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Madame Chairman and Members of the Subcommittee:

I appreciate the opportunity to appear before you today to discuss the mid-term outlook for natural gas markets in the United States.

The Energy Information Administration (EIA) is the statutorily chartered statistical and analytical agency within the Department of Energy. We are charged with providing objective, timely, and relevant data, analysis, and projections for the use of the Department of Energy, other Government agencies, the U.S. Congress, and the public. We do not take positions on policy issues. We produce data and analysis reports that are meant to help policy makers determine energy policy. Because we have an element of statutory independence with respect to the analyses that we publish, our views are strictly those of EIA. We do not speak for the Department, nor for any particular point of view with respect to energy policy, and our views should not be construed as representing those of the Department or the Administration. EIA's baseline projections on energy trends are widely used by Government agencies, the private sector, and academia for their own energy analyses.

The projections in this testimony are from the *Annual Energy Outlook 2002* (*AEO*). These projections are not meant to be exact predictions of the future, but represent a likely energy future, given technological and demographic trends, current laws and regulations, and consumer behavior as derived from known data. EIA recognizes that projections of energy markets are highly uncertain, subject to many random events that cannot be foreseen, such as weather, political disruptions, strikes, and technological breakthroughs. (Many of these uncertainties may be explored through alternative cases.)

Overview and Assumptions

The *Annual Energy Outlook* is produced using the National Energy Modeling System (NEMS), a computer-based, energy-economy modeling system of U.S. energy markets for the period through 2020. NEMS projects the production, imports, consumption, and prices of energy, subject to assumptions on

macroeconomic and financial factors, world energy markets, resource availability and costs, behavioral and technological choice criteria, cost and performance characteristics of energy technologies, and demographics. Two of the key assumptions in NEMS are world oil prices and macroeconomic growth.

World oil prices averaged about $22 per barrel in 2001. Between now and 2020 they are expected to rise to about $25 a barrel in 2000 dollars, as world oil demand increases from 76 million barrels per day to 119 million barrels per day. Growth in oil production in both OPEC and non-OPEC nations leads to relatively slow growth in prices through 2020. OPEC production is expected to reach 58 million barrels per day in 2020, nearly double the 31 million barrels per day produced in 2000. Non-OPEC production is expected to increase from 46 to 61 million barrels per day between 2000 and 2020.

Even though there was an economic slowdown in the United States in 2001, by 2003 gross domestic product is projected to grow by 3.1 percent and to continue to grow at an annual average rate of 3.0 percent between 2000 and 2020. Productivity growth (GDP growth minus labor force growth) is expected to increase 2.2 percent per year through 2020. The projected rates of growth in GDP and labor force productivity are lower in the first 5 years of the forecast period, reflecting present economic uncertainty and revisions to national income and product account data from the Bureau of Economic Analysis. They are expected to pick up as productivity increases and the economy moves back to its long-term growth path. Total population growth is expected to remain fairly steady, with an annual growth rate of 0.8 percent per year. The slowing growth in the size of the labor force results from the increasing size of the population over the age of 65.

Natural Gas Outlook to 2020

U.S. natural gas consumption is expected to increase by 2.2 percent annually from 2001 through 2020, to nearly 34 trillion cubic feet (Tcf) (Figure 1). Most new electricity generation capacity is expected to be fueled by natural gas. Despite decreasing coal prices to the electricity generation sector, natural-gas-fired electricity generators are expected to have advantages over coal-fired generators, including lower capital costs, higher fuel efficiency, shorter construction lead times, and lower emissions. In 2001, electricity generators, not including industrial cogenerators, were the third-largest consumers of natural gas. By 2020, however, the projected enormous growth in gas-fired generation makes electricity generators the largest gas-consuming sector, rising 0.2 Tcf above the industrial sector. Gas consumption by electric generators is expected to more than double over the forecast, from 4.3 Tcf in 2001 to 10.3 Tcf by 2020.

Historically the industrial sector is the largest gas-consuming sector, with significant amounts of gas used in the bulk chemical, refining, and metal durables sectors. Industrial consumption is expected to increase by 1.7 Tcf over the forecast, driven primarily by macroeconomic growth.

