


Rocky Mountain States Natural Gas

Resource Potential and Prerequisites to Expanded Production

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Intended as a reference source for government decision makers, this report was developed by the Department of Energy (DOE) Office of Fossil Energy, in cooperation with the National Energy Technology Laboratory and Energy Information Administration.

DOE's mission includes fostering a secure and reliable energy system that is environmentally and economically sustainable. DOE conducts research on advanced energy technologies and provides scientific, technical, and other information to inform industry and government decision making.

Natural gas is produced in over 30 states (darkened). The U.S. is the world's second-largest producer of natural gas and the third-largest producer of oil. Nearly every region has some oil and natural gas potential.

Overview

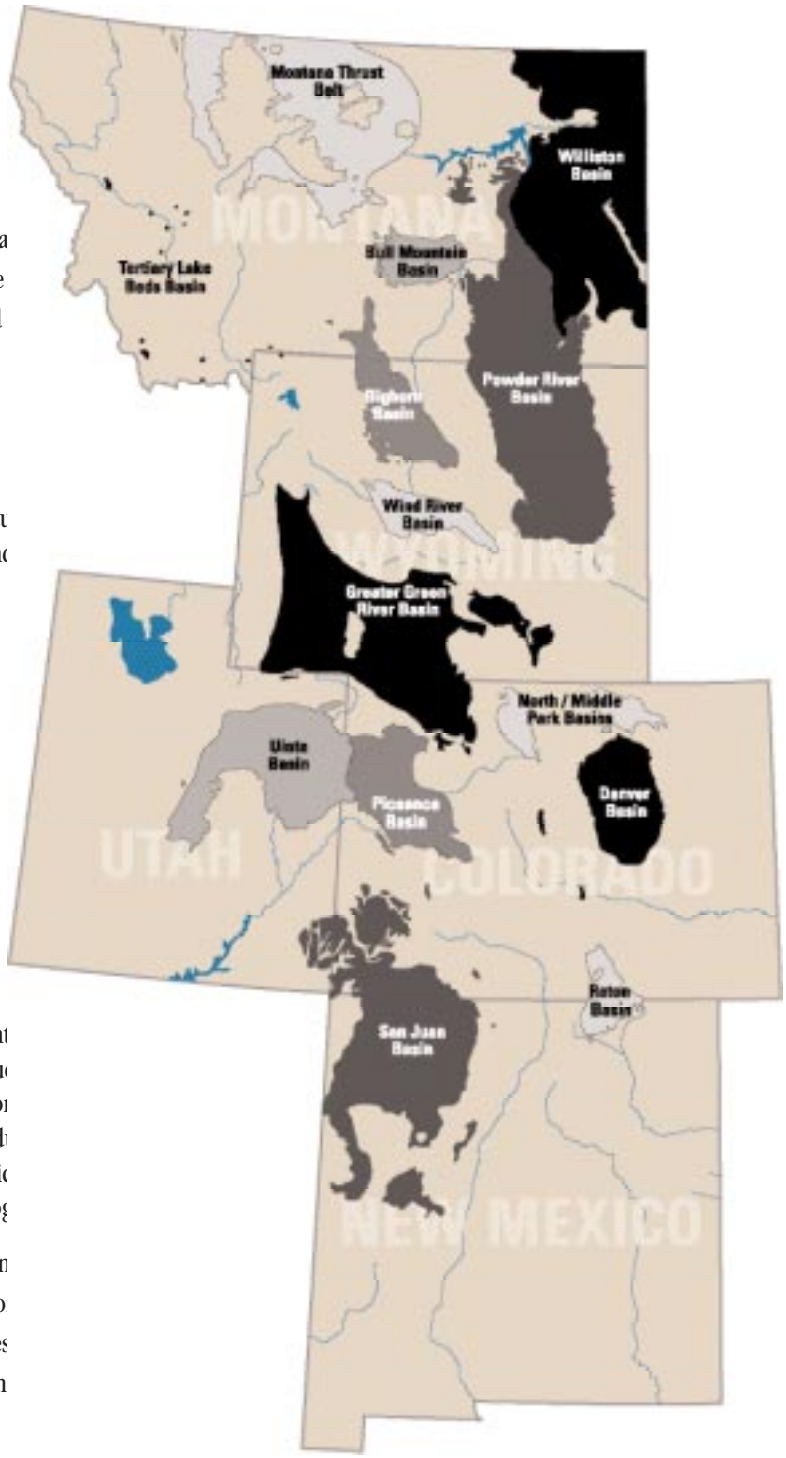
The Rocky Mountain States have the potential to supply the Nation with a vast, untapped resource of natural gas.

Today, growing demand for clean-burning natural gas, declining production in mature geologic basins, and renewed concerns about energy security illuminate the importance of the Rocky Mountain States a major producing region. Over the next two decades, production from the Rocky Mountain States will be critical to meeting the natural gas demand within the United States.

There are three prerequisites to achieving expanded production of this vital North American energy resource:

- **Addressing land-use and environmental concerns**. Much of the natu gas resource in the Rocky Mountain States lies under public lands, an public views on the proper use of these lands are diverse. Currently, land-use and environmental concerns restrict access to these resources and add costs, delays, and uncertainty to gas production. Strategies to increase natural gas production while protecting the environment and regional cultural values will be paramount. Managing produced water and carbon dioxide emissions for productive use may pose significant challenges.
- **Access to markets**. Severe pipeline constraints have contributed to two decades of depressed natural gas prices in the Rocky Mountain States. In recent years, price volatility, in large part due to limited pipeline infrastructure and market access, has discouraged investments in natural gas production in the region.
- **Technology advances.** The bulk of the natural gas in the Rocky Mount is contained in geologically complex, "unconventional" reservoirs, su sandstones and coalbeds. Only a small fraction of the gas resource co formations can be produced profitably with today's technology. Prod resources at reasonable costs will require the development and appli advanced exploration, drilling, completion, and production technolo

This report provides an overview of the available natural gas resources i Mountain States and highlights key issues that may limit future productio within this region. The report is not intended to propose solutions to thes rather to provide information and a framework for future discussions am Federal agencies, and interested parties.



Up to a dozen States have been characterized as Rocky Mountain States. This report focuses on natural gas resources in New Mexico, Colorado, Utah, Wyoming, and Montana.

How Much Natural Gas Is in the Rocky Mountain States?

Four categories of natural gas resources

In-place resources *are the total volumes of gas thought to exist (both discovered and yet-to-be discovered). Although the in-place resource is fixed, our current understanding of that volume is continually changing as technology and our knowledge of geology improve.*

Technically recoverable resources *are a subset of in-place resources that include only gas that is producible given available technology with little regard to costs. Estimates of technically recoverable resources are dynamic, changing to reflect the performance and potential of technology. Estimates of the Nation's technically recoverable gas resources currently range from 1,100 to 1,400 Tcf.*

Economically recoverable resources *are a subset of technically recoverable resources and include only gas that is economically producible. This very dynamic category changes not only with increasing knowledge and technology, but also with rapid and sometimes unpredictable changes in costs, prices, and regulations.*

Proved reserves *are gas resources that have been confirmed by drilling and are available for profitable production. Estimated U.S. natural gas proved reserves are currently 183 Tcf.*

What is a Tcf?

Natural gas is generally priced and sold in units of a thousand cubic feet (Mcf, using the Roman numeral for one thousand). Units of a trillion cubic feet (Tcf) are often used to measure large quantities, as in resources or reserves in the ground, or annual national energy consumption. A Tcf is one billion Mcf and is enough natural gas to:

- *Heat 15 million homes for one year.*
- *Generate 100 billion kilowatt-hours of electricity.*
- *Fuel 12 million natural gas-fired vehicles for one year.*

The Rocky Mountain States hold enormous volumes of natural gas. Increases in geologic understanding and progress in technology will be required to convert these resources into reserves and production.

In-place resources

Between 1987 and 1999, DOE worked closely with the U.S. Geological Survey[1] (USGS) to produce a series of detailed gas-in-place assessments for tight-sand natural gas resources in key producing basins in the Rocky Mountain States, including the Uinta-Piceance[2], Greater Green River, Wind River, and Bighorn Basins. These studies demonstrated the enormous resource present in the region—almost 7,000 trillion cubic feet (Tcf) of gas. Recent work by DOE confirms the presence of these large in-place resources.

With current technology, only a small percentage of the large amount of gas-in-place is technically recoverable. Data for tight gas and coalbed natural gas resources in four of the Rocky Mountain basins, for example, show that only 2 percent of the in-place resource is recoverable (Table 1).[3]

[1] See http://energy.usgs.gov.

[2] Pronounced "you-in-tah pea-ahnce."

Table 1. In-place and technically recoverable natural gas resources in four Rocky Mountain basins (Tcf)

Basin	Tight Gas Sands			Coalbed Natural Gas	
	In-Place Resources		Technically Recoverable	In-Place Resources	Technically Recoverable
	USGS	DOE			
Uinta-Piceance	420	N/A	19	91	4
Greater Green River	5,064	3,600	81	314	1
Wind River	995	1,100	N/A	6	<1
Big Horn	335	N/A	N/A	N/A	N/A
TOTALS	6,814	--	100	411	6

Source: U.S. Geological Survey, National Energy Technology Laboratory, and Advanced Resources International, Inc.

N/A = Not assessed.

Table 2. Technically recoverable natural gas resources in the Rocky Mountain States (Tcf)

Assessment Agency	Technically Recoverable Resources	Proved Reserves	Additional Technically Recoverable Resources		
			New Fields/ Reserve Growth	Tight Gas/ Shales	Coalbed Natural Gas
PGC (2002)**	288	50	175	N/A	63
NPC (1999)*	382	36	155	137	54
EIA (2003)	383	50	52	225	56
USGS (2002)***	226	43	13	127	43

* *Assumes advanced technology as of year 2010; coalbed natural gas resources include low Btu gas resources.*

** *Combines tight gas, gas shales, and conventional gas.*

*** *Includes only five gas basins in the Rocky Mountain States (Paradox-San Juan, Uinta-Piceance, Greater Green River, Powder River, and Montana Thrust Belt) .*

Technically recoverable resources

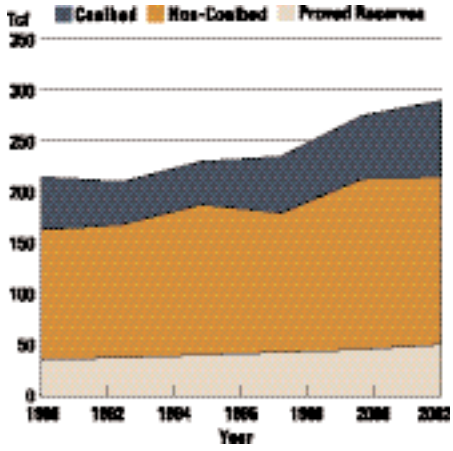
The technically recoverable gas resources in the Rocky Mountain States have been assessed periodically by a number of organizations, as summarized in Table 2. Each of these estimates, prepared at different times and using somewhat different assumptions, shows a large underdeveloped natural gas resource.

- The Potential Gas Committee (PGC, 2002[4]) recently increased their natural gas assessment for the Rocky Mountain States to 288 Tcf of technically recoverable resources, including 50 Tcf of proved reserves.
- The National Petroleum Council (NPC, 1999[5]) estimated 382 Tcf of future natural gas in the Rocky Mountain States, with 36 Tcf of proved reserves and 346 Tcf of additional technically recoverable resources. A new study, to be completed in September 2003, will provide further insights on natural gas resources in the Rocky Mountain States.
- The Energy Information Administration (EIA, 2003[6]) uses a natural gas resource base for the Rocky Mountain region of 383 Tcf, similar overall to the NPC, but with more tight gas and less conventional gas.
- As part of the recent EPCA study[7], the U.S. Geological Survey (USGS, 2002) placed the additional technically recoverable resource for five basins in the Rocky Mountain region at 226 Tcf, with 13 Tcf for conventional gas, 127 Tcf for tight sands and gas shales, and 43 Tcf each for coalbed natural gas and proved reserves.

As geologic knowledge and technology for finding and producing natural gas have improved, the estimated volume of natural gas resources in the Rocky Mountain States has grown. Figure 1 shows technically recoverable natural gas resources in the Rocky Mountain States as estimated by the PGC in their past six biennial assessments. The PGC's estimate of the remaining undeveloped natural gas resources in the Rocky Mountain States has increased 35 percent in 12 years, in addition to replacing production of about 2 to 3 Tcf per year.

