Natural gas is a safe, dependable and responsible energy choice – and a cornerstone of the Pacific Northwest’s energy, environmental and economic future. Natural gas heats our homes, powers businesses, fuels small and large vehicles and marine vessels, and serves as a key component in many of our most vital industrial processes.

This booklet provides an overview of natural gas and the myriad of benefits that this domestic, clean, safe, low-cost, reliable and abundant energy source offers Pacific Northwest (PNW) consumers. Already, 3.2 million regional natural gas users are enjoying its economic and environmental advantages, but expanding the use and applications of natural gas will help to provide an economically feasible, cleaner environment for future generations.

The Northwest Gas Association (NWGA) works to foster greater understanding and informed decision-making on issues related to natural gas among industry participants, opinion leaders and governing officials in the Pacific Northwest, encompassing British Columbia (BC), Washington, Oregon and Idaho.
Natural Gas 101

Natural gas is the Earth’s cleanest fossil fuel. Created naturally underground by years of pressure and decay, natural gas is composed almost entirely of methane, with trace amounts of other gases, including ethane, propane, butane and pentane. Its molecular makeup is one carbon (methane) atom and four hydrogen atoms. Natural gas is a domestic natural resource that is colorless and odorless in its ordinary state.

Origin

Much of the natural gas we find and use today began as microscopic plants and animals living in shallow marine environments millions of years ago. As living organisms, they absorbed energy from the sun, which was stored as carbon molecules in their bodies. When they died, they sank to the bottom of the sea and were covered by layer after layer of sediment. As this organic feedstock became buried deeper in the earth, heat combined with the pressure of compaction converted some of the bio-material into natural gas.

Migration

Once natural gas has been generated in nature, it tends to migrate within the sediments and rocks where it was created using the pore space, fractures and fissures that occur naturally in the subsurface. Some natural gas rises to the surface and shows up in seeps, while other gas molecules travel until they are trapped in impermeable layers of rock, shale, salt or clay. These trapped deposits comprise the reserves where we find natural gas today.

Getting Natural Gas to PNW Consumers

In the PNW, natural gas is delivered to 3.2 million consumers through a network with over 125,000 miles of transmission and distribution pipelines. The pipelines that transport natural gas from production areas in Alberta, BC, and the U.S. Rockies can deliver more than 4 million dekatherms per day (MMDth/day) to the region.

From wells in remote places to homes in your neighborhood, the natural gas industry operates a safe delivery system that is a model for the world.
There are Four Segments of the Natural Gas Industry involved in delivering natural gas from the wellhead to the consumer

1. **Producing Wells (producers)** such as Anadarko, BP, Devon, ExxonMobil and others, access natural gas by drilling wells into the rock then using pipes to bring the gas to the surface. In most wells, the pressure of the natural gas is enough to force it to the surface and into the gathering lines that run to central collection points. Where the gas can’t flow naturally, advanced drilling technology combined with hydraulic fracturing is used to bring gas to the surface.

2. **Processors** (midstream companies), like Enbridge, TransCanada and Williams typically connect the various producing wells via a raw-gas-gathering network of small diameter pipelines, and process the gas to transmission pipeline specifications.

3. **Transmission Pipelines**, such as Enbridge’s BC Pipeline, TransCanada’s GTN System and Williams NW Pipeline, act like interstate highways for gas, moving huge amounts of natural gas thousands of miles from production regions to market regions served by local distribution companies. Compressor stations located about every 50 to 60 miles boost pressure to counter what is lost from the friction of gas moving through the pipe.

4. **Distribution and Service Pipelines** (local distribution companies), such as those operated by Avista, Cascade Natural, FortisBC Energy, Intermountain, NW Natural, and Puget Sound Energy, are where the familiar “rotten egg” smell is added to natural gas before it is delivered to homes and businesses through distribution mains (utility pipelines). Finally, after passing through a meter that measures use, the gas travels to a customer’s equipment, appliances and vehicles.
Measuring Natural Gas

The energy content or heating value from natural gas is measured in a British thermal unit, called a Btu. One Btu is equivalent to the amount of heat needed to raise the temperature of one pound (16 ounces) of water by 1 degree Fahrenheit, or about the amount of energy released by striking a wooden kitchen match. Natural gas is sold from the wellhead to purchasers in standard volume measurements of thousands of cubic feet (Mcf). Consumers are billed for use in therms. One therm is equal to 1 cubic foot.