Combined consumption in the residential and commercial sectors is projected to increase 2.1 Tcf from 2001 to 2020, driven by increasing population, healthy economic growth, and preference by consumers to use natural gas as heating fuel over other heating fuel types. Because residential natural gas prices are projected to be lower than the prices of other fuels, the number of homes heated by natural gas is projected to increase more than those heated by electricity. Natural gas currently accounts for 20 percent of commercial energy consumption and is projected to maintain that share throughout the forecast.

Supply and Imports. Domestic gas production is projected to increase at an average annual rate of 2 percent over the forecast, rising from 19.3 Tcf in 2001 to 28.5 Tcf in 2020 (Figure 2). Growing production reflects rising wellhead gas prices from 2002 through 2020, relatively abundant gas resources, and improvements in technologies, particularly for offshore and unconventional gas. However, under the prices

in our reference case we do not expect that additional liquefied natural gas (LNG) facilities will be constructed or that an Alaskan pipeline will be built to the Lower 48 States through 2020. The national average wellhead price is projected to be $3.26 per thousand cubic feet (Mcf) in 2000 dollars in 2020.

The difference between consumption and production is met by the increasing use of imports throughout the forecast, particularly from Canada. By 2020, total net imports are expected to increase1.8 Tcf over 2001 levels of 3.6 Tcf. While we do not expect the construction of new LNG terminals in the United States by 2020, expansion at the existing terminals and opening of mothballed terminals is expected to result in a significant increase over 2001 LNG import levels, from 0.24 Tcf to 0.83 Tcf. One LNG facility, at Cove Point, Maryland, has been closed for years but is expected to reopen late in 2002 or early in 2003. By 2010, this facility plus the three currently operating facilities at Elba Island, Georgia; Everett, Massachusetts; and Lake Charles, Louisiana, will be operating at full capacity, including announced expansions.

Resources. The estimate of total technically recoverable natural gas resources in the United States as of January 1, 2000, that was used in developing this forecast, is 1,191 Tcf. Based on this estimate, the United States could produce almost 30 Tcf of natural gas a year for the next 40 years.

Proved natural gas reserves were 167 Tcf in the beginning of 2000 (Figure 3). Proved reserves are gas from known reservoirs that have been demonstrated with reasonable certainty (using geological and engineering data) as being recoverable in future years under existing economic and operating conditions.

Inferred natural gas reserves (at 233 Tcf) are gas in known reservoirs that are estimated to exist, but data are insufficient as to the certainty of recovery. Some 79 percent of inferred reserves are in onshore reservoirs.

Undiscovered resources are unproved resources that are estimated to exist in fields that have yet to be discovered. More than half of the estimated U.S. technically recoverable undiscovered resources are in the offshore, with 65 percent of these in deep waters, greater than 200 meters. The largest category of unproved resources is unconventional gas resources, 370 Tcf, with 69 percent from tight gas (low permeability deposits in sandstone formations).

Drilling. One of the key activities in producing natural gas is drilling. The slowdown in drilling that resulted from low natural gas wellhead prices in 1998 and 1999 is one of the contributing factors to the high winter prices of late 2000 and early 2001, and the subsequent boom in drilling in 2000 and 2001.

While lower prices are expected to bring down drilling levels in 2002, overall drilling generally increases in the AEO2002 forecast. The number of gas wells drilled is estimated to be 15,600 in 2000, 22,000 in 2001, 13,000 in 2002 and 21,700 in 2020 (Figure 4). Throughout the forecast about 96 percent of total gas wells are drilled for development in proven reservoirs.

Increases in drilling over the forecast are largely driven by growing revenues from drilling activities, as a result of both higher prices and higher production levels. A secondary driver of increased drilling is decreases in drilling costs resulting from technological advances. Technological improvements in the oil and gas supply industry are assumed to continue at historically estimated rates. For example, the annual rate of technological improvement in drilling costs is estimated to be a low of 0.9 percent for shallow wells and a high of 2.6 percent for deep wells.

Drilling Costs. Drilling costs are estimated at the regional level and take into account the separate impacts of drilling to greater depths, rig availability, the level of drilling activity in the given year, and technological progress. Technology exerts downward pressure on costs but drilling to greater depths, increases in drilling activity, and reductions in rig availability exert upward pressure on costs. In order for drilling costs to decline, technology must offset the impacts of these other components.