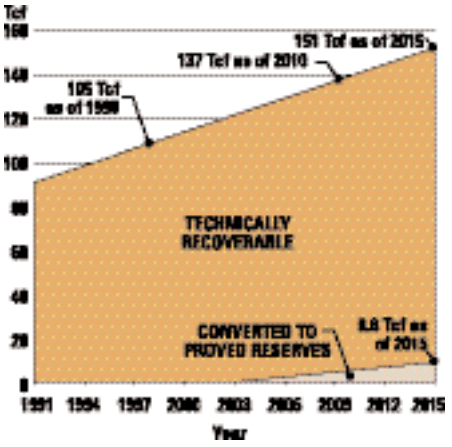
Assuming ongoing investment in expanding the geologic knowledge base and technology progress, upward trends in resource assessment and recovery are expected to continue. As seen in Figure 2, the NPC projects technically recoverable tight-gas sands resources in the Rocky Mountain States to grow from 105 Tcf in 1998, to 137 Tcf in 2010, and to 151 Tcf in 2015 (NPC, 1999).

Figure 1. Assessments of natural gas resources in the Rocky Mountain States have shown a steady, technology-driven expansion.



Source: Potential Gas Committee, 1990-2002.

Figure 2. With progress in technology, tight-gas technically recoverable resources are projected to grow. However, without access to resources and markets, only a small portion—6.6 Tcf—is converted to proved reserves and production.



Source: National Petroleum Council, 1999.

[3] These four deep coal basins have low gas-in-place recovery. Other Rocky Mountain coalbed basins have considerably higher recoveries. For example, the San Juan Basin, with 50 Tcf of gas-in-place in its Fruitland formation coals, has already produced 9 Tcf, has 9 Tcf in proved reserves, and still has 17 Tcf as additional technically recoverable natural gas: an overall recovery of 35 Tcf or 70% of the gas-in-place. The Powder River Basin, with 61 Tcf of gas-in-place, has produced 1 Tcf, has 2 Tcf of proved reserves, and has 36 Tcf of additional technically recoverable natural gas: an overall recovery of 39 Tcf or 64% of the gas-in-place. For more information, refer to footnote 21.

[4] The Potential Gas Committee is an organization of volunteer experts from the natural gas industry, government agencies, and academic institutions concerned with predictions of natural gas resources. See www.mines.edu/research/pgc.

[5] The National Petroleum Council is an advisory body to the Secretary of Energy. In March 2002, the Secretary of Energy requested that the Council conduct a study on natural gas in the United States in the 21st century, building on prior studies completed in 1992 and 1999. This study will be completed in September 2003. See www.npc.org.

[6] See www.eia.doe.gov.

[7] *Scientific Inventory of Onshore Federal Lands' Oil and Gas Resources and Reserves and the Extent and Nature of Restrictions or Impediments to Their Development* is a report prepared by Departments of the Interior, Agriculture, and Energy, January 2003, in compliance with the Energy Policy and Conservation Act (EPCA) Amendments of 2000, P.L. 106-469, Section 604. See Appendix II and www.doi.gov/epca. Also, see www.doi.gov/news/030116a.htm.

Challenges of estimating natural gas resources

All natural gas resource estimates change continually in response to advances in geologic knowledge, technology, and the economic and policy conditions under which extraction is expected to occur. Thus, it is of vital importance that accurate and timely assessments of the Nation's potential resources are available to ensure that public policy is based on sound information.

Estimates of resources in the Rocky Mountain States are even more uncertain. One factor contributing to uncertainty is the limited data available on sparsely drilled areas. A single, additional good or bad well can dramatically change the outlook for a prospective play[8] within the Rocky Mountain States. Similarly, the inability to accurately determine key reservoir parameters (such as water saturation) creates major uncertainty in assessed volumes.

A second major factor is the difficulty of estimating technology progress. The economics of unconventional resources are particularly sensitive to recovery technology; however, resource assessments typically limit consideration to either current technology or incremental improvement on current technology. Consequently, major technological leaps that significantly reduce exploration and product costs—such as reliable natural fracture detection or dramatic advances in drilling—can create large and unexpected additions to recoverable resources. For example, many early assessments in Rocky Mountain States excluded deep natural gas resources (deeper than 15,000 feet) based on the assumption that these resources would not be economic for the foreseeable future. Drilling to such depths is now commonplace.

[8] A "play" is a set of known or postulated natural gas accumulations sharing similar geologic, geographic, and temporal properties, such as source rock, migration pathway, timing, trapping mechanism, and hydrocarbon type.

Proved reserves

The Rocky Mountain States are providing a larger and larger portion of U.S. proved natural gas reserves. These reserves have increased by nearly two-thirds over the last decade—from 31 Tcf in 1990 to 50 Tcf in 2001—and now account for 27 percent of the U.S. total of 183 Tcf (Table 3).

About half of the increase has been from coalbed natural gas. In 2001, 84 percent of U.S. coalbed natural gas reserves (14.7 Tcf out of 17.5 Tcf) was from five Rocky Mountain States (Table 3). The remaining coalbed natural gas reserves are in Alabama, the mid-continent, and the Appalachian States of Pennsylvania, West Virginia, and Virginia.

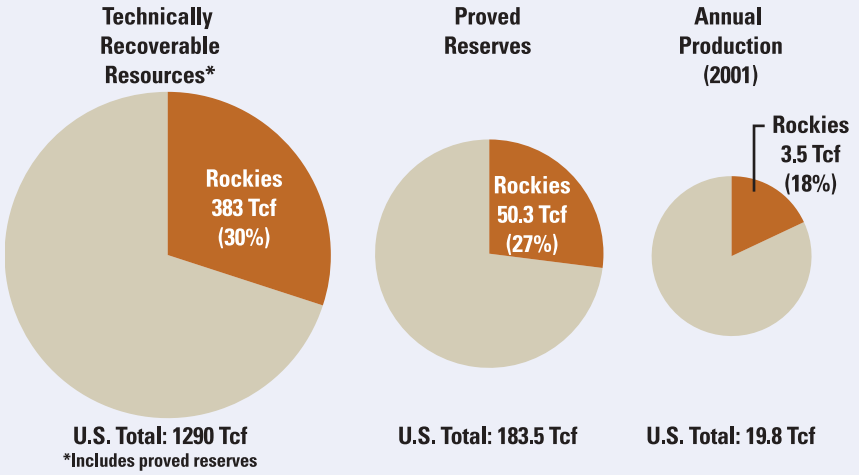
Table 3. Proved reserves, 2001 (Tcf)

	Colorado	Western New Mexico	Utah	Wyoming	Montana	5-State Total	U.S. Total
Total Dry Gas	12.5	13.9	4.6	18.4	0.9	50.3	183.5
Coalbed Natural Gas	6.3	4.3	1.7	2.3	0.1	14.7	17.5

Source: Energy Information Administration.

Natural gas production potential

The Rocky Mountain States provided 18% (3.5 Tcf) of the Nation's natural gas supply in 2001. With 30% (over 383 Tcf) of U.S. estimated technically recoverable resources, including 27% (over 50 Tcf) of U.S. natural gas proved reserves, this region has the potential to become a much larger source of the Nation's future natural gas supply.



Source: Energy Information Administration (2003).

Natural gas, essential to the U.S. economy, fueled a significant portion of total U.S. energy demand in 2001. By sector, total natural gas consumption represented 3% of transportation, 40% of commercial, 45% of residential, 36% of industrial, and 14% of power generation energy use.

Natural Gas Production in the Rocky Mountain States

Unconventional tight gas and coalbed natural gas account for the bulk of natural gas resources in the Rocky Mountain States.

Natural gas resources in the Rocky Mountain States are primarily in unconventional tight-gas or coalbed natural gas formations that present special production challenges. Advances in technology will be essential for unlocking these geologically complex resources.

Challenging formations

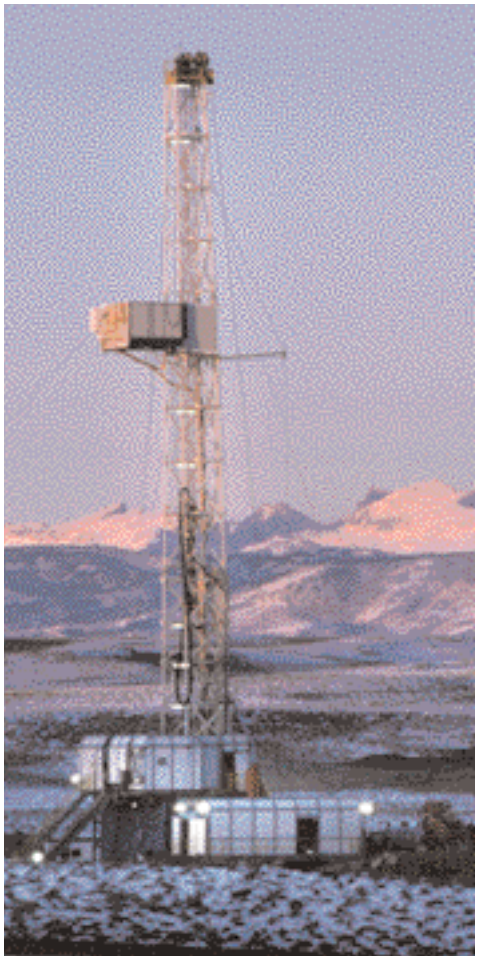
Tight-gas formations. In low-permeability natural gas reservoirs, gas is greatly restricted from flowing through the formation to the wellbore.[9] Such tight gas—particularly in the Rocky Mountain region—often occurs in continuous accumulations, typified by thick sequences of alternating sandstones and shales covering vast regions.

The good news is that tight-gas wells often can be highly productive if the wellbore can be connected with an existing, natural network of open fractures, which are present in many tight-sandstone reservoirs. Industry routinely uses hydraulic fracturing to access such networks. In the "frac" treatment, proppants and fluids are injected at high pressures to create a single, thin (a fraction of an inch) fracture that extends vertically outward from the borehole. Once the rock is cracked open, the fluid (which must be carefully designed so as not to damage the formation) flows back to the wellbore and is retrieved, and the proppant (typically sand) remains to prop the fracture open. Hydraulic fracturing is expensive, but can yield significant improvements in well productivity. Sometimes horizontal drilling is used to access natural fracture networks.

A major challenge in tight-sandstone production today is the development of technologies to locate and diagnose areas of densely spaced, open, and gas-filled fractures. When an extensive fracture network is tapped, tight-gas sandstone wells can be spectacularly successful.

Coalbed natural gas. Coal seams contain methane, sometimes mixed with trace amounts of nonhydrocarbon gases such as carbon dioxide. Most of this coalbed natural gas is stored on the internal surfaces of the coal itself through a phenomenon called adsorption. Compared to conventional reservoir rock, which stores natural gas in void spaces, coal can hold considerably more natural gas per cubic foot.

Coalbed natural gas production differs from conventional natural gas extraction. In conventional sandstone reservoirs, after a well is drilled and completed, natural gas flows into the well when pressure is reduced in the wellbore. More significant pressure reduction is required to produce coalbed natural gas. This reduction is achieved through dewatering. As water is pumped out of the coal seams, reservoir pressure decreases, allowing the natural gas to release (desorb) from the surface of the coal, diffuse through micropores, and then flow through coal cleats (natural fracture networks) into the well. In instances where a coal seam is mined, dewatering still takes place and the natural gas in the mined portion of the seam, if not recovered, may be emitted to the atmosphere as methane, a greenhouse gas.



Deep natural gas well in Wyoming.

Well productivity in the Rocky Mountain States ranges dramatically, from "superwells" of the conventional, deep Madden field (some with nearly 1 Tcf of reserves per well) and the exceptionally productive naturally fractured tight-gas wells, to common marginal/sub-economic tight-gas wells and thousands of very poor producers. The average well in the region will produce from 100 to 400 Mcf per day in the first few years, then slowly decline, ultimately reaching "stripper well" status after 15 to 20 years of production.

[9] Technically, tight-gas formations are defined as having average in situ permeabilities of 0.1 millidarcies or less.

Growth in Rocky Mountain States natural gas production

Annual production from Rocky Mountain States has risen from 2.3 Tcf—or 6.3 billion cubic feet per day (Bcfd)—in 1990 to over 3.5 Tcf (9.7 Bcfd) in 2001. Figure 3 shows the significant increase in Rocky Mountain natural gas production and reserves since 1990.

Both oil and natural gas have been produced in the Rocky Mountain States for about a century.

Key milestones contributing to increased natural gas production in the Rocky Mountain States over the past three decades include production from the Idaho-Wyoming thrust belt beginning in the late 1970s; increased production from the Greater Green River Basin (GGRB) in the mid 1980s; the development of San Juan Basin coalbed natural gas in the late 1980s; the recent addition of new tight-gas production in the Jonah Field of the GGRB; ultra-deep drilling (25,000 feet) in the Madden Field of the Wind River basin; and recent development of shallow coalbed natural gas in the Powder River Basin.