How Natural Gas is Used in the Pacific Northwest

Overall, about 30 percent of natural gas delivered to PNW consumers is used in the industrial sector, providing energy for everything from mining minerals to processing food. Generating electricity consumes about 29 percent (BC uses almost no gas to produce electricity). Another 16 percent is used in the commercial market, for heating and cooling office buildings, hospitals, schools, and for cooking in restaurants. Most of the remaining amount — about 25 percent — is used in the residential market, providing energy for home heating, hot water, cooking, clothes drying and air conditioning.

For more information on natural gas in the PNW, go to www.nwga.org/outlook

Frequently Used Units for Measuring Natural Gas

<table>
<thead>
<tr>
<th>Units</th>
<th>Btu Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 cubic foot (cf)</td>
<td>1,028</td>
</tr>
<tr>
<td>100 cubic feet (1 Ccf)</td>
<td>1 therm (approx)</td>
</tr>
<tr>
<td>1,000 cubic feet (1 Mcf)</td>
<td>1,028,000</td>
</tr>
<tr>
<td>1,000 cubic feet (1 Mcf)</td>
<td>1 therm</td>
</tr>
<tr>
<td>1 million (1,000,000) cubic feet (1 MMcf)</td>
<td>1,028,000 Btu</td>
</tr>
<tr>
<td>MMBtu</td>
<td>1 million Btu</td>
</tr>
</tbody>
</table>

PNW's Natural Gas Use by Sector

<table>
<thead>
<tr>
<th>Sector</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial</td>
<td>37%</td>
</tr>
<tr>
<td>Commercial</td>
<td>27%</td>
</tr>
<tr>
<td>Residential</td>
<td>25%</td>
</tr>
<tr>
<td>Generation</td>
<td>28%</td>
</tr>
<tr>
<td>Industrial</td>
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<td>Generation</td>
<td>28%</td>
</tr>
</tbody>
</table>

To provide an added layer of safety for leak detection purposes:
Utilities odorize natural gas with Mercaptan...

Utilities odorize natural gas with Mercaptan...

Natural Gas is Safe

Safety is the core value and top priority of the natural gas industry. The industry spends billions of dollars each year to maintain and improve its infrastructure through safety programs, markers, inspections, material specifications, construction techniques, corrosion and damage control, industry and peer education programs, and public education programs.

The natural gas industry knows that safety is a joint effort and proactively collaborates and engages in partnerships with federal and state regulators, public officials, emergency responders, excavators, consumers, and safety advocates. It is by working together that the industry continues to improve upon its longstanding record of providing natural gas safely, effectively and reliably.

The number one cause of pipeline incidents is third-party damage, such as that caused when excavation contractors or even homeowners inadvertently dig in to a gas line. Concentrated efforts by your local gas company, state and federal regulators and other public agencies, coupled with the new 8-1-1 Call Before You Dig number, have helped reduce damages from excavation by 60 percent since 2006. While the industry has multiple safeguards in place to protect consumers, it is important that consumers are actively involved in safety precautions. It’s a partnership!

Natural Gas: Safe, Clean, Efficient . . . and the Key to our Future

Did you know?

Transportation by pipeline is the safest form of energy delivery in the country.
Natural Gas is Clean

The cleanest burning fossil fuel, natural gas has already helped reduce greenhouse gas (GHG) emissions in the U.S. over the past decade as it has been tapped to replace heavy polluters such as coal. By 2015, natural gas accounted for more than 33 percent of electricity generated in the U.S.

Natural gas contributes to cleaner air by:

- Burning extremely efficiently, producing primarily heat and water vapor.
- Producing about 45 percent less carbon dioxide (CO₂) than coal, about 30 percent less than oil, and about 15 percent less than wood when burned.
- Providing almost no sulfur dioxide, dissolved solids or airborne particulates.

Natural gas is an important tool in the suite of GHG and CO₂ emissions reduction options available to the U.S. and Canada. As states and provinces move to further reduce CO₂ emissions from electric power generation, for example, natural gas use is expected to increase. And as the transportation sector makes use of the barely tapped market for clean-burning natural gas vehicles (NGVs), natural gas use and its beneficial impacts on GHG emissions will only increase.