Average onshore drilling costs per well have been increasing for the past decade as the use of relatively new, more expensive techniques has increased (Figure 5). Costs are estimated to increase in 2000 and 2001, primarily because of the growth in drilling in activity and rig demand. As technologies continue to reduce costs and the growth in drilling activity stabilizes, drilling costs on average are projected to decline. By 2020, average onshore drilling costs per well are projected to be almost 26 percent lower than in 2001 (9 percent lower than in 1999).

Historically, average offshore technology gains have been more substantial than average onshore gains. The average cost to drill an offshore well significantly increased after 1996 driven by an increase in drilling in the deep waters of the Gulf of Mexico. Continued technological improvements in deep water drilling is expected to lower the overall offshore drilling cost. By 2020, the cost to drill an offshore well is projected to be 19 percent lower than in 2001 and 15 percent lower than in 1999.

Finding Rates. Reserve additions are calculated through a set of equations distinguishing between new field discoveries, discoveries in known fields (also defined as extensions and new pools), and increases due to re-evaluation of discovered areas during the developmental phase (also known as revisions and adjustments).

The finding rate equations capture the impacts of technology, as well as the impact of prices and declining resources. In the absence of technological and economic change, the yield from exploratory and developmental drilling declines with cumulative additions. This reflects the natural progression of the discovery process from larger, more profitable fields to smaller less economical ones. The more mature the region, the faster the decline. Technological advancement accelerates the discovery of the resource by improving the ability to target the more promising resources and by making current uneconomic resources accessible and economic--it does not create new resources.

Natural gas finding rates have varied significantly over the historical period, particularly for offshore wells, but have generally increased from the levels seen in the early 1980's (Figure 6). Over the projection period, onshore gas finding rates are projected to remain fairly constant (roughly 1 billion cubic feet per well). Offshore finding rates are projected to be generally declining yet remaining well above the projected rate for onshore wells.

Reserve Additions. For most of the past two decades lower 48 natural gas production has exceeded reserve additions, but the pattern for natural gas reversed from 1994 through 1997. With the 1998 decline in prices, reserve additions once again fell below production, but they exceeded production again in 1999. After 2004, rising prices are projected to result in natural gas reserve additions that generally exceed production through 2020, even with expected increases in demand.

The relatively high projected levels of annual gas reserve additions through 2020 reflect an expected increase in exploratory and developmental drilling (Figure 7). This increase is a result of higher prices and expected strong growth in demand, as well as expected productivity gains from technology improvements

comparable to those of recent years.

Production by Source. Domestic gas production is expected to increase from 19.3 Tcf in 2000 to 28.5 Tcf in 2020. Increased U.S. natural gas production is expected to come primarily from lower 48 onshore conventional nonassociated sources--which accounted for 36 percent of U.S. domestic production in 2001--with an expected increase of 3.9 Tcf by 2020 (Figure 8).

Offshore production, mainly from wells in the Gulf of Mexico, is also expected to increase between 2001 and 2020, although less rapidly. Lower 48 offshore Gulf Coast production was 5.2 Tcf in 2001, down slightly from the record 5.5 Tcf level in 1996. But by 2020 this level is expected to increase to 6.8 Tcf.

Unconventional gas production increases at the fastest rate of any other source over the forecast period, largely because of expanded tight sands gas production in the Rocky Mountain region. Annual production from unconventional sources is expected to increase by 4.1 Tcf by the end of the forecast. Alaska natural gas production rises gradually over the forecast to provide for consumption in the State itself and continued LNG exports to Japan.

Incremental Production. The Rocky Mountain region, with the majority of the unconventional production (Figure 9), shows the greatest *increase* in production from 2000 through 2020 due to improved technologies and the availability of abundant resources. The highest producing region throughout the forecast is the offshore Gulf of Mexico. Innovative use of cost-saving technology in recent years and the expected mid-term continuation of recent huge finds, particularly in the deep waters of the Gulf of Mexico, support the projections. While the onshore Gulf Coast region is the second highest producing region throughout the forecast, it is the only region with a decline in production in the last 3 years. Both the Southwest and the Mid-continent regions grow at about the same rate as the total U.S. production, generally maintaining their regional share. The Northeast continues to be the second lowest producing region throughout the forecast, but shows the greatest growth in percentage terms. The majority of gas production from the Northeast is from unconventional sources such as tight sands and gas shales in Michigan, Pennsylvania, and West Virginia.