Increased gas production in the Rocky Mountain States is due, in significant part, to increased development of coalbed natural gas. In 2001, coalbed natural gas accounted for over half of all Rocky Mountain States natural gas production and 8 percent of total U.S. natural gas supply. Table 4 shows total natural gas production, including coalbed natural gas production, in five Rocky Mountain States and the U.S. for 2001.

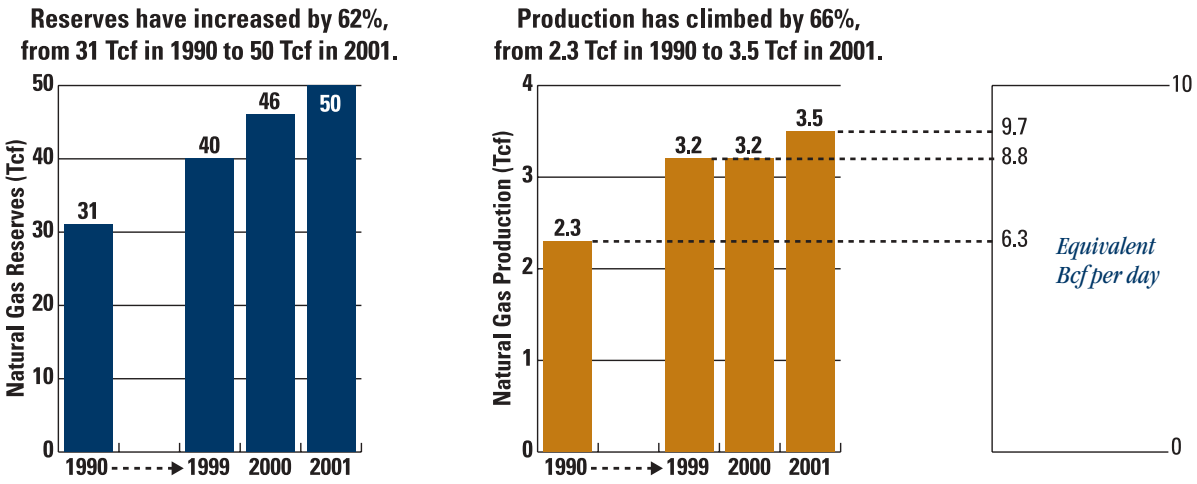
Looking ahead, the Rocky Mountain States are expected to provide the Nation's largest increase in new natural gas supply, as set forth by EIA's 2003 Annual Energy Outlook (Figure 4). **EIA's analysis assumes that the major prerequisites described in this document are successfully addressed**.

Table 4. Natural gas production in 2001 (Bcf)

	Colorado	Western New Mexico	Utah	Wyoming	Montana	5-State Total	U.S. Total
Total Dry Gas	882	1,018	288	1,286	73	3,547	19,779
Coalbed Natural Gas	490	517	83	278*	4	1,372	1,562

** The Wyoming Oil and Gas Commission reports 251 Bcf of coalbed natural gas in 2001.*
Source: Energy Information Administration.

Figure 3. Rocky Mountain States natural gas reserves and production have climbed steadily in the past years.



Source: Energy Information Administration, 1990-2001.

Natural gas development and agriculture coexist in many areas of the Rocky Mountain States.

The coming years promise active coalbed natural gas drilling in the Powder River Basin. Less than seven years ago, fewer than 200 wells produced just over 27 million cubic feet per day (MMcfd) of coalbed natural gas from this basin. Today, the Powder River Basin is arguably the hottest natural gas play in the United States, with 10,700 wells producing close to 1 billion cubic feet (Bcf) per day of coalbed natural gas and another 3,000 wells awaiting pipeline connection, electric service, issuance of water discharge permits, or the addition of compression. Table 5 provides well and production data for the Powder River Basin, reflecting its unprecedented pace of resource development.

Table 5. Powder River Basin coalbed natural gas data (Wyoming only)

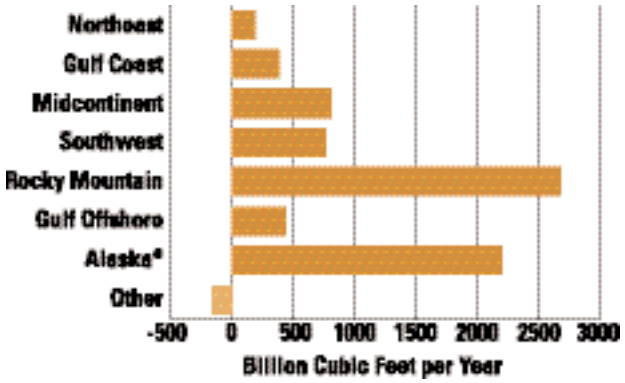
Date	Coalbed Natural Gas Production (MMcfd)	Water Production (Thousand barrels/day)	Producing Wells	Shut-In Wells*
12/1996	27	64	178	85
12/1998	111	229	652	362
12/2000	545	1,205	4,506	2,575
12/2002	961	1,608**	10,717	3,000

* *Includes wells with proved reserves but unable to produce pending pipeline connection, electric service, environmental permits, or compression equipment.*

** *On average, this was equivalent to about 4 gallons per minute per well. In aggregate, water production from all wells could have filled 41 one-acre, five-foot deep farm ponds per day, or supplemented the region's annual rainfall (16.6 inches at Sheridan, Wyoming) by about 0.1 inches.*

Source: Wyoming Oil and Gas Conservation Commission.

Figure 4. Rocky Mountain States could provide the largest regional increase—an additional 2.7 Tcf per year—in future U.S. natural gas supplies by 2025.



** Assumes that the Alaska Natural Gas Pipeline is completed before 2025.*

Source: Energy Information Administration, 2003.

Historical perspective on Rocky Mountain States gas production

In the early 1970s, domestic natural gas production was in a seemingly unstoppable decline. Energy prices were soaring, and our Nation's energy supplies and economic health were threatened. Congress was informed that a dwindling domestic natural gas resource could not sustain existing supply rates beyond the end of the decade and would likely be only a minor energy source by the year 2000.

In response to escalating gas supply shortages in the mid 1970s, Congress passed the Natural Gas Policy Act of 1978 (P.L. 95-621), which included the phased deregulation of wellhead price controls on natural gas as well as restrictions on gas use for power generation. Most significantly, the Federal government accelerated its efforts to assess opportunities for adding vast new potential natural gas sources. Tight-gas sandstones and coalbed natural gas were identified as prime candidates for securing the future of domestic gas supply. These resources were determined to exist throughout the Nation, but were particularly concentrated in the Rocky Mountain States.

Significant DOE-led research and development programs were initiated (later augmented by work by the Gas Research Institute and others), with the objectives of establishing the size and potential of these resources, and developing advanced technologies that would enable economic recovery of natural gas from these complex formations. The challenge was significant. Coalbed natural gas recovery technology was nonexistent and the tight-gas resource of the Rocky Mountain States was poorly understood and almost exclusively uneconomic. The gas production industry, accustomed to conventional gas structures and characteristics, expressed great skepticism about the prospect of widespread production from unconventional units.

Beginning in 1987, a cooperative program of resource assessments between DOE and the USGS convinced many that the region held an incredibly vast gas resource, which merited industry and government investments to overcome the technical challenges of large-scale tight-gas production.

Prerequisites to Expanded Natural Gas Production in the Rocky Mountain States

Cost-effective production is contingent on appropriate land use, environmental stewardship, access to markets, and technology advancement.

At first glance, the prospect of supplying a larger portion of growing natural gas demand from the Rocky Mountain States seems favorable. Not only is there a large resource (almost 7,000 Tcf gas-in-place), but estimates of its producibility have tended to increase with each passing year. However, production of this resource is currently being constrained by a number of factors. Three prerequisites to cost-effective production of natural gas from the Rocky Mountain States are addressing land-use and environmental concerns, access to markets, and technology advancement.

Prerequisite 1: Addressing Land-Use and Environmental Concerns

Environmental and land-use issues are central to natural gas production in any region, and particularly so in the Rocky Mountain States, where public lands, Federal mineral estates, wildlife, and sensitive environments are pervasive. A significant portion of public lands containing natural gas resources in the Rocky Mountain States is unavailable for leasing, in order to preserve wilderness, wildlife habitat, and other important societal values. For example, National Parks and areas designated as wilderness are managed for preservation, and natural gas drilling is prohibited. On public lands managed for multiple uses, operators must meet a wide array of environmental protection requirements.

21.2 million acres—36%—of Federal lands in five oil and natural gas basins in the Rocky Mountain States are permanently set aside to preserve wilderness, wildlife habitat, and other societal values.

Access to Federal lands

The complexity of gaining access to public lands and Federal mineral estates may be the most significant issue limiting natural gas production in the Rocky Mountain States. The Department of the Interior's Bureau of Land Management (BLM) and the Department of Agriculture's Forest Service manage the majority of public lands in the Rocky Mountain States.[10] These "Federal lands" are managed to accommodate a variety of uses, such as grazing, recreation, timber production, and mineral extraction. Before a natural gas well can be drilled on Federal lands, a lengthy series of planning, leasing, and permitting actions must be undertaken.

Federal lands managed by the BLM and the Forest Service in Rocky Mountain States exist within a patchwork of State, private, and Tribal lands. In some cases, geologic formations containing natural gas are overlain by complex ownership patterns, requiring industry to deal with several different surface owners and government agencies and to comply with multiple sets of

[10] See Appendix I, Stewards of Federal Lands, for information on the statutory authorities and multiple-use missions of these land management agencies, www.blm.gov and www.fs.fed.us. Also note, the Department of the Interior often refers to the Rocky Mountain area as the "Interior West."

leasing and operating requirements. A myriad of restrictions and leasing stipulations can impede access to natural gas resources, increase production costs, and delay activity. Restrictions range from areas unavailable for leasing, to areas where the minerals can be leased but the land surface may not be occupied to recover them, to limitations on drilling activity due to a variety of environmental considerations. Further, the application of these restrictions and stipulations can be inconsistent across government agencies and across different field offices within the same agency.

In early 2003, an inventory of selected onshore Federal lands was completed, as mandated by the Energy Policy and Conservation Act (EPCA). The purpose of this interagency effort involving the Department of the Interior (DOI), the Department of Agriculture, and DOE was to estimate the oil and gas resources underlying these lands and to identify impediments to their development. The EPCA study analyzed the proved reserves and technically recoverable resource potential of five Rocky Mountain basins that contain the bulk of the natural gas resource and much of the oil resource under Federal management in the onshore United States. Cumulative results can be found in Appendix II. The inventory of the five basins found that:

- 23.1 million acres (39 percent of the total study area) containing 63 percent (86.6 Tcf) of the technically recoverable natural gas resources including proved reserves are available for leasing with standard stipulations.
- 15.2 million acres (25 percent of the total study area) containing 25 percent (36.0 Tcf) of the technically recoverable natural gas resources including proved reserves are available for leasing with restrictions on operations beyond standard stipulations.
- 21.2 million acres (36 percent of the total study area) containing 12 percent (15.9 Tcf) of the technically recoverable natural gas resources including proved reserves are not available for leasing.

Federal stewardship creates a special interest and responsibility to maximize the value of oil and gas resources. Any increase in recovery of oil and gas resources from Federal lands directly contributes to Federal and State revenues. On average, DOI collects and distributes over $1 billion per year from bonuses, rents, and royalties from Federal onshore mineral leases. In the Rocky Mountain States, these revenues are distributed as follows:

- 50 percent goes directly to States within which specific leases are located. States determine how to use these monies—often for schools, roads, and general operations—and to mitigate development impacts.
- 40 percent goes to the Reclamation Fund of the U.S. Treasury, a special account that finances the Bureau of Reclamation's water projects in 17 Western States.
- The remaining 10 percent goes to the U.S. Treasury's General Fund.

From fiscal year 1982 through fiscal year 2002, DOI distributed over $10 billion in aggregate to the States of New Mexico, Colorado, Utah, Wyoming, and Montana.[11]

[11] U.S. Department of the Interior, Minerals Management Service, *Facts and Figures 2003*. Also see www.mrm.mms.gov/Intro/WhoWeAre.htm.

Standard Stipulations

Standard terms in Federal oil and gas leases address:

- *Rentals and royalties*
- *Bonds for lease operations*
- *Diligence, rate of development, and drainage to prevent unnecessary waste or damage to leased resources*
- *Plans, records, and other reports*
- *Inspections, easements, and rights-of-way*
- *Conduct of operations in a manner that minimizes adverse impacts on the environment, as well as for other land uses*
- *Adherence with Federal environmental protection laws and regulations*
- *Reclamation measures*
- *Property damages*
- *Protection of diverse interests and equal opportunity, including worker and public health and safety*
- *Lease transfer, relinquishment and/or forfeiture*

For further information on the stipulations of oil and gas leases, see BLM Form 3100-11 and 43 CFR 3100, and Forest Service Manual Part 2820.