Emissions of Natural Gas vs. Coal

When natural gas is used to generate electricity, total GHG emissions per MMBtu of natural gas consumed (on a CO₂-equivalent basis) are 129 pounds, compared with 212 pounds for coal. Stated another way, due to the higher efficiency of natural gas combined-cycle generation plants, natural gas emits 52-56 percent fewer GHGs than coal-fired boilers to produce the same amount of electricity. Source: Environmental Protection Agency (EPA)

Natural Gas is Efficient

The more energy we save, the lower our impact on the environment. But beyond using energy-efficient products, it’s also important to use the best (e.g., most efficient) energy source for the task. On average, a house fueled by natural gas is responsible for about one-third fewer GHG emissions than a comparable all-electric home, according to the AGA.

Benefits of Direct Use of Natural Gas

Why? Let’s take a look at what’s called the full fuel cycle, which accounts for how much energy is retained – or lost – from an energy source until its final use in your water heater, oven or home heating system. With the full fuel cycle in mind, direct use of natural gas comes out a winner in the energy efficiency race. For example, by the time you turn on an electric appliance, up to 68 percent of the energy value from the original fuel has been lost. That means the full fuel cycle efficiency is about 32 percent. By contrast, the full fuel cycle efficiency of a natural gas appliance is about 92 percent – a substantial difference. More efficient use of a fuel means less energy lost and less that needs to be produced, which reduces GHG emissions.

Natural Gas is also Cost-Effective

Besides gaining efficiency, however, consumers that convert to natural gas also immediately save on their monthly utility bills. Households that directly use natural gas for heating, cooking and clothes drying spend an average of $874 less per year than homes using electricity for those applications. In fact, low domestic natural gas prices have led to savings of almost $69 billion for existing residential natural gas customers in the U.S. over the past four years, according to AGA.
The Future of Natural Gas

Sure, it’s clean, but is it safe?
In co-operation with other major gas utilities, NWGA member, FortisBC undertook a study to determine if biomethane was a safe alternative to natural gas. Multiple gas sources were examined in numerous locations around North America and compared with conventional natural gas. Study results showed that upgraded biomethane is interchangeable with natural gas. In some cases, biomethane was purer (contained fewer contaminants) than conventional natural gas, meaning customers won’t see any difference in the quality of gas provided. You can rest easy that it meets the same safety standards as conventional natural gas. It is carbon neutral, extremely versatile and fully compatible with the North American pipeline infrastructure.

What are NWGA members doing with RNG?
NWGA members are currently using or considering the use of renewable natural gas. Here are a few examples:

- FortisBC: Four local supply projects (two farm and two landfill projects) are currently in operation, with two more set to come online in the next two years. Over 7,800 voluntary residential and commercial customers participate in the RNG program, each designating between 5-100% of their conventional natural gas as RNG. Cumulative demand for RNG since the program began in 2011 has resulted in a reduction of over 30,000 tons of GHG emissions. For more information, go to FortisBC’s website at https://www.fortisbc.com/NaturalGas/RenewableNaturalGas

- NW Natural: In April 2017, NW Natural and the City of Portland announced a partnership, where NW Natural will recover and clean biogas from the Columbia Boulevard Wastewater Treatment Plant and inject it into their distribution system. This project will also include a natural gas fueling station. According the City of Portland, this will be the City’s single largest climate action project. It will cut greenhouse gas emissions by 21,000 tons annually, generate upwards of $3 million in revenue a year for the City, and replace 1.34 million gallons of dirty diesel fuel with clean renewable natural gas—enough to run 154 garbage trucks for an entire year.

What is RNG?
Renewable gas is natural gas (biomethane) produced from existing waste streams and a variety of renewable and sustainable biomass sources, including animal waste (e.g. Cow manure from dairy farms), landfills, sewage treatment plants, crop residuals and food waste. It is composed of primarily methane, just like geologic natural gas.

As organic matter, or biomass, breaks down in the absence of oxygen; the bacteria produces methane and carbon dioxide (CO₂) as a natural byproduct. The raw biogas, which contains methane and other compounds, can be concentrated in one location and captured. Once collected, it can be purified (or upgraded) into biomethane that meets the quality standards of pipeline systems.

Upgrading to Biogas
The process of upgrading may vary from project to project, but the goal is to ensure the gas introduced into the system meets the same quality standards as natural gas. The process leaves behind primarily methane and small quantities of other gasses. The first step is to remove contaminant gasses through a careful gas cleaning process that leaves only CO₂. The CO₂, which lowers the heating value of the gas, is removed using well-proven gas processing technology employed around the world.

