Chapter 1

Introduction and Overview

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INTRODUCTION

The passage of the Powerplant and Industrial Fuel Use Act in 1978, which put legal restraints on future uses of natural gas in the industrial and electric utility sectors, took place in an atmosphere of extreme pessimism about future gas supplies. An Electric Power Research Institute report published a year earlier stated that:

> Today almost every important supply indicator points ominously to the fact that the Nation's ability to meet present and future demands for natural gas may be deteriorating rapidly and will continue to do so unless aggressive and innovative measures to rectify the situation are implemented immediately. [1]

These pessimistic predictions were based partly on short-term problems— periodic curtailments of natural gas deliveries that caused considerable hardship to industry and occasionally even to public facilities and to the commercial sector. They were also based, however, on disturbing long-term trends, such as a declining finding rate for new gasfields and, starting in the late 1960s, the ominous and apparently unstoppable decline of proved gas reserves (fig. 1).

Since 1978, the national perception of future natural gas availability has changed, for several reasons, to one of relative optimism. First, short-term supply is now in a state of surplus; a large gas "bubble," or surplus deliverability, was caused by a combination of energy conservation, recession-induced reductions in industrial activity, and industrial fuel switching from gas to oil as a result of declining oil prices and increased gas prices. At the same time, reserve additions have rebounded from the depressed levels of the 1970s to over 20 trillion cubic feet (TCF) in 1981[2] and over 17 TCF in 1982.[3] Also, the U.S. Geological survey (USGS) and the Potential Gas Committee (PGC) have each recently reaffirmed their earlier estimates of the remaining recoverable resources[4] in the Lower 48 States:[5] the latest USGS estimate implies that about 770 TCF of gas remain as of January 1983, while the PGC estimate implies an even more optimistic 910 TCF.[6] These estimates, which do **not** include gas that could be recovered with completely new technologies and/or substantially higher prices, both exceed the amount of gas that the United States has already produced during the entire history of its gas use. And finally, a series of recent reports by the National Petroleum Council and others[7] have projected that large supplies of "unconventional" gas from tight gas reservoirs, Devonian shales, and coal seams can be made available well within this century.

Along with this new optimism has come some new uncertainty about future gas supply, however. This uncertainty stems from: 1) the current

[1] R. Ciliano, et al., *A Comparative State-of-the-Art Assessment of Gas Supply Modeling,* EPRI report EA-201, February 1977.

[2] Energy Information Administration, US. *Crude Oil, Natural Gas, and Natural Gas Liquids Reserves, 1981* Annual Report, U.S. Department of Energy, August 1982. Because the EIA data series appears to differ somewhat from the earlier American Gas Association data (EIA began in 1977), the interpretation of the recent higher reserve add It Ions is somewhat controversial.

[3] Energy Information Administration, *U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves,* U.S. Department of Energy, August 1983.