Federal planning, leasing, and permitting

Before a natural gas well can be drilled on Federal land, a complex series of planning, leasing, and permitting actions must be undertaken by land management agencies, principally BLM and the Forest Service.

Planning

Before any Federal lands can be offered for lease, they must be evaluated through a multiple-use planning process, resulting in "resource management plans" (RMPs) in BLM, and "forest plans" in the Forest Service. Environmental Impact Statements (EISs), required by the National Environmental Policy Act (NEPA), must be prepared to gather and evaluate available environmental information. This public process includes public meetings to scope the issues, drafts for public review of and comment on proposed alternatives, and a comment period following the final EIS. Finally, a Record of Decision (ROD) is issued to document the decisions in the plan and actions to be taken. Some decisions involve designation of lands in the planning area that are available for leasing and specification of restrictions to be placed on those leases.

Time-sensitive plans. *RMPs and forest plans are intended to be updated every 10 to 15 years. The updating process commonly takes two-and-a-half to three years, sometimes longer. However, BLM is expediting 21 time-sensitive RMPs. These plans address high-priority and complex issues, including increasing demands on the wildland-urban interface in the rapidly urbanizing West; new listings of threatened and endangered species; increased demands for domestic energy supply; new mineral extraction technologies; the need for modernization of energy transmission infrastructure; and Congressional and court-mandated deadlines. Nine of the 21 plans are located in the Rocky Mountain States in areas with prospective natural gas resources: Colorado (Roan Plateau); Montana (Powder River); New Mexico (Farmington); Utah (Price, Vernal); and Wyoming (Powder River, Great Divide, Pinedale, Jack Morrow Hills). Some time-sensitive plans have already been completed, and all are scheduled to be completed by the end of 2004.*[12]

Wyoming and Montana coalbed natural gas. *Two recent BLM planning decisions in the Rocky Mountain States address the development of coalbed natural gas. After almost three years of comprehensive environmental analysis regarding development of these resources in the Powder River Basin, BLM has issued two EISs and accompanying RODs. The BLM worked with multiple State and Federal agencies and Tribes before issuing decisions in April 2003.*

The two EISs addressed the impacts of resource development for approximately 8 million acres of Federally administered public lands and mineral estate in Wyoming, approximately 4.7 million acres in the BLM's Montana planning areas, and the entire State of Montana.[13] *To extract the estimated 39 Tcf of natural gas in the Powder River Basin, almost 51,000 wells are anticipated in the Wyoming portion of the basin over the next 10 years. An additional 26,000 wells are expected to be needed in the Montana portion of the basin as well as in the rest of the State over the next 20 years. Impacts to air quality, geology, and minerals; hydrology; Indian trust resources; lands and realty; noise; wildlife; livestock grazing; and cultural and paleontological resources were assessed. With the EISs completed, BLM and the State of Montana can consider drilling and development proposals in the area studied. Before any project proposals are approved, site-specific environmental reviews must be conducted to identify potential environmental impacts and appropriate mitigation measures.*

As part of the NEPA process, RODs are issued to finalize proposed decisions addressed in the EISs. The RODs also summarize a preferred alternative[14] *for government action, including how current oil and gas programs would be altered to allow coalbed natural gas development to occur on the Federally administered public lands within the Power River Basin, as well as within the entire State of Montana. The RODs establish a working group—consisting of Tribes and State and Federal agencies—that will assist the BLM in addressing natural gas and oil development issues in the basin and ensuring coordination between Montana and Wyoming on issues common to both States. They also specify required mitigation measures appropriate for each environmental resource and the monitoring procedures that will be implemented by the agencies and required of industry.*

[12] For example, see www.pinedalermp.com.

[13] The Montana EIS was developed jointly with the State of Montana and addressed coalbed natural gas development in the entire State, as required by Montana State law.

[14] The Montana preferred alternative allows industry to use various water-handling methods with emphasis on beneficial reuse and protection of surface-water quality. All development activities must be directed toward sustaining resources, social values, and existing land uses. The Wyoming preferred alternative includes a water-handling method that emphasizes infiltration and the use of only natural gas-fired compressors in the basin. The remaining management actions under the alternative outline the number of wells per watershed and the typical drilling and infrastructure construction methods.

Leasing

Once lands are made available for leasing, lands nominated by industry or the public are offered in competitive lease sales. Sales occur at least quarterly when parcels are available. A sale notice is published for public review at least 45 days before each sale. A minimum bonus of $2 per acre is required to open bidding with the highest bidder being offered the lease. The successful bidder must pay the bonus, plus a $1.50 per acre rental fee and a $75 administrative fee. Any parcels that did not receive bids are available for noncompetitive leasing for two years. Leases grant the right to explore for, drill, and produce oil and gas and have a primary term of 10 years.

After 10 years, the lease can be extended as long as commercial quantities of oil or gas are produced. Royalty on production is, at minimum, 12.5 percent for both competitive and noncompetitive leases. Before the lease is issued, stipulations specified in the land-use plan are attached, in addition to standard stipulations that require diligent and environmentally protective operations. The lessee must also provide a bond that assures both compliance with requirements and that wells will be properly plugged and abandoned at the end of their productive life. No separate NEPA analysis is required at the leasing stage.

Permitting

Once a lease is obtained, the operator must get permits to drill the wells. Additional NEPA analysis is performed at this stage, along with interagency consultations on endangered species and cultural (archaeological) resources and a site inspection to determine site-specific requirements. Each well must have at least an Environmental Assessment, a NEPA analysis that is less involved than an EIS. However, large projects or wells in especially sensitive environments may require a full EIS, taking up to two years or longer. The NEPA analysis as well as the surveys for threatened or endangered species and cultural resource sites may result in additional "conditions of approval."

Improved permitting. *While BLM's goal is to issue a drilling permit within 35 days of receiving a complete application, the process commonly takes longer. An industry analysis of BLM data from 2002 found approval times ranged from 67 to 370 days with an average of 137 days.[15] In April 2003, the DOI announced fundamental new management strategies aimed at improving BLM's permitting process.[16] The new approaches advance President Bush's National Energy Policy and his goal of strengthening America's energy security while giving the DOI, oil and gas producers, and all Americans more effective environmental analyses and less bureaucratic application processing. These innovative strategies will update the permit application process while ensuring protection of cultural, environmental, and other resources on Federal lands.*

[15] Independent Petroleum Association of Mountain States, *Permitting Delays Worsen on Federal Lands*, February 2003. See www.ipams.org.

[16] See www.blm.gov/nhp/news/releases/pages/2003/pr030414_ogpermits.htm.

[17] Timing may be concurrent, rather than sequential.

[18] The operator has the option of submitting a "notice of staking" (NOS), in which case BLM conducts the on-site inspection before submittal of the permit application. Results of the inspection can then be incorporated in the APD, which can shorten approval time.

[19] White, R., 2002. Powder River Basin Coalbed Methane Drilling Processes, Presentation at the CBM 2002 Information Fair, Gillette, WY. For information on State requirements, see: www.emnrd.state.nm.us/ocd; www.oil-gas.state.co.us; www.ogm.utah.gov/oilgas; http://wogcc.state.wy.us; www.bogc.dnrc.state.mt.us.

Obtaining a drilling permit on Federal lands

Industry must adhere to numerous regulatory requirements to drill for and produce natural gas on Federal lands in the Rocky Mountain States. These are contained in permits, lease conditions, operating orders, and notices to lessees. A primary requirement is the Application for Permit to Drill (APD).[17]

1. *Operator submits an APD,[18] which is posted for 30 days.*
2. *Operator notified within 7 working days whether APD is complete.*
3. *On-site inspection held within 15 days of APD submittal.*
4. *Surface use and reclamation conditions of approval developed within 5 working days of inspections.*
5. *BLM consults with Fish and Wildlife Service on threatened and endangered species; review/survey conducted; mitigation measures specified if needed.*
6. *BLM consults with State Historic Preservation Office on cultural resources; review/survey conducted; mitigation measures specified if needed.*
7. *Conditions of approval may be required to protect animal habitat or archaeological sites.*
8. *Complete NEPA analysis within 5 working days (Forest Service has additional 30-day comment period followed by 45-day appeal period).*

State permits

Permits[19] required by Wyoming agencies for a coalbed natural gas well in the Powder River Basin:

Form 1	*Permit to Drill (application)*
Form 3	*Completion Report*
Form 4	*Sundry Notices*
Form 4A	*Severance Tax Certification*
Form 14B	*Permit to Use and Construct Earthen Pit*
U.W. 5	*Appropriate Ground Water (application)*
U.W. 6	*Statement of Completion*
U.W. 8	*Proof of Appropriate and Beneficial Use of Ground Water*
NPDES	*Water Discharge Permit*

Drilling permits for wells not on Federal lands are issued by the State in approximately one week.

Natural gas wells share the landscape with wildlife on lands that are managed for multiple uses.

Land management issues

Recently, many, if not most, significant Federal land management decisions allowing natural gas development have been challenged in court by individuals or groups who do not want to see the development proceed. For example, BLM was sued almost immediately on its environmental impact statements and records of decision to move forward with coalbed natural gas development in the Powder River Basin.

Litigation delays natural gas exploration and development in two ways: First, activity is delayed while the lawsuits are resolved. Second, the land management agencies expend considerable time and resources to assure that their decisions are litigation-proof. Since most of these lawsuits address procedural rather than substantive matters, this extra effort does not necessarily add to the quality of or basis for the decision and therefore may not increase environmental protection. Costs, staff time, and delays could be reduced if ways were found to decrease the number of lawsuits filed against land management decisions while assuring public participation in the decision process and protecting the rights of those directly affected by the decisions.

Another set of important issues arises in those cases where the Federal government owns the rights to the minerals underground, but the surface of the land is privately owned. This is known as "split estate." BLM manages 300 million acres of split estate nationwide. Much of the Federally owned natural gas resource in the Powder River Basin, including much coalbed natural gas, is in split estate. Current law generally gives the mineral lessee the right to recover the natural gas even if the surface owner does not wish the operations on the land. The surface owner is entitled to damages, such as from loss of crops, that result from the natural gas operations. BLM requires that the lessee make a good-faith effort to reach an access agreement with the surface owner, and to submit a self-certification regarding an agreement, waiver, compensation, or adequate bond for damages with the drilling application permit. An agreement is achieved in the majority of cases, but split-estate issues have resulted in friction between landowners, such as ranchers and farmers, and natural gas producers.

Environmental protection issues

Water management issues. Ensuring water quality and adequate supplies of water for future generations are issues of importance to all Americans, particularly in the West. States regulate the management of produced-water discharges from natural gas operations,[20] and gas producers have a variety of water management options depending on the characteristics of the produced water and the surface and subsurface environment. They may store the water in constructed surface ponds, letting the water evaporate in the arid climate and infiltrate into the ground. If the water is fresh enough, it may be discharged, under an approved permit, into a stream or river. If necessary, the water may be treated with a process such as reverse osmosis so that it is made fresh enough to discharge. In other cases, produced water is injected underground to depths of thousands of feet. The economics of the various methods can play a large role in determining whether the gas production project will make enough profit to go forward.[21]

Where possible, gas producers find beneficial uses for the water, such as livestock watering, irrigation under the right conditions, or recharge of shallow drinking water aquifers. Such uses can have benefits for producers, landowners, and the region in general. Currently, DOE and BLM are jointly funding a study of the opportunities for beneficial use of produced water throughout the Rocky Mountain States. The study is looking at the technical, economic, and regulatory feasibility of a wide range of options for beneficial use.

Managing the significant volumes of water often produced in association with coalbed natural gas is particularly challenging. In the Powder River Basin of Wyoming and Montana, for example, nearly 14,000 coalbed natural gas wells were drilled in the Wyodak and Big George formations from the end of 1998 through 2001 (with over 10,700 producing), and coalbed natural gas production grew from 111 Mcfd to 960 Mcfd. Along with this growth has come growth in produced water. By the end of 2002, coalbed natural gas wells were producing 1.6 million barrels[22] of water per day, up from about 200,000 barrels per day at the end of 1998.

Production and disposal of this water has become a significant potential barrier to expansion of coalbed natural gas production in the basin. A major concern is the sheer quantity of water, which poses questions about aquifer depletion and a potential threat of stream erosion and contamination of groundwater. In some settings, wells had been drilled into coals or adjacent formations for the sole purpose of providing water for human consumption, livestock watering, or agricultural purposes. Producing significant volumes of water to liberate coalbed natural gas may drop the water table and reduce the deliverability potential of water-bearing formations that are used as aquifers.