Once the gas is clean, only methane remains along with a small amount of nitrogen, making it almost impossible to distinguish from conventional natural gas. Purified biogas free from undesirable contaminants is called biomethane—also known as renewable natural gas.

The Future of Natural Gas

The Potential for Renewable Natural Gas

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What about the environment?
The creation of biogas does not deplete the earth’s non-renewable resources, in fact, it captures and uses biogases from decomposing organic wastes that would otherwise go directly into the atmosphere and facilitates a closed-loop carbon process.

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Natural Gas is the cleanest alternative transportation fuel available and can reduce greenhouse gas emissions by 20% to 30% compared to diesel and gasoline.

When it comes to other harmful pollutants like nitrous oxides (NOx), sulfur oxides (SOx) and particulate matter (PM), natural gas does even better. Recent studies found that natural gas engines produce dramatically lower smog-causing NOx emissions than the cleanest diesel and electric engines, while emitting almost no asthma-inducing SOx or PM.

In heavily-used fleet applications (think United Parcel Service, waste haulers, etc.), natural gas vehicles can be deployed in greater numbers providing the most pollution reduction for the dollars spent. Over time, NGV trucks offer lower operating costs than even the newest diesel trucks because of lower operating, fuel and maintenance costs.

In the U.S. today, NGVs are already serving 40 major airports, comprise 20 percent of transit buses and 60 percent of new garbage-hauling trucks ordered, and are being adopted in the long-haul trucking market, rail industry and by marine shippers. Still, the potential for natural gas to serve the transportation market has barely been tapped. Because natural gas is abundant domestically, cost-effective and already used in nearly all classes of vehicles, it makes sense to pursue wider deployment of NGVs for both environmental and economic reasons.

For more information on NGV’s emissions, go to the www.nwga.org.

About the Northwest Gas Association

The Northwest Gas Association (NWGA) is a trade organization of the Pacific Northwest natural gas industry. Our members include natural gas utilities serving communities in the Northwest and interstate pipelines that move natural gas from supply basins into and through the region. NWGA members deliver or distribute all the natural gas consumed in the Pacific Northwest.

NWGA’s mission is to advance the safe, dependable and responsible use of natural gas as a cornerstone of the region’s energy, environmental and economic foundation. Its efforts foster greater understanding and informed decision-making among industry participants, opinion leaders and governing officials in the Pacific Northwest on issues related to natural gas.

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For over 120 years Avista has served the businesses and communities of the Pacific Northwest with reliable service and value. Avista Utilities, the company’s utility operating division, serves 375,000 electric and 336,000 natural gas customers. Its service territory covers 30,000 square miles in eastern Washington, northern Idaho and parts of southern and eastern Oregon, with a population of 1.6 million. Transmission and distribution operations include energy delivery, generation, and resource assets. Operations also include the purchase, transmission, distribution, and sale of electric energy on both retail and wholesale basis. The company also purchases, transports, distributes, and sells natural gas. Avista’s stock is traded under the ticker symbol “AVA.” For more information about Avista, please visit www.avistacorp.com or www.avistautilities.com.

Founded in 1953, Cascade Natural Gas Corporation is an investor-owned natural gas utility that serves nearly 280,000 residential, commercial, and industrial customers in 96 communities in Oregon and Washington. Customers are served from three regions comprised of twelve districts (*), fifteen operations offices, and surrounding communities: Northwest Region – including Bellingham*, Mount Vernon*, Bremerton*, Aberdeen* and Longview*; Central – including Yakima*, Wenatchee*, Moses Lake, Kennewick* and Walla Walla*; Southern – including Bend*, Ontario*, Baker City, Pendleton* and Hermiston.

The area served by Cascade covers more than 32,000 square miles and is home to more than 1,000,000 people. Cascade’s headquarters are located in Kennewick, Washington. Cascade Natural Gas Corporation is a subsidiary of MDU Resources, Inc.
Enbridge’s natural gas business in British Columbia (B.C.) includes a natural gas gathering, processing and transmission system that has formed the backbone of the natural gas sector in province since 1957. This system connects B.C.’s natural gas exploration and production industry with millions of consumers in B.C., Alberta and the U.S. Pacific Northwest. Today, nearly 80 per cent of the gas produced in B.C. touches this system.