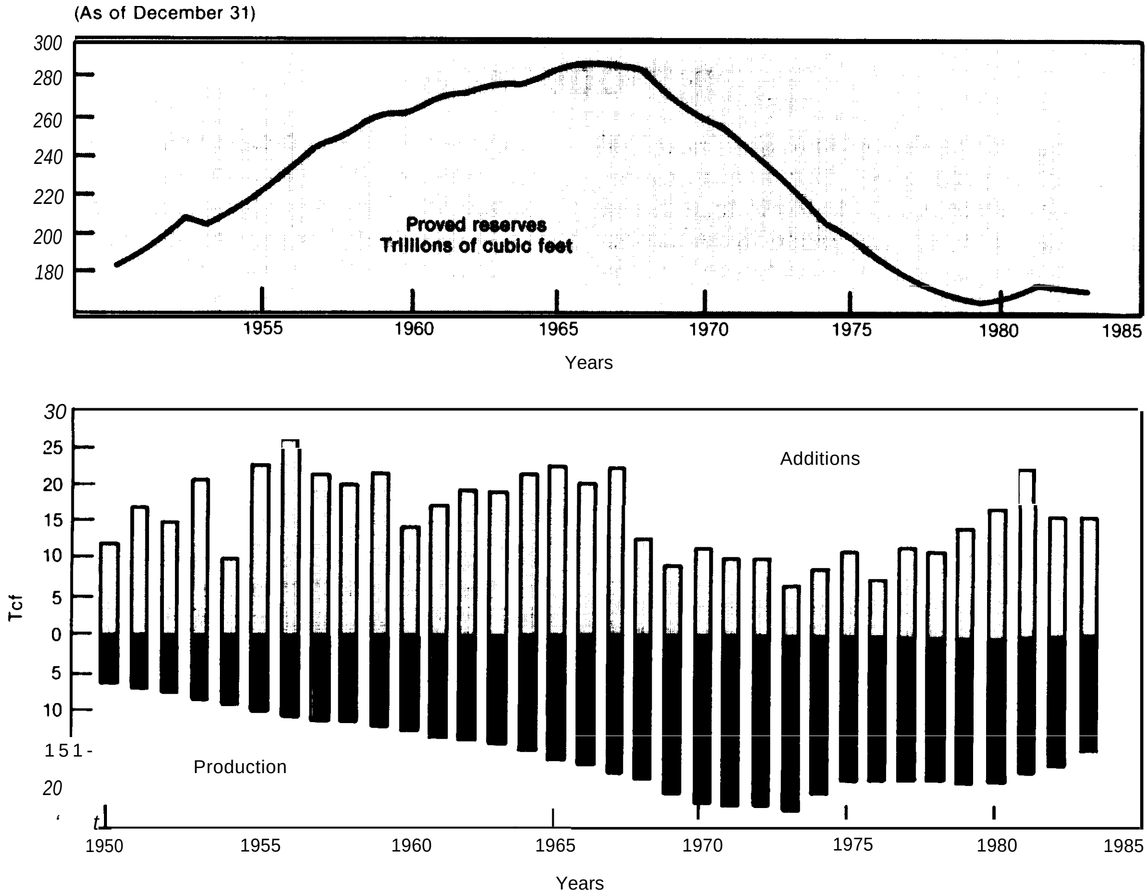
[4] "Resources" and "reserves' are terms that are often—incorrectly—used Interchangeably. The term "reserves" or "proved reserves" refers to the portion of the total gas resource base that has been positively identified by drilling and estimated directly by engineering measurements, and that is recoverable at current prices and technology. "Resources" refer to a broader, more speculative estimate of the total gas remaining to be produced, under conditions defined by the estimator.

[5] B. M. Miller, et al,, *Geological Estimates of Undiscovered Recoverable Oil and Gas Resources in the United States,* USGS Circular 725, 1975; and Potential Gas Committee, *Potential Supply of Natural Gas in the United States (as of Dec. 31, 1980)* (Potential Gas Agency, Colorado School of Mines, Golden, CO), May 1981.

[6] G. L. Do[ton, et al,, *Estimates of Undiscovered Recoverable Conventional Resources of Oil and Gas in the United States,* U.S. Geological Survey Circular 860, 1981; and Potential Gas Committee, *Potential Supply of Natural Gas in the United States (as of Dec. 31, 1982)* (Potential Gas Agency, Colorado School of Mines, Golden, CO), June 1983.

[7] National Petroleum Council, *Unconventional Gas Sources: Volume V: Tight Gas Reservoirs-Parts I and II,* December 1 960 and other volumes; R. E, Zielinski and R. D. McIver, *Resource and Exploration Assessment of the Oil and Gas Potential in the Devonian Gas Shales of the Appalachian Basin,* U.S. Department of Energy Report, DOE/DP/0053-1 125, undated; and other reports.

Figure 1.—Natural Gas Production, Additions to Reserves, and Total Reserves of the U.S. Lower 48 States



SOURCE American Gas Association, The Gas Energy Supply Outlook: 1983-2000, October 1983.

low level of proved reserves (which increases the volatility of production); 2) substantial changes in gas prices and demand; 3) rapid advances in technology and the subsequent emergence of new and relatively unproven gas supply regions such as the Western Overthrust Belt; and 4) the potential shift of production from the familiar conventional sources to the less familiar unconventional sources of gas.

In reaction to this changing outlook for U.S. natural gas supply, the House Committee on Energy and Commerce and its Subcommittee on Fossil and Synthetic Fuels, supported by the Subcommittee on Energy Research and Development of the Senate Committee on Energy and Natural Resources, asked OTA to conduct **a study of domestic (Lower 48 States onshore and offshore) natural gas availability over the next few decades.** The study was to examine both conventional and unconventional sources of natural gas, review current estimates of resource bases and production potentials, and examine key technical issues that will affect the future development of those sources.