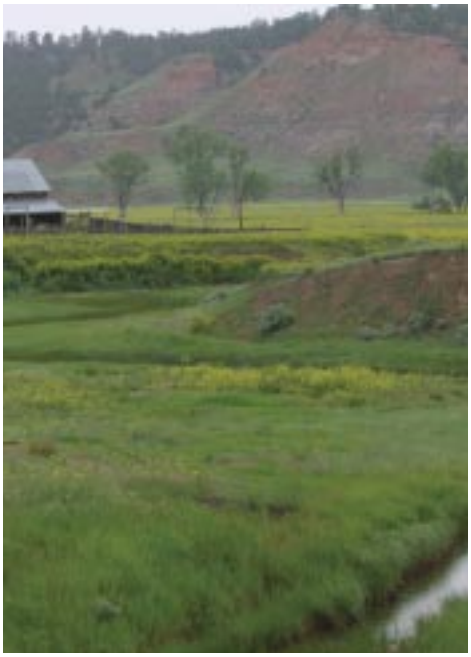
Sodium content is another concern. Most produced water in this basin is relatively low in salt and dissolved solids. Some is fresh enough to be potable for humans, and most is fresh enough to water livestock and wildlife. While not salty, the water can contain high levels of sodium in other forms,

Beneficial uses of produced water in the Powder River Basin include spray irrigation for agriculture, reservoirs for ranch and farm use, and livestock watering.

[20] For example, discharges are regulated through State Departments of Environmental Quality, issuing National Pollutant Discharge Elimination System permits under Federally approved State programs for implementing the Clean Water Act.

[21] See Advanced Resources International, Inc., *Powder River Basin Coalbed Methane Development and Produced Water Management Study*, for U.S. Department of Energy, December 2002.

[22] A barrel = 42 U.S. gallons.



Discharges of produced water to rivers, streams, and drainages must meet State and Federal water quality standards.

resulting in a high sodium absorption ratio. Such water can break down clay-based soils, making them unsuitable for agriculture. Thus, this water should not be used for irrigation unless either the water or the soil is properly treated. For example, adding calcium to the soil in the form of gypsum can alleviate the problem.

Best management practices for coalbed natural gas. Opposition to coalbed natural gas development has been aroused in some areas because a small minority of operators have not met the requirements of their permits or have not managed their operations as well as they could. Impacts of exploring for and producing coalbed natural gas can be mitigated using best management practices (BMPs)—economically feasible, site-specific techniques, procedures, or measures that are applied to achieve desired outcomes. BMPs not only lessen any potential adverse impacts of coalbed natural gas operations but also may improve operational efficiency and reduce costs. While some are sophisticated techniques, others are as simple as carpooling workers to well sites to reduce dust and disturbance, and avoiding vehicle trips during times that school buses are on the road to increase safety for students. The Western Governors' Association[23] has highlighted the importance of BMPs, hosting a workshop and pursuing the development of a nationwide coalbed natural gas BMP handbook. In June 2002, the Association passed a resolution on natural gas from coal seams that stated, "The Governors believe that many issues might be alleviated through sharing of information and best management practices across the States and the private sector."

Regional air quality. Maintaining the pristine air of the Rocky Mountain States—especially around the national parks and forests of Wyoming—poses a special challenge. Small changes in air quality can have noticeable effects, especially on visibility. The region is valued for its striking vistas and scenery, but the ability to see these sights over long distances has degraded over time as air emissions have increased from a number of sources, including traffic, urban development, and industrial activities. Natural gas development is one of these activities.

Some Federal and State agencies as well as environmentalists have expressed concern about the contribution of natural gas drilling, production, and transportation to the increase of particulates in the atmosphere, leading to lower visibility and "regional haze." Of particular concern are emissions such as dust from service roads and nitrogen oxides from compressors, which can travel long distances and sometimes transform chemically to impair visibility. However, the combination of emissions, transport, weather, atmospheric chemistry, and deposition is extremely complicated, making it difficult to understand and predict the contribution of natural gas development to regional air quality. Such understanding is critical to cost-effective regulation of air emissions. Federal and State agencies and industry are working to properly characterize the situation with sophisticated computer models, and to gather data on what is happening in the atmosphere to gain a better understanding of the determinants of regional air quality. This understanding can serve as the scientific basis for better, more targeted regulatory decisions in the future.

Impacts of seismic work. Seismic imaging of underground geologic formations is considered a best practice because it enables industry to pinpoint the location of gas deposits, resulting in higher drilling success rates. Greater success and fewer dry holes not only improve the economics of gas production, but also lessen environmental impacts through less surface disturbance, less drilling waste, and fewer air emissions.

[23] See www.westgov.org.

Seismic imaging entails sending sound waves into the ground and recording their reflection back to the surface. Computer processing of these reflections allows companies to draw images of the underground formations. The sound waves are generated either with small explosives or with special trucks that shake the ground. Both methods have some environmental impacts, including disturbing plants, animal habitats, and, in select locations, fragile soils that are part of desert ecosystems. While seismic survey activities have been controversial in some areas, proper planning can ensure that impacts are as minimal and localized as possible.

Studies of the actual impacts of seismic imaging in sensitive areas can help Federal and private land managers consider the merits of the technology, weighing its impacts versus the benefits of increasing natural gas supplies and reducing environmental impacts of drilling. On balance, the environmental impact of using seismic imaging is far less than drilling more wells to obtain the same information about formations below the surface.

Carbon management. Some conventional, high-volume natural gas wells in the Rocky Mountain States (e.g., in the Madden and LaBarge formations) produce significant quantities of carbon dioxide along with the natural gas. Coalbed natural gas wells also may produce more carbon dioxide over time as the methane is depleted, and carbon dioxide begins to desorb from the coal.

Currently, carbon dioxide is separated from the natural gas and vented to the atmosphere. In light of climate-change concerns, this option is likely to be less attractive, and possibly prohibited, in the future. Attention is turning to finding lower-cost methods to separate the carbon dioxide for use in enhanced oil recovery processes and, at the same time, sequestering it underground. Future research may improve the technical and economic feasibility of carbon management related to natural gas production.

Importance of environmental science

Decisions on which lands to lease, what conditions to attach to leases, and when to approve drilling permits rely heavily on information about impacts of natural gas exploration and development on environmental factors such as water, air, and animal habitat. Data on impacts are sometimes available from scientific studies and surveys. When they are not available, decisions are based on partial information or perceptions. For example, some BLM and Forest Service managers designate a large area of Federal land as critical habitat for one or more species in the absence of information to the contrary, and do site-specific analysis only when stipulations for specific leases are being considered. Exceptions to stipulations may be made over 50 percent of the time because the species do not actually occupy the whole area.

More critically, stipulations may be made on incomplete or incorrect understanding of the true impact of oil and gas activities on animal species and their habitat. For example, some stipulations require service roads to avoid areas where sage grouse stage their courting rituals. However, there is some evidence that male sage grouse favor open areas such as roads on which to do their courting. More information on such questions would help land managers make cost-effective decisions.

Stakeholder issues

The breadth and diversity of issues of potential concern to various stakeholders add to the complexity of developing natural gas resources in the Rocky Mountain States. These may include:

- *Inconsistencies in applying restrictions and stipulations among government agencies and among different field offices within the same agency.*
- *Relationships with surface owners and methods used to protect their rights and interests in split-estate areas.*
- *Protection for threatened and endangered species and surveys to determine whether a lease contains habitat for such species.*
- *Designation of some areas as having wilderness characteristics, either through Federal action or by citizen nomination.*
- *Consultation with Native American Tribes.*
- *Archaeological reviews required by the National Historic Preservation Act and related issues involving cultural resources.*
- *Visual impacts of oil and gas operations.*
- *Noise from oil and gas operations.*
- *Aging and inadequate infrastructure.*
- *Conflicts between oil and gas and other mineral operations, such as coal and potash.*
- *Urban and suburban encroachment on oil and gas fields.*
- *Compatibility of traditional Western values with the cumulative impacts of urbanization and oil and gas development.*
- *"Sense of place," i.e., an emotional or spiritual attachment to certain locations, which has been used as justification for designating certain areas as off-limits to drilling.*

As part of an ongoing oil and natural gas research program, DOE conducts environmental studies and other research activities related to the impact of natural gas development on water, air, animal habitat, and other environmental resources. DOE and BLM have established a Federal Lands Technology Partnership to address environmental research needs identified by BLM field offices, including best management practices, improved data-management techniques, and web-based information systems. These projects provide a sound scientific basis for improving access to natural gas and oil resources on Federal lands while protecting valuable environmental resources.

With ongoing cooperative intergovernmental efforts in science, technology, and policy, our Nation can effectively meet its energy and land-use and environmental protection goals. By considering both regional and National needs, and applying the best scientific and technical information to public policy decision making, the United States will benefit from reliable natural gas supplies as part of a secure, balanced energy portfolio well into the future.

Prerequisite 2: Access to Markets

Significant expansion to the Nation's delivery system—over 290,000 miles of new transmission and distribution pipelines—may be needed to serve growing natural gas demand.

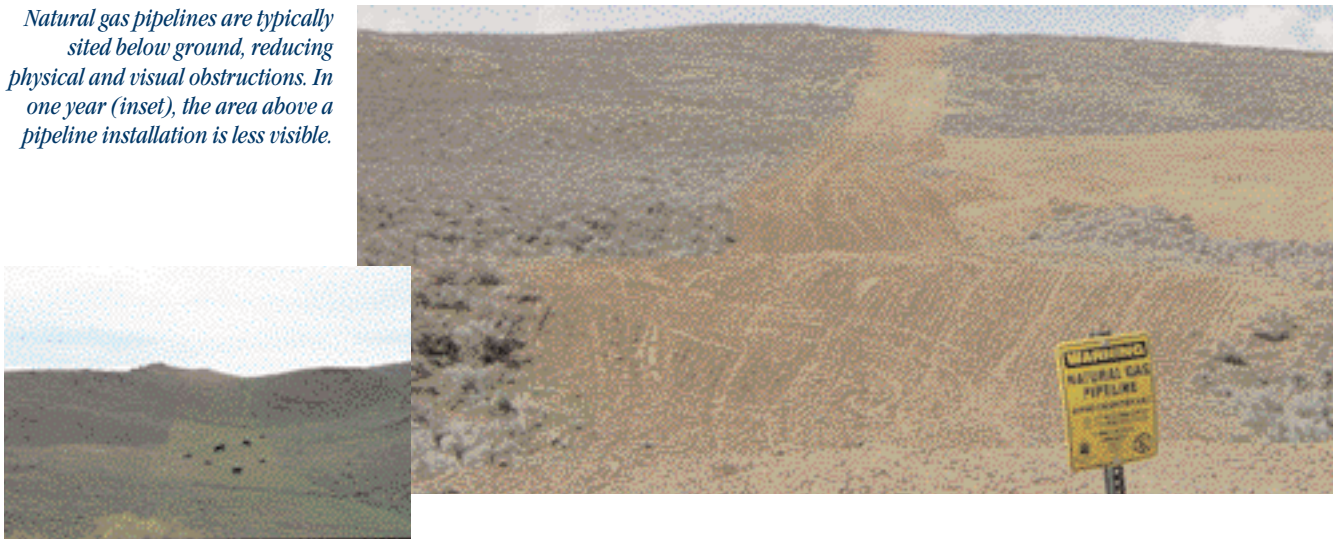
Lack of access to markets is one of the most serious barriers facing natural gas producers in the Rocky Mountain States. The local gas market, consisting primarily of Denver, Salt Lake City, and their surrounding areas, is relatively modest and highly seasonal. To justify further investment in natural gas development in the region and to enable the Rocky Mountain States to provide the Nation with additional gas supply, the region needs new interstate pipelines and increased access to Midwestern and California gas markets.

During 2001 and 2002, only 800 million cubic feet per day (MMcfd) of new interstate pipeline capacity, led by the Trailblazer 2002 System Expansion, was added in the Rockies, as shown in Appendix III. As a result, only 260 Bcf of new supply is able to leave the region (at 90-percent capacity utilization), far less than the natural gas productive capacity added during this time. The Powder River coalbed natural gas field by itself captured more than half of this new capacity, leaving little for others such as the Jonah/Pinedale gas field in Wyoming or the Wasatch and Ferron gas fields in Utah.