This natural gas is used to heat homes, hospitals, businesses and schools. It is also used as a fuel for electric power generation and is a staple in a number of industrial and manufacturing processes that create hundreds of products that improve our daily lives.

On February 27, 2017, Enbridge completed its merger with Spectra Energy. With the competition of this merger, Enbridge became the owner and operator of the natural gas business in B.C. that was previously owned and operated by Spectra Energy.

FortisBC

We deliver approximately 21 percent of the total energy consumed in British Columbia, which is the most energy delivered by any utility in the province. Whether delivering electricity, natural gas or propane, our more than 2,200 employees serve approximately 1.1 million customers in 135 communities.

FortisBC owns and operates approximately 48,200 kilometres of natural gas transmission and distribution pipelines and approximately 7,200 kilometres of transmission and distribution power lines. Under our regulated utility operations, we also own and operate two liquefied natural gas (LNG) storage facilities and four hydroelectric generating plants.

FortisBC Inc. and FortisBC Energy Inc. do business as FortisBC. We are indirectly wholly owned by our parent company, Fortis Inc., a leader in the North American electric and gas utility business. Through its subsidiaries, Fortis Inc. serves more than three million natural gas and electricity customers.
Incorporated in 1950, and beginning operations in 1956, Intermountain Gas Company is a natural gas utility serving southern Idaho in an area that includes 75 cities and 23 counties, with a population of about 1,200,000. The company is based in Boise, Idaho. Intermountain serves 120 industrial customers. Potato processing, dairies and meat processors, chemical, fertilizer and electronics are the largest market segments. In 2016, 48% of gas sales were for industrial use, with commercial and residential segments using about 16% and 32%, respectively.

Intermountain owns and operates a six-million therm liquefied natural gas storage facility near Nampa, Idaho. During 2016, Intermountain delivered 670 million therms (64 billion cubic feet) of natural gas to an average of 345,000 customers. In 2016, the number of natural gas customers grew by 1.5%. Intermountain owns and operates 12,361 miles of transmission laterals, distribution lines, and services.

The company is a subsidiary of MDU Resources Group, Inc., of Bismarck, North Dakota.

NW Natural, a 158 year-old company with approximately 1,100 employees, is headquartered in Portland, Oregon. It is one of the fastest-growing natural gas local distribution companies in the country. NW Natural serves more than 700,000 customers in Oregon and SW Washington. Its service area includes the Portland-Vancouver metropolitan area, the populous Willamette Valley, the Oregon coast and portions of the Columbia River Gorge.

NW Natural purchases gas for its core market from a variety of suppliers in the Western United States and Canada. The company operates an underground gas storage facility developed from depleted natural gas reservoirs near Mist in Columbia County, Oregon and, with PG&E, is currently developing another underground storage facility at Gill Ranch, near Fresno, California. NW Natural sells storage services from the Mist facility into the interstate market and will sell storage capacity into the market from Gill Ranch. In addition, the company operates two liquefied natural gas storage facilities in Oregon.

In keeping with its steady growth, NW Natural has increased annual dividends paid to shareholders every year for 61 consecutive years, one of only a handful of companies to achieve such a dividend record. NW Natural common stock is traded on the New York Stock Exchange (NYSE: NWN).
Puget Sound Energy

Puget Sound Energy (PSE) is Washington state’s oldest and largest energy utility, serving more than 1.1 million electric customers and almost 790,000 natural gas customers, primarily in the Puget Sound region. PSE meets the energy needs of its growing customer base through incremental, cost-effective energy efficiency, low-cost procurement of sustainable energy resources, and far-sighted investment in the energy-delivery infrastructure.

Within close proximity to the utility’s service area is the Jackson Prairie Underground Natural Gas Storage Project, operated by PSE and jointly owned with Avista Utilities and Williams-Northwest Pipeline. Since its first day of operation in 1964, the Jackson Prairie Storage facility has grown to meet increasing demands on the Pacific Northwest gas supply system. Its underground storage capacity of 41 billion cubic feet of natural gas can provide 1.15 billion cubic feet of daily delivery of gas—enough to heat nearly 1.2 million homes on a cold winter day.

A new liquefied natural gas facility is also under construction by PSE in the Port of Tacoma. The facility will provide PSE natural gas customers a reliable supply on peak load days as well as fuel for maritime shipping.