This report presents the results of OTA's study of U.S. natural gas availability,

[8]The current proved reserves in the Lower 48 States would very quickly be depleted without a constant influx of new reserves. A failure to add substantially to reserves would soon be followed by a major decline in gas production.

OVERVIEW

There is a distinct possibility that the United States' traditional domestic sources of natural gas, with only modest help from supplemental sources, will be sufficient to maintain present levels of gas usage for the next few decades. In fact, the projection of only moderate rates of decline in production from these traditional sources, barring any collapse of drilling activity, appears to have a growing consensus among gas analysts. OTA concludes, however, that this is not the only plausible future course for U.S. natural gas availability; it is also quite possible that gas supplies from current sources will decline considerably more sharply over the next few decades than predicted by most recent forecasts. In other words, the uncertainty of both the future production and total recoverable resources of natural gas is still high, and the range of plausible gas "futures" is greater than is generally acknowledged. Thus, complacency about U.S. natural gas availability over the next few decades would be an error. **If the United States wants to be confident about the availability of a continued high level of gas supply for the next few decades, it must ensure that it can gain access to significant new sources of supply in case its traditional supply turns downward.**

In addition to "conventional" gas obtainable at current prices with available technology, the United States has substantial gas resources that can come into production only with improved recovery technologies or higher gas prices, or both, This gas resides in tight gas reservoirs, in Devonian shales, in coal seams, and in harder-to-produce conventional-type gas reservoirs. Also, there are substantial possibilities for expanded gas imports. **For each of these alternatives, the magnitude of the recoverable resource base and, for the new sources, the time required to reach high production (or import) levels are difficult to assess. Given the uncertainties about future production, reliance on only one or two of the alternatives might expose the United States to future gas supply shortages. Instead, a** diversified development strategy **that allows for access to all potential gas sources appears most desirable. OTA believes that the probability of obtaining adequate gas supplies is high if such a strategy is pursued.**

Conventional and Unconventional Gas

Conventional natural gas is gas that is recoverable using technology that is either currently available or is a modest extension of current technology, at prices similar to or slightly higher than today's. Virtually all of the resource estimates of "remaining recoverable U.S. gas resources"-including the well-known resource estimate published by the U.S. Geological Survey[9]–are meant to be estimates of conventional gas only.[10] Consequently, OTA's analysis of future conventional gas supplies excludes gas whose recovery depends on new technologies that are not readily foreseeable extensions of existing technologies, or well head prices much higher than today 's. In addition, in order to focus on technical rather than market uncertainties in the supply of conventional gas, the analysis assumes that demand for gas is high enough that exploration and production are not curtailed because of soft markets. Consequently, **"pessimistic" scenarios examined in the analysis of conventional supply reflect only pessimism about technical prospects for gas discovery and production and do not reflect the possibility that low gas demand may drive down exploratory drilling, discovery rates, and production.** Also, the analysis cannot account for any effects that higher gas prices and advancing technology may have on expansion of conventional production into deeper and more hostile waters and other geologically conventional but (currently) uneconomic formations.

Unconventional gas is produced from *reservoirs that are different in geologic character from conventional gas reservoirs,* and requires higher gas prices or significant advances in production technology—or both—for its economic recovery. Thus, in examining unconventional gas supplies, OTA has relaxed the price and technology assumptions adopted for evaluating conventional

[9] G. L. Dolton, et al., Estimates *of Undiscovered Recoverable Conventional Resources of Oil and Gas in the United* States, U.S. Geological Survey Circular 860, 1981.

[10] However, it is certain that these estimates do include some gas that might be characterized as unconventional. Because some production of tight sands gas and gas from Devonian shales has occurred in the past and occurs today, the boundary between "conventional" and "unconventional" is ambiguous.

gas supply. Unconventional gas sources include gas from low-permeability[11] sandstone and limestone formations (so-called "tight gas"), Devonian shales, coal seams, and geopressurized aquifers. Recently, gas vented from deep within the Earth ("deep source gas") and gas hydrates–gas trapped with water in an ice-like state—have been added to the "unconventional" category. (See box A for definitions of the individual unconventional sources.) Of these six unconventional sources, three—tight gas, Devonian shale gas, and coal seam methane—generally are considered to be the most likely to play a significant role in U.S. gas supply within the next 20 to 30 years. OTA has chosen to focus its analysis on these three sources.