While considerable expansion took place in gathering systems (over 2,800 MMcfd), this mainly provided improved local and within-basin transportation, leading to excess supply at the Opal Hub in southwestern Wyoming and the CIG Hub[24] in northeastern Colorado. Gas sales prices at these hubs plummeted as producers bid to capture limited pipeline capacity. Basis differentials (the amount that Rocky Mountain natural gas prices at Opal/CIG are lower than the benchmark price at Henry Hub in Louisiana) of $1.50 to $2.00 per Mcf were common once the winter heating season ended in early 2002. Because of these price differentials, the State of Wyoming estimated that it was losing $1 million per day in production taxes and royalties during the year. In Wyoming, production taxes and royalties on oil and gas production fund the State's educational system and pay for many other essential services.

[24] Hubs are locations where pipelines intersect, enabling the trading, transportation, and storage of natural gas.

Natural gas pipelines are typically sited below ground, reducing physical and visual obstructions. In one year (inset), the area above a pipeline installation is less visible.



In May 2003, the expansion of the Kern River Transmission System came on line, adding 900 MMcfd (300 Bcf annual) of capacity from Opal to California markets. This project was the first implemented using the NEPA pre-filing process designed to expedite the certification of interstate natural gas pipeline projects by the Federal Energy Regulatory Commission (FERC). The new process, put into place with assistance from the White House Task Force on Energy Project Streamlining[25] and the Western Governors' Association, saved the Kern River expansion project six months compared to the previous approval process. With the expansion, the surplus natural gas production at Jonah/Pinedale reached market and helped narrow the basis differential to about $.60 per Mcf.

Little additional interstate pipeline capacity is planned for the rest of 2003 and 2004. Two announced projects, the Kinder-Morgan Advantage Pipeline and Northern Border's Bison Project, are both on hold. The two remaining active projects, the WBI Grasslands pipeline and the Trailblazer and Northwest Pipeline expansions, would together add only 330 MMcfd (110 Bcf annual) of capacity out of the region. New gathering systems and within-region pipelines, such as CIG's Front Range Expansion, will increase service to the Denver market and provide better gathering of Utah's gas production, but will do little to expand interstate transportation.

In 2005 and 2006, additional take-away capacity is planned, including several southern pipeline systems serving the San Juan Basin: Transwestern's Sun Devil Expansion (780 MMcfd of capacity), Kinder-Morgan's Silver Canyon Pipeline (750 MMcfd of capacity), and TransColorado's Window Rock Extension (150 MMcfd of capacity). CIG's 500 MMcfd Cheyenne Plains Pipeline, planned from Colorado to Kansas, recently applied with FERC for approval to construct a new, major interstate gas pipeline. This pipeline, expected to be in service by mid 2005, would provide important market access for Wyoming, Colorado, and Utah natural gas.

[25] See www.etf.energy.gov.

Encouraging new pipeline capacity

To encourage more interstate pipeline capacity additions, the State of Wyoming recently passed legislation establishing a more active and powerful Pipeline Authority. Its aims are to identify the highest-value markets for Wyoming natural gas, support the construction of new pipeline capacity out of Wyoming to Midwestern and California markets, narrow the basis differentials to a more historical value of $0.30 to $0.50 per Mcf, and encourage increased development of Wyoming's bountiful gas resource.

Many other States also recognize the importance of expanding the capacity of the Nation's natural gas delivery system. Through organizations such as the Interstate Oil and Gas Compact Commission[26] and National Association of Regulatory Utility Commissioners,[27] States are exploring concepts for expediting pipeline siting and permitting, and enhancing pipeline safety and integrity. Various Federal agencies and the White House also have been tackling the issue, and stakeholders with diverse views are contributing to this effort through organizations such as the Keystone Center.[28]

[26] The Interstate Oil and Gas Compact Commission, representing the governors of oil- and gas-producing States, was established in 1935 and is among the oldest and largest interstate compacts in the Nation; see www.iogcc.state.ok.us.

[27] The National Association of Regulatory Utility Commissioners, founded in 1889, consists of government agencies engaged in the regulation of telecommunications, energy, and water utilities and carriers in the 50 States, District of Columbia, Puerto Rico, and Virgin Islands; see www.naruc.org.

[28] The Keystone Center, founded in 1975 and based in Colorado, is a non-profit public policy and educational organization; see www.keystone.org.

Coalbed natural gas producing area (foreground) on remote Tribal lands in Montana.

Volatile and lower prices discourage investment

Rocky Mountain States natural gas prices have been highly volatile, adding uncertainty to potential returns from investment in exploration and production and discouraging investment in the region's geologically complex, risky, and often economically marginal prospects. This price volatility is illustrated in Figure 5. Although spot prices do not reflect the prices paid for all production in the area, they are a useful indicator of general price trends.

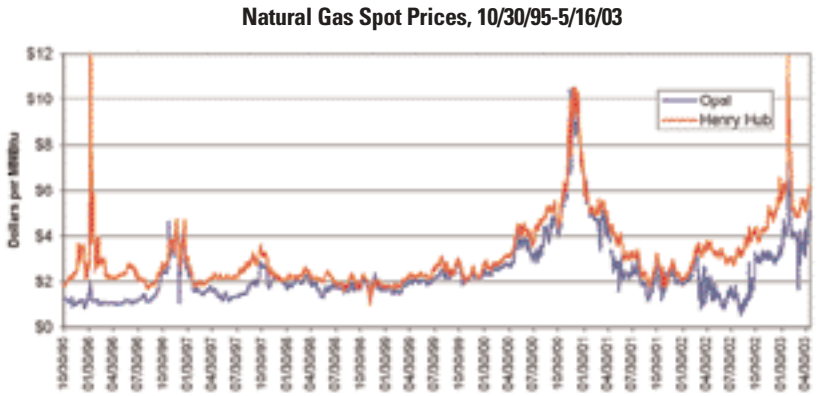


Figure 5. Price volatility has created uncertainty for those investing in natural gas production.

Source: NGI's Daily Gas Price Index.

A second economic disadvantage confronting prospects in the Rocky Mountain States is the persistently lower price for natural gas in this region compared with others. For example, during the most recent seven years, Opal prices typically have been lower than Henry Hub prices by about 24 percent, (Figure 6). When markets have persistent price differences, industry often responds by building additional transportation capacity, allowing lower-cost gas to gain access to higher-value markets, with the price difference covering the shipping cost. This incentive to build continues until price differences between markets reflect the prevailing transportation cost. Severe fluctuations in prices, however, undermine the economic appeal of building capacity. A root cause of these low, volatile prices is limited access to markets due to constrained interstate pipeline capacity serving the Rocky Mountain States.

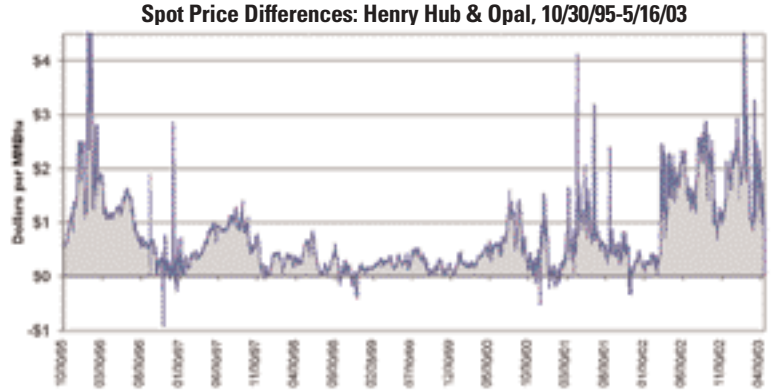


Figure 6. Natural gas prices are generally lower in the Rocky Mountain States than in other regions, principally due to limited pipeline capacity serving the region.

Source: Energy Information Administration, derived from daily spot prices as published in NGI's Daily Gas Price Index.

Drilling a natural gas well in shallow coalbed formations of the Prairie Dog Creek area of the Powder River Basin, Sheridan County, Wyoming.

A typical coalbed well head, before the gas and water lines are plumbed and covered by housing.

Prerequisite 3: Technology Advances

Little was known 25 years ago about the vast unconventional resources lying dormant under the Rocky Mountain States, and industry was skeptical that economic production was possible. Since 1980, however, due to advanced technology and improved geologic knowledge, production and reserve estimates in the region have more than doubled. For example, in 1980, natural gas production from coalbeds was essentially zero. Today, coalbed natural gas production in the San Juan Basin is 2.7 Bcf per day and the Powder River Basin, which was written off just 10 years ago, is projected to hold nearly 40 Tcf of technically recoverable gas.

Still, estimates suggest that only a small percentage of the remaining Rocky Mountain in-place resource is technically recoverable with current technologies. The size of the economically recoverable resource is smaller still. To realize the full potential of this resource, further advances in technology as well as access to the resource are essential.

Maintaining recent rates of technology advancement will be a challenge. The past decade has seen a precipitous decline in private R&D spending related to oil and natural gas exploration and production. This trend (Figure 7), which has been visible through the systematic dismantling of nearly every private U.S. upstream energy R&D center, has been confirmed in a recent study, *Who Will Fund America's Energy Future?* by the Interstate Oil and Gas Compact Commission.

Further, because of industry's shifting focus to prospects offshore and overseas, the research private industry is conducting is not focused on the unique problems of the increasingly complex remaining onshore domestic natural gas resource base. R&D spending by government on improved natural gas supply technology is also declining.

Gas producers in the Rocky Mountain States face significant challenges when trying to economically recover gas from unconventional resources. At each step of the process, advanced technology provides the most effective means to reduce the costs and risks that make the vast majority of unconventional resources sub-economic. Advanced technology also provides the means to minimize adverse impacts on the environment, including historic and cultural resources, wildlife habitat, and agricultural resources. Advanced exploration and drilling technologies would enable industry to target resources far beneath the earth's surface with fewer wells, recovering the same volumes of reserves with less waste, less surface disturbance, and fewer impacts on our air and water.

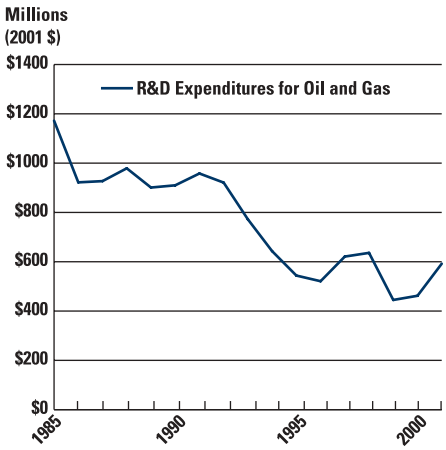


Figure 7. Energy industry R&D investments have been cut in half since 1985.

Source: Energy Information Administration, 2002, Performance Profiles of Major Energy Producers: 2000, DOE/EIA-0206 (00); and EIA, 1999, Performance Profiles of Major Energy Producers: 1997, DOE/EIA-0206 (97).

Exploration

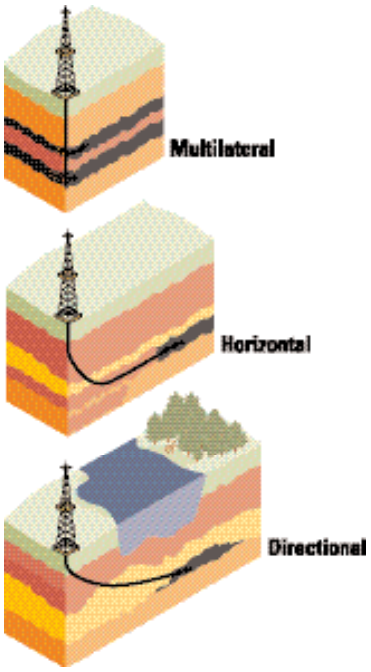
Two decades ago, companies operating in the Rocky Mountain States relied heavily on the traditional method of exploration: seeking out reservoirs in promising geologic orientations. However, this technique was not successful in extending production beyond conventional accumulations. More than a decade of tight-gas R&D has now provided operators with a workable approach: find areas of dense natural fracturing in the gas-bearing rock that will allow the natural gas to flow easily to the wells. This approach has greatly increased resource recovery potential, but finding such fractures reliably and cheaply continues to be a significant technological challenge.

Drilling

Natural gas wells in the Rocky Mountain States have traditionally been drilled vertically at depths ranging from a few hundred feet to over 19,000 feet (e.g., on the Pinedale Anticline). Depending on subsurface geology, technology advances now allow wells to deviate a few degrees from vertical to completely horizontal. With directional and horizontal drilling, operators can reach reservoirs up to several miles from the drilling rig, thus avoiding sensitive environments on the surface. At present, costs for drilling and completing directional and horizontal wells are considerably higher than for conventional vertical wells.

Horizontal drilling would seem particularly well suited to the tight-gas reservoirs of the Rocky Mountain States, because horizontal wells can more easily intersect the systems of vertical natural fractures that can give the gas a flow path to the well. However, industry's experience with horizontal wells in the Rocky Mountain States has been mixed. For example, of the six horizontal wells drilled in the early 1990s in the Uinta-Piceance Basin, most were abandoned due to high water production, some after an initial period of very high gas production. Further research is needed to overcome these obstacles if horizontal drilling is to make a significant contribution to increasing natural gas production in the region.