PSE, the utility subsidiary of Puget Energy, is regulated by the Washington Utilities and Transportation Commission.

TC Energy

TC Energy is one of the largest U.S. transporters of Canadian natural gas. GTN’s 612-mile, 36- and 42-inch-diameter pipeline system is the primary path for Western Canada Sedimentary Basin natural gas to reach markets in the Pacific Northwest, California, Nevada, and the rest of the U.S. West. GTN’s strategic value derives from its position downstream of TransCanada’s Alberta and British Columbia pipeline systems.

GTN’s customers are principally local retail gas distribution utilities, electric generators, natural gas marketing companies, natural gas producers, and industrial companies. GTN also operates North Baja Pipeline, LLC (NBP), which is owned by TC PipeLines, LP. The NBP system primarily serves electric generation customers in Mexico via Gasoducto Bajanorte (owned by Sempra Energy International). As a result of an Expansion completed in April 2008, the NBP system is now bi-directional, making it capable of importing 600 million cubic feet a day of LNG-sourced gas to serve U.S. markets.
Williams Northwest Pipeline

Williams Northwest Pipeline (Northwest) has provided safe and reliable transportation of natural gas to the Pacific Northwest and Intermountain region for more than 50 years. With initial pipeline facilities constructed in 1956, Northwest has upgraded and expanded its system significantly over the years in order to meet the regions increasing demand for natural gas.

Northwest’s natural gas transmission system includes 3,900 miles of pipeline and extends from the Colorado/New Mexico state border to the U.S./Canadian border in the state of Washington.

Northwest’s wide customer base includes local distribution companies, marketers, producers, electric generators and various industrial users. Its transmission system serves customers with long-term firm transportation agreements, including peak service, with an aggregate capacity of 3.8 million dekatherms per day of natural gas.

Northwest’s bi-directional system provides access to abundant natural gas supplies in the Rocky Mountain region, the San Juan Basin and the Western Canadian Sedimentary Basin, including British Columbia and Alberta. This offers customers supply diversity and choice. For the Rocky Mountain region, the San Juan Basin and the Western Canadian Sedimentary Basin, Northwest’s bi-directional system provides access to abundant natural gas supplies in the

Regional Contacts

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British Columbia Premier Office
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Canadian Energy Pipeline Association (CEPA)
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www.governor.wa.gov

Washington Utilities and Transportation Commission (WUTC)
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About Williams Partners:
Williams Partners L.P. (NYSE: WPZ) is a leading diversified master limited partnership focused on natural gas transportation, gathering, treating, and processing; storage, natural gas liquid fractionation; and oil transportation. The partnership owns interests in three major interstate natural gas pipelines, including Northwest Pipeline GP. Williams (NYSE: WM) owns approximately 84 percent of Williams Partners, including the general-partner interest.

Website www.williams.com
Glossary

Alternate Fuel
Other fuels that can be substituted for the fuel in use to generate power or run equipment. In the case of natural gas, the most common alternative fuels are distillate fuel oils, residual fuel oils, coal and wood.

Btu
British thermal unit, a measure of the energy content of a fuel. The heat required to raise the temperature of one pound of water by one degree Fahrenheit at a specified temperature and pressure. One Btu equals 252 calories, 778 foot-pounds, 1,055 joules or 0.293 watt hours. One cubic foot of natural gas contains about 1,027 Btus.

Burner Tip
A generic term referring to the ultimate point of consumption for natural gas. Also, an attachment for a burner head which forms a burner port.

Capacity Release
Capacity of customers for the curtailment plan. A customer may be required to partially cut back or totally eliminate his take of gas depending on the severity of the shortfall between gas supply and demand and the customer’s position in the hierarchy.

Curtailment
A method to balance natural gas requirements with available supply. Usually there is a hierarchy of customers for the curtailment plan. A customer may be required to partially or totally eliminate its take of gas depending on the severity of the shortfall between gas supply and demand and the customer’s position in the hierarchy.

Decline Rate
The rate by which natural gas production slows as a natural gas well is drawn down (depleted) over time.

Direct-Connect Customers
Customers with available supply. Usually very large industrial customers connected directly to an interstate pipeline system. These customers purchase their own gas supplies and contract directly with the pipeline for transportation, thereby bypassing the bundled services typically offered by local distribution companies.