[11] Permeability is a measure of how easily liquids and gases flow through porous rock. Thus, low-permeability rock is rock through which liquids and gases may flow only with difficulty.

Projections of Future Production

OTA finds that, even if the uncertainties about future gas prices and markets could somehow be eliminated, the technical and geological uncertainties associated with the gas resource base and exploration process are too great to allow a reliable consensus to be established about a single "most likely" estimate of future annual gas production. For the production of *conventional* gas, a credible *range* for Lower 48 State production levels in the year 2000 is 9 trillion to 19 trillion cubic feet per year (TCF), assuming gas demand remains high and gas prices do not soar. This range encom-

Box A—The Unconventional Gas Resources

1. **Tight gas** or **tight sands gas** is natural gas that is found in rock formations of extremely low permeability. It is characterized by slow rates of production, and tight gas wells generally are stimulated to increase flow rates by artificially fracturing the rock around the wellbore. Tight gas formations are found in all gas-producing basins in the United States.
2. **Devonian shale gas** is natural gas found in the fractures and pore spaces and adsorbed (bound) to the physical structure of shales deposited during the Devonian period of geologic time. Devonian shales occur predominantly in the Appalachian, Illinois, and Michigan basins. The natural fractures in the shale provide critical flow pathways for production, but the low permeability of both the shales and the natural fractures generally must be overcome with artificial fracturing or other well stimulation techniques.
3. **Coalbed methane** is natural gas created as part of the coal formation process. It is found predominantly in the form of gas adsorbed to the coal itself, but also as free gas in the pores and fractures of the coal. As with Devonian shale gas, the natural fracture system plays a critical role in production. Also playing a key role is the water often found in the coal seams; the water must be removed before gas can "desorb" from the coal and flow to the well.
4. **Natural gas from geopressurized aquifers** is gas dissolved in brines deep within the Earth under high pressures and temperatures, found primarily in the gulf coast region but also present in the San Joaquin, Piceance, and other basins. In order to produce the gas, the brines are pumped to the surface, the gas removed, and the brines disposed of.
5. **Gas hydrates** are an ice-like mixture of gas and water, called a "clathrate," that forms under certain temperature/pressure conditions often found under water depths greater than 100 ft and under permafrost. The resource is potentially huge and may be augmented by free gas trapped under the impermeable hydrate. At this time, all proposed production methods are highly speculative.
6. **Deep source gas** is natural gas that supposedly has been vented from deep within the Earth and accumulated both as conventional (and the other forms of unconventional) gas and as gas trapped under the "basement" rocks. Its existence—as yet unproven—would imply that large quantities of gas may be found in areas where gas would be unexpected because of a lack of organic-rich sediments. It would also imply that the deep gas resource to be found beneath existing shallow gasfields may be very large.

passes drastically different conceptions of the role of conventional natural gas in the United States' future energy supply. The width of the range reflects uncertainties about the magnitude and character of the remaining conventional resource, the appropriate interpretation and extrapolation of past discovery trends, and the production rates possible from reserves not yet discovered.

Projections of *unconventional/* gas production suffer from many of the geologic uncertainties associated with projections of the conventional resource, but in a more severe form because there has been less information-gathering and because measurement of geologic parameters generally is more difficult in the unconventional fields. In addition, these projections are confounded by difficulty in forecasting the rate of development of newly emerging production technologies and by the lack of an extensive production history to provide guidance about the shape of future production. Furthermore, because of the technological risks, the pace of development of the unconventional gas sources will be particularly sensitive to gas prices and to the availability of lower risk prospects for conventional gas production.

In light of these uncertainties, **OTA believes that the year** 2000 **production of unconventional tight gas, over and above production in areas being developed today, could range anywhere from 1 to 4 TCF/yr or perhaps even higher,** depending on gas prices, conventional gas production, the pace of tight gas research programs, and the outcome of numerous geological and technological uncertainties. Similarly, **new Devonian shale production could range from negligible amounts to about 1.0 to 1.5 TCF/yr by the year 2000.** At this time, the technical uncertainties associated with producing coal seam methane are too great to provide a useful estimate of future production from this resource.