To reduce risks to equipment and personnel, operators often drill wells "overbalanced" (the weight of the drilling mud exceeding reservoir pressure). Overbalanced drilling can reduce drilling efficiency and natural gas recovery potential as drilling fluid penetrates the reservoir blocking pathways to the well. More advanced "underbalanced" drilling technology—used extensively north of the border in Canada—has potential advantages, such as increased rate of penetration and reduced reservoir damage. However, questions remain as to the feasibility and effectiveness of using such technology in the types of reservoirs common to the Rocky Mountain States.



Advanced drilling technologies enable wells to be drilled more efficiently. They also allow more gas to be recovered with fewer wells, less waste, and less surface disturbance, protecting sensitive environments.

Hydraulic fracturing and groundwater

Oil and gas industry and State officials are praising the key findings of a draft EPA report[29] that found hydraulic fracturing of coalbed natural gas wells does not contaminate underground drinking water sources. The issue had threatened to severely raise the costs associated with fracturing by potentially requiring operators to use only potable water in fracturing.

Environmental groups in Alabama, Colorado, Virginia, and Wyoming have argued that fracturing damages aquifers and causes related groundwater contamination. After nearly four years of review, EPA did not find "persuasive evidence" that any drinking water wells had been contaminated by hydraulic fracturing related to coalbed natural gas production.

[29] *Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs*, EPA 816-D-02-006, Draft August 2002. See www.epa.gov/safewater/uic/cbmstudy.html.

Completion

Gas accumulations in the Rocky Mountain States can exist across thousands of feet of vertical geologic section, with dozens of separate gas-bearing sandstones. One of the biggest challenges facing operators is selecting which intervals ("zones") to complete and produce. Before production can start, the connection between the geological formation and the well must be established and assured. Completion includes installing pipe in the well, called casing, cementing the casing in place, and making holes in the casing at the depth of the gas-bearing rock, along with the other activities that allow the gas to flow from the rock into the well and up to the surface. Because all these zones may require costly hydraulic fracturing, selecting the best zones to complete can make the difference between a profitable and unprofitable well. Improvements in geophysical well logging tools to allow better identification of the most prolific gas-bearing intervals ("pay zones") will be critical to fully developing tight-sand resources.

Essentially all wells drilled in the Rocky Mountain States require hydraulic fracturing to establish commercial rates of flow. In many unconventional wells, fracturing multiple zones can account for one-third to one-half the total cost of the well. Industry continues to experiment with fracturing methods and materials, but as yet, no single method produces positive results in all settings.

Industry faces a somewhat different situation in the Powder River Basin to access natural gas in numerous sequences of thin coal seams (less than 20 feet in thickness). With geologic conditions unique to the basin—shallow, underpressured, low-rank (low-strength) coals surrounded by water-bearing aquifers—operators are exploring the feasibility of multi-seam well-completion techniques utilized in other coalbed natural gas basins. Recent study by DOE suggests that multi-seam completion technology, if properly modified and successful, could significantly increase resource recovery.

Production

Unexpected and unexplained water production is becoming a problem in several areas of the Rockies, and is challenging the industry's basic understanding of the tight-gas resource. Not only must fractures be found, but operators now must discern if those fractures are connected to a source of water that will quickly choke off gas production. Unless solved in the very near future, this problem threatens many key emerging tight-gas plays in the Rocky Mountain region. For example, a number of the deep wells in the Cave Gulch area of the Wind River Basin initially produced natural gas at rates of more than 5,000 Mcf per day, but needed to be shut in within a year due to high water production. The ability to diagnose water-prone areas prior to drilling will be a critical factor in allowing tight-gas production to fulfill expectations.

Technology transfer

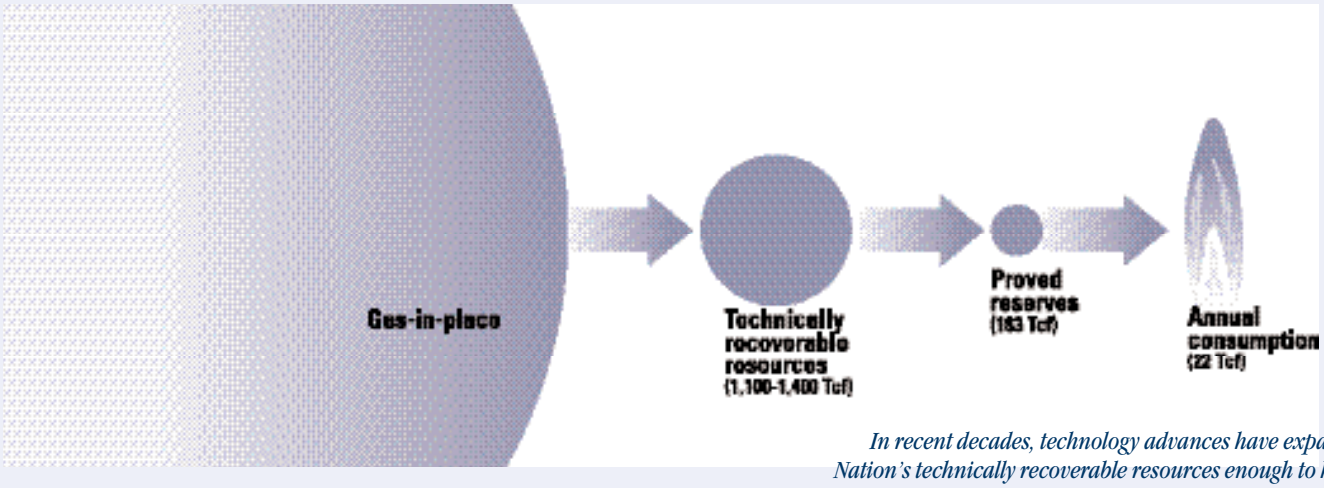
Finally, the advanced technologies discussed here will not contribute to economic resource production unless they are applied in the field. However, such technologies are not being widely used in the Rocky Mountain States because the many smaller independents operating there often cannot accept the additional cost and risk of using emerging technology, and the service companies that provide these technologies focus on other, more lucrative regional markets. These risks can be overcome by the continued demonstration and transfer of advanced technology to these producers. DOE, through its R&D program, works with industry, States, Tribes, the DOI, universities, and organizations such as the Petroleum Technology Transfer Council[30] to accelerate the transfer of advanced natural gas exploration and production technologies in the region.

[30] The Petroleum Technology Transfer Council is a regionally focused, not-for-profit organization with programs to meet the technology needs of U.S. independent oil and gas producers; see www.pttc.org. For information about DOE's technology R&D projects, see www.npto.doe.gov and www.netl.doe.gov.

Technology is key to supply

To meet the Nation's need for natural gas, industry continually explores and develops the remaining technically recoverable gas resource base. Attempts to identify and drill the most profitable prospects generally meet with mixed success (ranging from less than 10% in frontier regions to 80% in mature areas). Gas that is discovered and can be profitably produced is added to gas reserves. These reserve additions must replace the continual depletion of reserves due to ongoing consumption (approximately 22 Tcf/y currently).

As a result of this process, if nothing else is done, the technically recoverable resource base will decrease, both in quality and quantity. To counter this effect, industry relies largely on: (1) shifting to less-explored areas (increasingly overseas), and (2) incremental technology advances to slowly expand and improve the economics of the remaining resource. Significant resource expansion, however, often requires a collaborative government-industry effort of high-risk, high-return R&D to produce critical technology advances that unlock portions of a vast, untapped gas-in-place resource. Over the past three decades, such successes have delivered tight-gas sands, coalbed natural gas, the deepwater Gulf of Mexico, and gas shales into the Nation's resource base—effectively replenishing the technically recoverable resource base at a rate approximating its consumption. In coming decades, continued resource expansion certainly will be needed to maintain the healthy and diverse resource base that will allow industry to continue to meet growing demand.



In recent decades, technology advances have expanded our Nation's technically recoverable resources enough to keep pace with depletion of reserves due to natural gas consumption.

Conclusion

By addressing the prerequisites discussed in this document, our Nation can realize the great promise of expanded natural gas production from the Rocky Mountain States.

Natural gas is a critical component of the Nation's energy portfolio. Ensuring abundant, affordable, and reliable natural gas supplies will require efficient use and conservation of valuable natural gas in all its applications, increasing supplies, and enhancing the delivery system.

Clearly, the potential supply of natural gas from the Rocky Mountain States is huge. Yet, the vast majority of this resource is unrecoverable with today's technology. Additionally, much of the resource is currently restricted or off-limits, and environmental concerns often delay projects or add significantly to development costs. Although it is too soon to tell, additional new and proposed pipeline capacity should reduce or eliminate price volatility experienced in the past, which has also restricted regional production.

Projections call for production of natural gas, particularly from unconventional resources such as coalbeds and tight sands, to continue to expand. As this happens, one can expect that natural gas development in this region may entail considerable controversy and debate. Issues that must continually be addressed include access to resources, permitting of wells and transmission pipelines, water production and management, and air quality. It is imperative that all stakeholders come together to formulate and implement environmentally sound and economically feasible development of this most important supply of clean-burning, domestic energy.

Appendix I
Stewards of Federal Lands

About one-eighth of the land in the United States (262 million acres) and 300 million additional acres of subsurface mineral resources are managed by the Department of Interior (DOI) Bureau of Land Management (BLM). These public lands[31] are located primarily in 12 western States, including Alaska. The BLM's multiple-use mission is to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations. The Bureau manages such activities as outdoor recreation, livestock grazing, mineral development, and energy production, and conserves natural, historical, cultural, and other resources on the public lands.

The Forest Service, an agency of the Department of Agriculture, manages an additional 192 million acres within the National Forest System, which includes National grasslands. Like the BLM, the Forest Service has a multiple-use mission and fosters development of mineral resources within the framework of sustainable forest management, watershed health, and public safety. Exploration, development, and production of energy resources and reclamation activities are part of the Forest Service ecosystem management responsibility. The Forest Service ensures that exploration, development, and production of energy resources are conducted in an environmentally sensitive manner and that these activities are integrated with the planning and management of other resources using the principles of ecosystem management. National forests and grasslands have an essential role in contributing to an adequate and stable supply of mineral and energy resources while continuing to sustain the land's productivity for other uses and its capability to support biodiversity goals.

BLM administers public lands within a framework of laws, including the Minerals Leasing Act and the Federal Land Policy and Management Act, and uses adaptive management and environmental monitoring techniques to perform its responsibilities. All oil and gas leases on federally managed public lands, even those with the least-restrictive stipulations, are subject to full compliance with all substantive and procedural environmental laws and regulations. These laws include the National Environmental Policy Act (NEPA), Clean Water Act, Clean Air Act, Safe Drinking Water Act, Endangered Species Act, and the National Historic Preservation Act. While compliance with these laws may delay, modify, or prohibit oil and gas activities, these laws represent certain values and bounds that Congress believed appropriate to place on Federal land managers for the stewardship of public lands.

In addition to these laws, the Forest Service manages its mineral and energy resources under the National Forest Management Act, which is the primary statute governing the development of forest plans that guide all resource management activities on national forests, and the Federal Onshore Oil and Gas Leasing Reform Act. Through an interagency agreement, BLM issues leases and permits for drilling on Forest Service lands and conducts inspection and enforcement of oil and gas exploration and production activities. The Forest Service decides which of its lands are available for leasing and conducts environmental analyses under NEPA on those lands before permits can be issued.

[31] Public lands managed by the Federal Government are frequently referred to as "Federal lands."

Appendix II
EPCA Inventory

In November 2002, Congress reauthorized the Energy Policy and Conservation Act (EPCA), which mandated a scientific study inventorying onshore Federal lands. This interagency effort—involving the Department of the Interior (DOI), Department of Agriculture, and DOE—was completed in early 2003. Its purpose was to estimate the oil and gas resources underlying these lands and to identify the extent and nature of any restrictions or impediments to their development. DOI will use the results as part of its planning process to enhance informed policy decision making.

The EPCA study analyzed the proved reserves and technically recoverable resource potential of five Rocky Mountain basins that contain the bulk of the natural gas resource and much of the oil resource under public ownership in the onshore United States: Paradox-San Juan Basin (Colorado, New Mexico, and Utah), Uinta-Piceance Basin (Colorado and Utah), Greater Green River Basin (Colorado, Utah, and Wyoming), Powder River Basin (Montana and Wyoming), and Montana Thrust Belt (Montana). Cumulative results for all five basins are shown here. Products of the study include detailed computerized maps of the resources and restrictions in the five basins.