Deliverability
Maximum rate at which natural gas can be extracted from a supply well, transported through a pipeline or withdrawn from a storage well over a given period of time.

Demand Side Management (DSM)
Utility activities designed to influence the amount and timing of customer demand, producing changes to the overall demand. Conservation programs are a DSM technique.

Dig-in
When buried gas facilities (or other underground utilities) are damaged by excavation.

Displacement
Method by which one company trades a like amount of gas to another, even though the gas itself does not move.

Dual-Fuel Capability
Ability of an energy-burning facility to alternately utilize more than one kind of fuel, usually gas and oil.

Firm Service
Service offered to customers under schedules or contracts which anticipate no interruptions. The period of service may be for only a specified part of the year as in Off-Peak Service. Certain firm service contracts may contain clauses which permit unexpected interruption in case the supply to residential customers is threatened during an emergency.

Fixed Costs
Costs which relate entirely or predominantly to the capital outlay necessary to provide the system capacity plus operating expenses which do not vary materially with the quantity of gas transported through the pipeline system.

Force Majeure
A superior force, “act of God” or unexpected and disruptive event, which may serve to relieve a party from a contract or obligation.

Forward or Futures Contract
Contract for future delivery of a commodity such as natural gas at a price determined in advance.

Fuel Switching
Act of an end-user with dual-fuel capability switching fuel types if one type of fuel becomes more economical or reliable than the other.

Gasification
The process during which liquefied natural gas (LNG) is returned to its gaseous state through an increase in temperature and a decrease in pressure.

Hedging
Any method of minimizing the risk of price change.

Henry Hub
A pipeline interchange located in Louisiana which serves as the delivery point of NYMEX natural gas futures contracts. Henry Hub is one of the most active natural gas trading points in North America and is commonly used as an index against which prices at other trading points are compared.

Hydrostatic Test
A strength test of equipment (pipe) in which the item is filled with liquid, subjected to suitable pressure, and then shut in, and the pressure monitored.

Integrated Resource Planning
A utility planning method whereby alternative resource mixes, including demand-side and supply-side options, are evaluated in order to determine which resource plan minimizes the overall cost of service, subject to reliability and various other constraints.

Interruptible Service
A transportation service similar to firm service in operation, but a lower priority for scheduling, subject to interruption if capacity is required for firm service. Interruptible customers trade the risk of occasional and temporary supply interruptions in return for a lower service rate.

Line Pack
Natural gas occupying all pressurized sections of the pipeline network. Introduction of new gas at a receipt point “packs” or adds pressure to the line. Removal of gas at a delivery point lowers the pressure (unpacks the line).

Liquefied Natural Gas (LNG)
Natural gas which has been liquefied by reducing its temperature to minus 260 degrees Fahrenheit at atmospheric pressure (i.e. liquefaction). In volume, it occupies 1,600 of that of the vapor at standard conditions, making long distance shipping feasible.

Load/Load Balancing/Load Factor
The load is the amount of gas delivered or required at any specified point or points on a system; load originates primarily at the gas consuming equipment (burner tip) of the customers. Load balancing is the process by which a pipeline uses line pack and storage capabilities to equalize system gas pressures. The load factor represents the percentage of total capacity that is utilized in a given period of time.

Local Distribution Company (LDC)
Company engaged primarily in the purchase and distribution of natural gas to end-users. Closely regulated at the state level, LDCs do not profit from the resale of natural gas (see purchased gas adjustment). They are allowed to earn a return on the investments necessary to distribute the gas to end users.

Looping
Increasing the capacity of a transmission system by installing an additional pipeline alongside the original.

Main
A distribution line that serves as a common source of supply for more than one service line.

Market Hub
Point of interconnection between two or more pipelines, gas processors or storage facilities where the transfer of gas and related service takes place, coordinated by the operator of the hub.

Market Entity
Entity that links customers and gas companies by providing services such as accounting, supply aggregation and sales, and arranging for transportation.

Mileage-Based Rates
Rates designed to reflect the difference in pipeline costs based on the distance between supply sources and delivery points.

Odorant
Any material added to natural or LP gas in small concentrations to impart a distinctive odor. Odorants in common use include various mercaptans, organic sulfides, and blends of these.

Open Season
Period during which a pipeline company consults with market participants seeking customers for a pipeline expansion.
Operational Flow Order (OFO)
An order issued by a pipeline prescribing specific actions to be taken by shippers to alleviate conditions that threaten or could threaten safe operations or pipeline integrity.