In addition to domestic Lower 48 production, the United States can supplement its gas supply with pipeline i reports from Canada and Mexico, and imports of liquefied natural gas (LNG) from a variety of suppliers. Also, there is the possibility of pipeline or LNG deliveries of natural gas from Alaska. OTA has examined available estimates of future pipeline gas imports and Alaskan gas deliveries to the U.S. Lower 48 States; these estimates range from 1 to about 6 TCF/yr by 2000. LNG imports are even less certain, and were not projected. Factors affecting gas imports include the U.S. domestic gas supply balance, gas prices, and the export policies and energy supply situations of the exporting nations.

The separate projections of conventional gas production, unconventional gas production, and gas imports cannot simply be added together to yield a projection of *total* U.S. natural gas availability, because the projections have different baseline assumptions and because the projections are not independent—the gas volume attained by any one of the sources affects and is affected by the volume attained by the others. The nature of this interdependence is that neither the "lows' '-the pessimistic estimates–nor the "highs' '-the optimistic estimates–are likely to occur together in the same scenario.

Resource	*Year* 2000 *production, TCF/yr*
Conventional gas	9-19
Tight gas	1 -4+
Devonian shale gas	0-1.5
Coal seam methane	**unknown**
imports and Alaskan gas	**1-6+**

The Gas Resource Base

Uncertainties about the magnitude and character of the conventional and unconventional gas resource bases are an important source of uncertainty in projections of future gas production.[12] For **conventional** gas, the critical areas of uncertainty include the:

- role of small gasfields, which up to now have provided an extremely small share of cumulative production and proved reserves;
- potential of deep onshore gas, and gas in frontier areas such as the Eastern and Western Overthrust Belts, the eastern Gulf of Mexico, the Georges Bank, and elsewhere;
- potential for obtaining substantial quantities of additional gas from older gasfields; and
- the possibility of finding large quantities of gas in stratigraphic traps[13] bypassed by old exploration methods:

[12] This is not a trivial statement. It the resource base were sufficiently large, uncertainty about the majority of its still might not affect projections of near-term production, which presumably will draw from the best-understood portion of the base.

[13] *Stratigraphic traps:* traps, i.e., geologic barriers that ' 'trap' gas and 011 and allow them to accumulate, formed by gradual changes in the permeability of sedimentary layers rather than by (more easily detected) abrupt structural shifts and deformation of the layers.

In addition, there remain challenging questions about the appropriate interpretation of past trends in gas discovery and their usefulness in projecting remaining discoveries. **Accounting for these uncertainties, OTA concludes that a reasonable range for the remaining conventional gas resource in the U.S. Lower 48 States is 430 to 900 TCF.** Because the definition of "conventional" includes price and technology constraints, however, **this range is conservative; it excludes gas in** deepwater offshore areas, in deep onshore formations, and in small fields that will be added to the economically recoverable resource base by future gas price increases and technological advances.

Three **unconventional** sources are examined in this report. Of the three, **tight gas** generally is considered to have the largest recoverable resource base. Because tight formations often occur in basins that have undergone much conventional gas development, and because considerable development of relatively tight gas has already occurred, there is a substantial base of information from which to project the tight gas resource. The primary areas of remaining uncertainty associated with the tight gas resource base magnitude include:

- the volume of recoverable gas present in the Northern Great Plains and in the numerous tight gas basins that are unexplored or lightly explored;
- the ability of well stimulation technologies to allow production from low-permeability "lenses" (small, discontinuous reservoirs that occur in large, thick formations) that are not penetrated directly by the wellbore (without such "remote" production, much of the tight resource will not be economically recoverable except at extremely high gas prices); and
- our future ability to create very long fractures at low costs.

In addition, the size of the tight gas recoverable resource is quite sensitive to gas prices and to required rates of return. Given the uncertainties associated with all the above factors, **the tight gas recoverable resource will most likely be in the range of 100 to** 400 **TCF.** A more optimistic—but still plausible—view held by some industry scientists would raise the high end of the range by a few hundred TCF.