Historic Gas Production. The growth in natural gas production projected from 2000 to 2020 is not unprecedented for the natural gas industry. From 1952 to 1972 production increased faster than projected over the next 20 years (Figure 10). However, the natural gas market in the 1960's was quite different than today's market and from the market anticipated in the future. One difference is the deregulation of natural gas prices at the wellhead. Even in real terms prices were significantly lower during the earlier time frame than they are today. The average wellhead price from 1952 to 1971 was only 27 percent of the average wellhead price between 1995 and 2000 ($0.64 compared to $2.38 per Mcf in 2000 dollars). Higher prices provide greater incentive to increase production.

A more important difference is the quality of available prospects. Producers tend to first drill for the gas that is relatively cheaper to access and produce. Progressively over time the more expensive prospects are tapped. However, vast improvements in exploration and production technologies have brought overall costs down significantly. One of the key areas of improvement has been the ability to better determine where gas is located before drilling an expensive and potentially dry hole.

Prices. Wellhead natural gas prices are expected to be more sensitive to variation in technological change than are the levels of natural gas production and consumption. The projected price of natural gas reflects the long-run marginal cost of domestic natural gas production and imports, which depends strongly on technological progress. Natural gas production and imports, however, vary across the technology cases only to the extent that demand for natural gas responds to the change in price.

Natural gas demand is relatively unresponsive to price changes in the short term but can be more responsive over time as price differences among competing fuels lead to different decisions with regard to purchases of natural-gas-consuming equipment.

Over the projection period, lower 48 natural gas wellhead prices are projected to increase from the average wellhead natural gas price of $2.38 per thousand cubic feet between 1995 and 2000 in the reference and technology cases (Figure 11). The slow and rapid technology cases assume that the rate of technological improvement in production costs, finding rates, and success rates will respectively decrease or increase by 25 percent, relative to the historical rate assumed in the reference case.

The lower 48 average wellhead price in 2020 is projected to be $4.06 per thousand cubic feet in the slow technology case, which is 25 percent higher than the reference case price of $3.26 per thousand cubic feet in 2020 ($5.56 in nominal dollars). In the rapid technology case, lower 48 natural gas wellhead prices are projected to remain relatively flat from 2005 through 2020, reaching $2.73 per thousand cubic feet in 2020, which is 16 percent lower than in the reference case. These price forecasts are long-term price trends and as such do not reflect the volatility in short-term markets. For example, the variation from the general price trajectory in any given year could be significant, as happened in 2001.

Access to Restricted Federal Lands and Waters. Federal access restrictions substantially affect the Rocky Mountain region, where considerable natural gas resources are either off limits to exploration and development or subject to Federal lease stipulations when production is allowed. Federal access limitations also affect offshore natural gas resources in the Pacific, Atlantic, and Eastern Gulf of Mexico Outer Continental Shelf. If Federal access restrictions were reduced as described in the EIA's December 2001 study, *U.S. Natural Gas Markets: Mid-term Prospects for Natural Gas Supply*, the technically recoverable natural gas resource base would be expected to increase by 86 tcf, expanding the resource base 7 percent (from 1,191 Tcf to 1,277 Tcf), and 50.8 Tcf of resources in the Rocky Mountain region would become less costly to develop because of shorter lead times. This reduction in restrictions does not include access to the estimated 62.5 Tcf of natural gas resources in National Parks, National Monuments, and wilderness and roadless areas.

With the larger, less costly resource base, cumulative lower 48 reserve additions throughout the forecast are projected to be 15 Tcf higher than in the reference case (506 Tcf compared to 491 Tcf). The remaining lower 48 natural gas reserves in 2020 are projected to be 11 Tcf higher than in the reference case. With this improved reserve position, natural gas production in 2020 is projected to be 0.6 tcf higher, and the average wellhead price is projected to be 11 cents per thousand cubic feet lower than in the reference case (Figure 12).

Conclusion

In summary, domestic natural gas production is projected to increase by 2 percent per year on average over the forecast period. A similar rate of increase is expected for the price, from a base price representing the average over the last 5 years of the 1990's -- $2.18 per Mcf in 2000 dollars. With a slightly more rapid

growth in imports (2.4 percent per year), largely from Canada, sufficient supplies are expected to be available to satisfy the growing demand for natural gas, primarily from electric generators.

Thank you, Madame Chairman and members of the Subcommittee. I will be happy to answer any questions you may have.

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