Peak Day/Shaving
A peak day is the one-day (24 hours) of maximum system deliveries of gas during a year. Peak shaving is a load management technique where supplemental supplies, such as LNG or storage gas, are used to accommodate seasonal periods of peak customer demand.

Pig
A device used to clean and/or inspect the internal surface of a pipeline. They are inserted into the pipeline by means of a device called a pig-trap and pushed through the line by pressure of the flowing fluid, usually gas.

Postage-Stamp Rate
Flat rates charged for natural gas transportation service without regard to distance.

Price Signals
Commodity prices help market participants interpret the status of the marketplace. For example, low natural gas prices signal an increase in the abundance of gas, low demand, increased supply, or a combination thereof.

Proving reserves
An estimated quantity of natural gas deemed to be recoverable in the future from known oil and gas reservoirs under anticipated economic and current operating conditions. Reservoirs that have demonstrated the ability to produce by either actual production or conclusive formation test are considered proved.

Purchased Gas Adjustment
A provision approved by a regulatory agency allowing a company to make filings to change its rates reflecting its cost of purchased gas. If actual purchased gas costs were lower than anticipated during the previous period, customers may experience a rate decrease. The reverse is true if actual purchased gas costs were higher than anticipated.

Spot Market/Price
A market characterized by short-term, interruptible contracts for specified volumes of gas. Participants may be any of the elements of the gas industry - producer, transporter, distributor, or end user. Brokers may also be utilized. The Spot Price is a current one-time purchase price.

Storage Facility
A subsurface geologic formation suitable for and used to store natural gas for the purpose of fuller utilization of pipeline facilities and effective market delivery or load management.

Stress Crack
Internal or external crack in a material caused by tensile or shear stresses less than that normally required for mechanical failure in air. The development of such cracks is frequently related to and accelerated by the environment to which the material is exposed. More often than not, the environment does not visibly attach, soften, or dissolve the surface. The stresses may be internal, external, or a combination of both.

Sweet/Sour Gas
Sweet gas in its natural state can be used without purifying. Sour gas contains enough sulfur in its natural state to make it impractical to use without purifying.

Transportation
The act of moving gas from a designated receipt point to a designated delivery point pursuant to the terms of a contract between the transporter and the shipper. Generally it is the shipper’s own gas which is being moved.

Unbundling
The separation of the various components of gas sales, storage, transmission, delivery and etc. into an ala carte menu of services from which a customer may choose only those desired; an aspect of a deregulated market.

Unconventional Gas
Natural gas that can not be economically produced using current technology.

Variable Costs
Operating costs which, in the aggregate, vary either directly or indirectly in relation to any change in the volume of gas sold and/or transported; i.e., compressor station fuel and expenses.

Wellhead/Wellhead Price
The wellhead is the point at which gas flows from the ground. The wellhead price is the price of gas flowing from the wellhead, exclusive of gathering, treating, or transportation charges.

Working Gas
Gas in storage which is available for withdrawal during a normal injection and withdrawal cycle.

Common Conversion

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Common Unit</th>
<th>BTU Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>Therm</td>
<td>100,000</td>
</tr>
<tr>
<td>Diesel (light)</td>
<td>Gallon</td>
<td>140,000</td>
</tr>
<tr>
<td>PS300</td>
<td>Gallon</td>
<td>150,000</td>
</tr>
<tr>
<td>Bunker C (heavy)</td>
<td>Barrel</td>
<td>6,400,000</td>
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<tr>
<td>Propane</td>
<td>Gallon</td>
<td>92,500</td>
</tr>
<tr>
<td>Electricity</td>
<td>KWH</td>
<td>3,413</td>
</tr>
<tr>
<td>LNG</td>
<td>Gallon</td>
<td>85,800</td>
</tr>
</tbody>
</table>

1 Ton A/C = 12,000 BTU
1 Boiler HP = 42,000 BTU
100 Boiler HP = 42 Therms
100 lb steam = 1 Therm
1 engine HP = 10,000 BTU
1 BTU = 1 lb water raised 1 F
1 Cu Ft natural gas = 1000 BTU
Boiler efficiency = 80%
Water Heater Efficiency = 75%
BTU = British Thermal Unit
KW = 1000 Watts
1 Therm = 29.3 KWH

Demand charge - not applicable with natural gas