Devonian shale gas, like tight gas, has a considerable history of production, but its development has been more constrained both in area and in technological innovation, and there is less information available for a reliable estimate of recoverable resources. In particular, until recently, resource appraisers did not have the reservoir modeling capabilities that are available to assessors of tight gas resources. primary areas of uncertainty include: basic geological/resource characteristics of areas outside the current limited development area; the potential recovery efficiency available with new stimulation technologies and improved drilling patterns; and the potential for economic recovery from areas that do not have well-developed natural fracture systems. Given these uncertainties, **a moderately conservative range for the Devonian shale recoverable resource is 20 to 50 TCF for the Appalachian Basin,[15] with a reasonable potential for up to 80 or 100 TCF with high gas prices and successful technology development. in addition,** there is some potential to add considerably to the recoverable resource if a means is found to produce from the unfractured part of the shale.

Coal seam methane has not been extensively developed to date, although there are small development efforts in the Black Warrior Basin in Alabama, the San Juan Basin in New Mexico, and elsewhere. It is the least understood of the three resources, with important uncertainties associated with the basic characteristics of the coal resource, the gas production mechanisms, and the possibilities for and characteristics of new stimulation methods. In addition, access to the gas residing in shallow, minable coal seams is hampered by concerns about ownership of the gas and the possibility that well stimulation (fracturing) will damage the integrity of the rock overlying the coal seam, adversely affecting mine safety. Ex-

[14] Of the several existing estimates of the tight gas resource, only one–the study by the National Petroleum Council—has attempted to estimate the resources in the unexplored/lightly explored basins.

[15] Less is known about the two other Devonian shale basins, the Michigan and Illinois Basins. However, recoverable resources appear likely to be considerably smaller than those in the Appalachian Basin.

isting resource estimates are crude, and although it seems likely that the recoverable resource will be at least a few multiples of 10 TCF, the range of possible resource values probably extends, at least speculatively, up into the 100s of TCF at high gas prices.

Resource	*Recoverable resource, TCF*
Conventional gas	**430-900+**
Tight gas	**100-400+**
Devonian shale gas	**20-100+**
Coal seam methane	**20-200 +**

Natural Gas and Energy Policy

The resource and production estimates have implications for national energy policy. One of the more important is that **any policy that would tend to restrict U.S. gas availability to "conventional" gas supplies—e.g., a policy that restricted gas prices to below market levels and thus discouraged technology development–would strengthen the possibility that natural gas could be in short supply by the 1990s.** This is because the lower end of the range of year **2000** production potential for conventional gas is **9** TCF/yr, far below expected gas requirements. **A willingness to let gas prices seek a market level and an active encouragement of technology development and the exploitation of new gas sources would make it more likely that any shortfall of conventional gas could be made up by alternative gas sources.**

The total recoverable gas resource base will respond to price increases and technology advances in a number of ways. First, as noted above, **the boundaries—and thus the magnitude—of the conventional gas resource base will expand with higher prices and improved technology.** These boundaries are defined by maximum water depth, minimum exploitable field size, maximum feasible drilling depth as a function of field size and geology, minimum "pay" (gas-bearing) thickness, and so on.[16] Not only will formerly uneconomic fields and reservoirs now be developed, but measures will be taken to increase gas recovery from fields and reservoirs whose development would have been less intensive under the old conditions. In fact, because gas prices in some fields have been controlled at below-market rates, gas recovery could be increased merely by allowing gas from these fields to obtain today's free market prices. OTA **calculated the potential increase in recoverable gas from decontrol of the price-controlled fields, over and above increases already programmed into existing legislation, to be 19 to 38 TCF.**[17]

Second, **the magnitude of the unconventional gas recoverable resource base will increase substantially with higher gas prices and advances in recovery technology.** For example, current studies imply that doubling gas prices from today's levels would approximately double the recoverable tight gas resource with present technology. Similarly, solving the numerous remaining technical problems associated with the unconventional resources—improving logging techniques, expanding effective fracture lengths and increasing fracture efficiencies, developing accurate reservoir simulation models, and so on—will allow higher recovery efficiencies and open up more difficult areas to commercial exploitation. (See box B for a list of technical requirements for developing the unconventional gas resources.) With tight gas, which has already seen considerable commercial exploitation and technology development, further technology development still holds the promise of expanding the recoverable resource by 40 percent or more. With Devonian shale gas and coal bed methane, further technology development holds the promise of even larger gains.