Summary of All EPCA Inventory Areas—Oil and Natural Gas Resources Affected by Access Categories

(Totals may not equal sums due to independent rounding.)

		Area		Resources			
				Total Liquids*		Total Natural Gas**	
	Access Category	(acres x 1000)	Percent of Federal	(MMBbl)***	Percent of Federal	(Bcf)****	Percent of Federal
More Constrained	1. No Leasing (Statutory/Executive Order)	10,068	16.9%	298	7.7%	9,035	6.5%
	2. No Leasing (Administrative, Pending Land-Use Plan)	6,007	10.1%	116	3.0%	3,690	2.7%
	3. No Leasing (Administrative)	5,098	8.6%	182	4.7%	3,185	2.3%
	4. Leasing, No Surface Occupancy	2,714	4.6%	50	1.3%	3,120	2.3%
	5. Leasing, Cumulative Timing Limitations on Drilling >9 Months	25	0.0%	3	0.1%	114	0.1%
	6. Leasing, Cumulative Timing Limitations on Drilling 6-9 Months	2,521	4.2%	250	6.5%	5,549	4.0%
	7. Leasing, Cumulative Timing Limitations on Drilling 3-6 Months	5,442	9.2%	528	13.7%	20,401	14.7%
	8. Leasing, Cumulative Timing Limitations on Drilling <3 Months	697	1.2%	8	0.2%	733	0.5%
	9. Leasing, Controlled Surface Use	3,753	6.3%	221	5.7%	6,080	4.4%
Less Constrained	10. Leasing, Standard Lease Terms	23,091	38.9%	2,198	57.0%	86,566	62.5%
	Total, Federal Lands Including Split Estate	59,416	100.0%	3,854	100.0%	138,472	100.0%
	Total Non-Federal	44,256		2,455		87,668	
	Total Study Area	103,672		6,309		226,141	

* Comprising oil, natural gas liquids, and liquids associated with natural gas reservoirs.

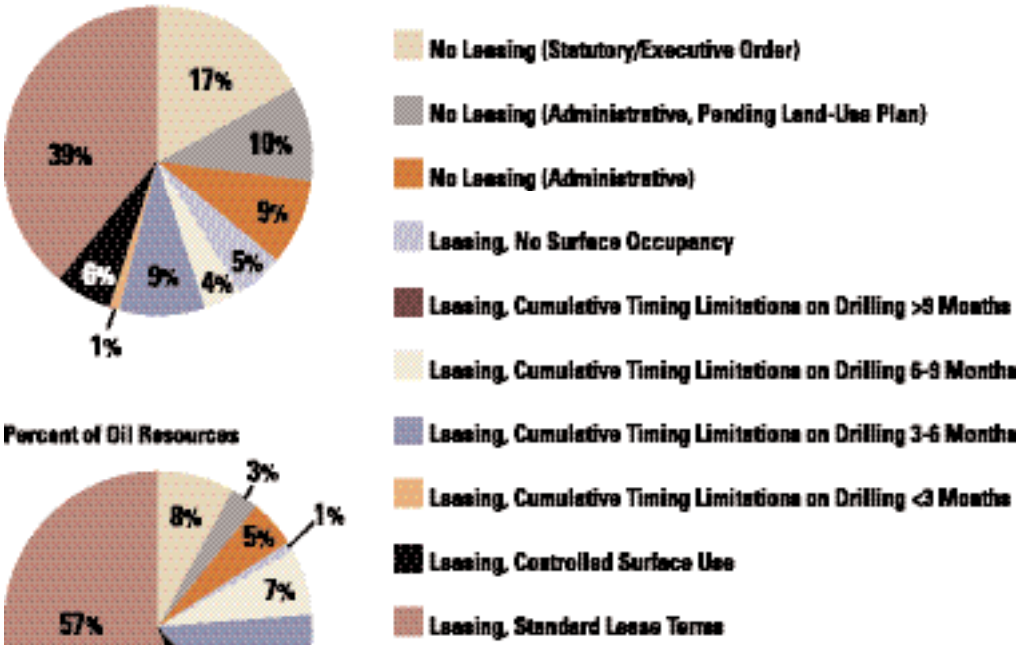
**Comprising associated dissolved and nonassociated natural gas.

***MMBbl: Millions of barrels.

****Bcf: Billion cubic feet.

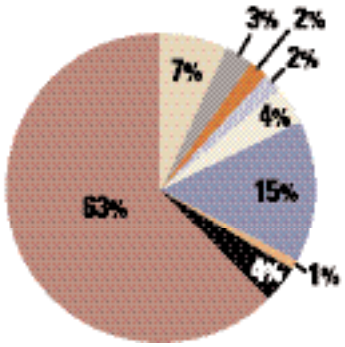
Appendix II continued

Percent of Federal and Split-Estate Lands



Percent of Oil Resources

Percent of Natural Gas Resources



Totals may not equal sums due to independent rounding.

Source: Scientific Inventory of Onshore Federal Lands' Oil and Gas Resources and Reserves and the Extent and Nature of Restrictions or Impediments to Their Development, *a report prepared by Departments of the Interior, Agriculture, and Energy, January 2003, in compliance with the Energy Policy and Conservation Act Amendments of 2000, P.L. 106-469, Section 604.*

Appendix III–New and Planned Pipelines and Pipeline Expansions

State from	State to	Project Name	Status	In Service	Miles	Capacity (MMcfd)	Comment
Rocky Mountains Area Gathering System and Area Internal Pipeline Construction Projects Completed or in Progress in 2001 & 2002							
CO	CO	CIG Front Range Expansion	Completed	01-Oct-01	53	87	Increases service to Denver area
CO	CO	CIG Parachute Lateral Expansion	Completed	01-Sep-01	NA	58	Directed to Central and Western markets
WY	WY	Fort Union Gathering Expansion	Completed	19-Sep-01	62	200	Expansion of gathering capabilities in Powder River Basin (CBM) gas
UT	UT	Questar's Mainline 104 Expansion	Completed	30-Nov-01	76	265	Directed to Western markets
WY	CO	WIG Medicine Bow Loop Expansion	Completed	01-Dec-01	155	675	Directed to Midwest markets (CBM)
CO	CO	CIG Valley Line Expansion	Completed	01-Dec-02	119	282	Increases service to Denver area
WY	WY	Everest Energy's Rimrock Pipeline	Completed	23-Apr-02	50	350	Expansion of gathering capabilities in Powder River Basin (CBM) gas
WY	WY	Jonah Gas Gathering's Opal Loop Project	Completed	15-Jan-02	50	400	Expansion of gathering capabilities in Green River Basin
WY	WY	Jonah Gas Gathering's Pinedale Expansion	Completed	15-Nov-02	43	200	Expansion of gathering capabilities in Green River Basin
WY	WY	Rendezvous Gathering Pipeline	Completed	01-Jun-02	39	275	Expansion of gathering capabilities in Powder River Basin (CBM) gas
WY	WY	Williams Field Service's Merna Trench Line	Completed	01-Nov-02	32	25	Expansion of gathering capabilities in Powder River Basin (CBM) gas
				Total	*679*	*2,817*	
Rocky Mountains Area Pipeline Construction Projects to California, Southwest and Midwest Markets, 2001-2002							
WY	CA	KRT 2001 System Expansion	Completed	01-Jul-01	922	135	Directed to Western markets
CO	TX	CIG Raton Basin Expansion	Completed	01-Oct-01	70	84	CBM gas to Southwest markets
NM	CA	Questar's Southern Trails Pipeline	Completed	01-Jul-02	405	87	Supply source Four Corners area
NM	CA	Transwestern PL Red Rock Expansion	Completed	17-Jun-02	0	120	Expansion by compression only
CO	NE	Trailblazer 2002 System Expansion	Completed	10-May-02	NA	324	Directed to Midwest markets (CBM)
CO	OK	CIG Raton Basin 2002 Expansion	Completed	15-Dec-02	54	47	CBM gas to Southwest markets
				Total	*1,451*	*797*	
Planned Rocky Mountains Area Gathering System and Area Internal Pipeline Construction Projects, 2003							
CO	CO	Questar's Southern System Expansion	Announced	2003	NA	40	Directed to Western markets
WY	WY	Questar/KRT Lateral	Announced	2003	NA	150	Directed to Western markets
UT	UT	Carbon Energy's Wolf Point Pipeline	Filed FERC	2003	22	100	Improves Utah gas gathering operations (CBM)
CO	CO	CIG Cheyenne to Front Range Expansion	Filed FERC	2003	NA	500	Increases service to Denver area (CBM)
CO	CO	CIG Valley Line II Expansion	Filed FERC	2003	NA	92	Increases service to Denver area
WY	MT	Energy West's Shoshone Pipeline	Filed FERC	2003	34	14	Improves gas gathering in northern Wyoming/southern Montana (CBM)
UT	WY	Questar's Overthrust Tie Line 112	Filed FERC	2003	16	217	Links Utah production with Wyoming's Overthrust Pipeline
				Total	*72*	*1,113*	
Planned Interstate Pipeline Construction Projects Supplying Midwest and Western Markets, 2003-2004							
WY	CA	KRT 2003 System Expansion	Approved by FERC	2003	716	900	Doubles existing Kern capacity (In Operation)
WY	ND	WBI Grasslands Project	Filed FERC	2003	246	80	Directed to Midwest markets (CBM) (In Operation, Nov 03)
CO	NE	Trailblazer System 2004 Expansion	Announced	2004	NA	75	Directed to Midwest markets (CBM) (No Change)
WY	WA	Northwest Pipeline Rockies Expansion	Approved by FERC	2003	91	175	Western Wyoming gas to Northwest markets (No Change)
WY	KS	KM Advantage Pipeline	Announced	2004	386	330	Directed to Midwest markets (CBM) (On Hold)
WY	MT	NBP Bison Project	Announced	2004	325	250	Directed to Midwest markets (CBM) (On Hold)
				Total (w/o On Hold)	*1,053*	*1,230*	
Planned Interstate Pipeline Construction Projects Supplying Midwest and Western Markets, 2005-2006							
CO	KS	CIG Cheyenne Plains Pipeline	Filed FERC	2005	400	500	Directed to Midwest markets (CBM)
NM	CA	Transwestern Sun Devil Expansion	Announced	2005	400	780	Supply source is San Juan Basin
NM	AZ	TransColorado's Window Rock Extension	Announced	2005	100	150	Supply source is San Juan Basin and/or Unita-Piceance Basin
WY	ND	WBI Grasslands Project Expansion	Filed FERC	2005	NA	100	Directed at Midwest markets
AZ	CA	KM Silver Canyon Pipeline	Announced	2006	100	750	Linked to Window Rock Extension
				Total	*1,000*	*2,280*	

CIG = Colorado Interstate Pipeline, EP = El Paso Natural Gas, KM = KM Interstate Pipeline, KRT = Kern River Gas Transmission, NBP = Northern Border Pipeline, WBI = Williston Basin Interstate Pipeline, WIG = Wyoming Interstate Pipeline, NA = Not available, CBM = Coalbed methane/coalbed natural gas

Source: Energy Information Administration, Natural Gas Division.

Natural gas wells often blend in with the landscape.

Our quality of life depends on natural gas

Natural gas, a largely North American resource, will remain a vital contributor to a diverse and well-balanced U.S. energy portfolio. As the cleanest of the fossil fuels, it will also further goals to protect the quality of our Nation's environment.

Natural gas:

- Is the number one fuel used by today's manufacturing and process industries.
- Is a primary feedstock for fertilizers, pharmaceuticals, chemicals, and plastics.
- Fuels more than 50% of the Nation's homes and businesses.
- Provides a growing portion of the Nation's electricity; in recent years, 95% of new power generation capacity in the U.S. has been gas fired.

Total annual consumption of natural gas in the United States currently stands at over 22 Tcf and is projected to grow to almost 35 Tcf by 2025.

Select photos and figures courtesy of: ALL Consulting, Anadarko Petroleum Corporation, Advanced Resources International, Inc., Stephen Collector, Bob Lynn, J.M. Huber, Independent Petroleum Association of Mountain States, Wyoming Coalbed Methane Clearinghouse, Department of the Interior's Bureau of Land Management and U.S. Geological Survey, and Energy Information Administration.

Design: Akoya

Natural gas is the second largest energy source used in the United States. Natural gas fuels residential and commercial heating and cooling across the Nation, from homes to restaurants to greenhouses to swimming pools. Industry relies on natural gas for power and process heating, from furnaces to kilns to paper and paint drying and food processing, and for the manufacturing of fertilizer, aluminum, plastics, and pharmaceuticals. Natural gas is a primary fuel for electric power generation, and a new source of energy for transportation.

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