to Bentek Energy LLC. In recent years a strong January winter heating season consumption month had been about 2.9 Tcf.

- In addition, 8.4 Tcf of natural gas was consumed by end-users during the entire period of January through March 2014. It is the largest volume of consumption by end-users for this three-month period on record. In fact, February recorded its strongest demand for any February on record, as did March.

Winter Month Average Daily Natural Gas Demand

All Sectors

Source: Bentek Energy
This sustained demand for natural gas matters, because it placed incessant pressure on the domestic supply system, from flowing gas and underground storage to marginal providers, such as supplemental LNG and propane-air pipeline imports from Canada, and even small increases in LNG imports. There was no respite from this pressure for many regions of the country.
A key development of the past decade has been the emergence of power generation as a large and critical market for natural gas. Also significant is the fact that gas to power generation not only peaks during the summer to serve cooling loads across the country but also during the winter to serve peak heating loads (see figure below).

This is particularly important in regions such as New England where, during winter months, natural gas home heating loads are strong, while demand for gas to power generation is concurrently high, given the current generation fuel mix in this region. In New England this condition is exacerbated by pipeline capacity constraints during critical winter periods.

Power generation consumption of natural gas in January 2014 set winter heating season records for average daily volumes (about 21 Bcf per day) as well as for a single day, recording the highest daily volume ever during a winter month at 31 Bcf for that day, according to Bentek Energy. But demand for gas to power generation had been nearly as strong in December and served as a harbinger for the following winter months.

**DAILY U.S. NATURAL GAS FLOW INTO POWER GENERATION — 2014**

![Graph showing daily natural gas flow into power generation in 2014.](image)

*Source: Bentek Energy*

Demand levels for gas to industrial consumers rose during the 2013-14 WHS, given the additional requirements needed to maintain heat in facilities; however, it was the temperature-sensitive heating requirements for residential and commercial space heating that dominated the winter market.
• Residential and commercial heating requirements reached 78 Bcf on January 7, 2014—a new record. During the prior five years a strong demand day had been closer to 56 Bcf per day on average. The events of January 7 thus led to a 40 percent increase in peak day demand. Total end-user demand reached nearly 140 Bcf for on January 7—also a historic record.

Domestic Natural Gas Supply Sources 2013-14 WHS

The protracted 2013-14 winter heating season event produced constant pressure on domestic natural gas supply sources; however, they generally performed up to par, due to planning and preparation, system-wide. Demand requirements were met by flowing gas from lower-48 state production, underground storage, increased availability of Canadian gas and LNG imports on critical days, and supplemental supplies from propane-air and LNG peaking facilities (often within the local gas utility’s footprint).

• According to the Energy Information Administration, domestic dry gas production in January 2014 averaged about 67 Bcf per day. Five years earlier—in January 2009—it had averaged 57 Bcf per day. As the figure below shows, domestic natural gas production has been rising steadily since 2006.

• More production signifies not only increased flowing gas during key winter heating season periods but also more availability to meet summer cooling loads and storage injections.

![Daily U.S. Dry Natural Gas Production Graph](image)

Source: Bentek Energy

• Natural gas market watchers are familiar with the extraordinary deployment of storage volumes to meet demand loads during the 2013-14 WHS, which resulted in the lowest inventory of working gas remaining in storage at the end of March since 2003.
Underground storage tends to supply 15 to 20 percent of winter heating season supplies on average, dependent on various factors.

During the 2013-14 WHS, underground storage provided in excess of 20 percent of total supply and set records for monthly withdrawals. The previous record for net volumes withdrawn from storage during a winter heating season month had been 847 Bcf in January 2003. That record was shattered in January 2014 with more than 950 Bcf withdrawn from working gas inventories across the country.

The following figure quantifies daily changes in working gas as a positive supply element, with volumes withdrawn from storage as high as 68 Bcf for a single day—on January 7, 2014. More typical for a peak day during the preceding five years, storage inventories may have contributed 45 Bcf nationally for the peak day.
In addition to domestically produced gas and withdrawals from storage, small but critical amounts of imported LNG as well as supplemental supplies from above ground LNG and propane-air peaking facilities may be used to meet the needle-peak of coldest day demand. Of course, natural gas imports from Canada serve a critical role on a daily basis as well as on the margin on the coldest days.
NET US DAILY IMPORTS OF NATURAL GAS FROM CANADA
JANUARY-APRIL 2014

Source: Bentek Energy

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