Another important conclusion is that, **given the high risks and long leadtimes necessary to establish new sources of supply, the United States should place a high premium on providing an early warning of any impending shifts in gas supply.** Comprehensive data collection and gas supply analysis capabilities exist outside of the Federal Government, for example, in organizations such as the American Gas Association and Gas Research Institute. The perspectives of these organizations and the uses to which they put their forecasts may be quite dissimilar to the perspec-

[16] An ongoing OTA study, *Technology for Developing Offshore Oil and Gas Resources in Hostile Environments,* is examining one of these ' 'bound aries. "

[17] At a market price of $3.50/MCF (1 983 dollars),

Box B.—Technical Requirements for Developing Unconventional Gas Resources

- Improve well measurement technology and interpretive techniques (especially to identify gas-bearing strata, forecast post-stimulation performance, assist in fracture design, and aid "real time" fracture control).
- Increase fracture lengths while improving prediction of fracture direction, containment in proper strata, etc.
- Develop fracturing techniques that can penetrate remote lenses (tight gas).
- Develop "real-time" reservoir and fracture propagation models to allow adjustment of the fracturing process as the fracture is being created.
- Develop new fracturing fluids to prevent "formation damage" (reduction in the flow capability of the reservoir rock due to blocking of pores and other flow passages).
- Develop methods to monitor fracture behavior.
- Improve drilling techniques, especially deviated drilling (primarily coal seam methane, but applicable to Devonian shale and tight gas as well).
- Develop effective dewatering systems (coal seam methane).
- Develop technology to produce from zones with poorly developed natural fracture systems (Devonian shale, coal seam methane).
- Understand the flow mechanisms and geologic features controlling production, develop reservoir models (coal seam methane, Devonian shale, tight gas—in that order, starting with least advanced state-of-the-art).
- Develop exploration techniques to locate fractured zones (especially Devonian shale).

tive and required uses of the Government, however. Consequently, Congress may not wish to rely solely on such organizations for warnings about impending supply problems, Inside the Federal Government, the Energy Information Administration plays the critical role in collecting and analyzing natural gas supply statistics. Maintenance of EIA's capabilities in this area, as well as protection of its independence from the Department of Energy policymaking apparatus should be considered a high priority by those valuing an independent warning system for future supply problems.

HOW THIS REPORT IS ORGANIZED

The remainder of the report is organized as follows:

- Part I—Conventional Gas Supplies:
  - *Chapter 2: Summary--Availability of Conventional Gas Supplies* summarizes OTA's major findings about future production of conventional gas, the magnitude of the conventional gas resource base, and the potential for gas imports to the Lower 48 States.
  - *Chapter 3: Natural Gas Basics* presents a brief review of basic natural gas terminology and concepts.
  - *Chapter 4: The Conventional Natural Gas Resource Base* reviews resource assessment methodologies, describes and critiques several specific gas resource assessments, evaluates a number of critical resource issues, and presents OTA's conclusions about the magnitude of the remaining resource base.
  - *Chapter 5: Conventional Gas Production Potential* describes four approaches used by OTA to evaluate the gas production potential to the year 2000, and presents OTA's conclusions about this potential.
  - *Chapter 6: Gas imports–Overview* briefly reviews the prospects for gas imports to the Lower 48 States–liquefied gas imports and pipeline imports from Alaska, Canada, and Mexico.
- Part n-Unconventional Gas Supplies:
  - *Chapter 7: Introduction and Summary–Availability of Unconventional Gas Supplies*

briefly defines the unconventional gas resources, describes the definitional problem of separating unconventional from conventional gas, and introduces the major uncertainties in defining the resource base and production potential, then describes the technologies for producing unconventional gas and summarizes OTA's findings about the size of the resource base and the future production potential for this gas.

– *Chapter 8: Tight Gas* describes the tight gas resource and the technology necessary to exploit it, and discusses and evaluates projections of the resource base and future production.
– *Chapter 9: Gas From Devonian Shales* and *Chapter 10: Coalbed Methane* duplicate chapter 8 for these two resources.