STATEMENT OF

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HEARING ON SOURCES OF ENERGY SUPPLY AND CONSUMPTION

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Mr. Chairman and Members of the Subcommittee:

I appreciate the opportunity to appear before you today to discuss the long-term outlook for energy markets in the United States.

The Energy Information Administration (EIA) is an autonomous 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, but we do 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. However, EIA's baseline projections on energy trends are widely used by government agencies, the private sector, and academia for their own energy analyses.

Each year, EIA publishes the *Annual Energy Outlook*, which provides projections and analysis of domestic energy consumption, supply, prices, and energy-related carbon dioxide emissions through 2020. The projections in this testimony are from the *Annual Energy Outlook 2001* (*AEO2001*), published by EIA in December 2000. 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. In addition to these short-term phenomena, long-term trends in technology development, demographics, economic growth, and energy resources may evolve along a different path than assumed in the *AEO2001* reference case. Many of these uncertainties are explored through alternative cases in *AEO2001*.

Energy Consumption

Total energy consumption in the United States is projected to increase from 97.1 to 127.0 quadrillion British thermal units (Btu) between 1999 and 2020, an average annual increase of 1.3 percent. Energy consumption increased from 67.9 quadrillion Btu in 1970 to 81.0 quadrillion Btu in 1979, with a downturn in 1974 and 1975 during the first oil price increase. During the early 1980s, energy consumption again declined to 73.3 quadrillion Btu in 1983, due in part to the second oil price increase. Since 1983, energy consumption has been generally increasing, with an average annual increase of 1.8 percent through 2000.

Transportation energy demand is expected to increase at an average annual rate of 1.8 percent to 38.5 quadrillion Btu in 2020 and is the fastest growing end-use sector (Figure 1). The growth in transportation use is driven by 3.6-percent projected annual growth in air travel, the most rapidly increasing transportation mode, and 1.9-percent annual growth in light-duty vehicle travel, the largest component of transportation energy demand, coupled with slow projected growth in vehicle efficiency. The projected growth in travel is a result of continued growth in the economy

and in personal income.

Residential and commercial energy consumption is projected to increase at average annual rates of 1.2 and 1.4 percent, respectively, reaching 24.4 quadrillion Btu in 2020 for residential demand and 20.8 quadrillion Btu for commercial demand. Projected economic and population growth leads to expansion of the housing and commercial building stock. In addition, it is expected that the growth in personal income will increase equipment purchases and continue the trend to larger new homes. In both sectors, the growth in demand is led by electricity consumption for a variety of equipment—telecommunications, computers, office equipment, and other appliances. Electricity use is projected to increase at annual rates of 1.9 and 2.0 percent, in the residential and commercial sectors, respectively. Industrial energy demand is projected to increase at an average rate of 1.0 percent per year, reaching 43.4 quadrillion Btu in 2020, as efficiency improvements in the use of energy help to offset growth in manufacturing output.

The projections incorporate promulgated efficiency standards for new energy-using equipment in buildings, as authorized by the National Appliance Energy Conservation Act of 1987 and periodically updated by the Department of Energy, and for motors, as required by the Energy Policy Act of 1992. Since *AEO2001* included only those laws, regulations, and standards in effect as of July 1, 2000, the new standards for residential clothes washers, water heaters, and central air conditioners and heat pumps and commercial heating, cooling, and water heating equipment issued in January 2001 and revised in April are not included. In addition to the impact of efficiency standards, improvements in efficiency are projected as a result of expected technological improvement and market forces.

Petroleum demand is projected to grow at an average rate of 1.4 percent per year through 2020, led by the growth in demand for transportation (Figure 2). Petroleum demand has declined during periods of high oil prices and economic slowdowns, specifically 1973 to 1975, 1978 to 1983, and 1989 to 1991. Since 1991, petroleum consumption has increased at an average annual rate of 1.7 percent, from 16.7 million barrels per day to record levels of 19.5 million barrels per day in 1999 and 2000. Through 2020, consumption of petroleum for transportation uses is projected to increase from about two-thirds to 72 percent of total petroleum demand. Projected growth in travel more than offsets efficiency gains, and expected economic growth increases petroleum use for freight and shipping through 2020.

Natural gas consumption is expected to increase at an average rate of 2.3 percent per year. The demand for natural gas generally declined through most of the 1970s and earlier 1980s but began to increase again after its recent low of 16.2 trillion cubic feet in 1986. Between 1994 and 1999, natural gas demand remained in the range of 21 to 22 trillion cubic feet but increased by 1 trillion cubic feet from 1999 to 2000, reaching a record high of 22.7 trillion cubic feet. In the projections, natural gas consumption is expected to increase in all sectors, but the most rapid growth is for electricity generation, where natural gas use (excluding cogenerators) is projected to grow from 3.8 to 11.3 trillion cubic feet between 1999 and 2020.

Total coal consumption is expected to increase from 1,044 to 1,297 million tons per year

between 1999 and 2020, an average annual increase of 1.0 percent. Unlike petroleum and natural gas, coal consumption has generally increased since 1970, growing at an average annual rate of 2.4 percent over the last three decades. In the projections, coal remains the primary fuel for generation, although its share of generation is expected to decline from 51 to 44 percent between 1999 and 2020. About 90 percent of all coal consumption is used for electricity generation.

Total renewable fuel consumption, including ethanol used in gasoline, is projected to increase at an average rate of 1.1 percent per year through 2020. In 2020, about 55 percent of renewable energy is used for electricity generation and the rest for dispersed heating and cooling, industrial uses, and fuel blending. Since 1973, total renewable energy consumption is estimated to have increased from 4.6 quadrillion Btu to 7.1 quadrillion Btu in 2000, with 75 percent of the growth in the use of wood and waste.

Nuclear generating capacity is projected to decline through 2020 due to retirements of some existing facilities, for which continued operation is not economical compared to the cost of a new generating facility. Nuclear generating capacity increased from 7 to 100 gigawatts between 1970 and 1990, peaking at 101 gigawatts in 1996. Between 1970 to 2000, nuclear generation increased from 22 to 754 billion kilowatthours. Of the 97 gigawatts of nuclear capacity available in 1999, 26 gigawatts is projected to be retired by 2020, and no new plants are expected to be constructed by 2020. As a result, nuclear generation is projected to decline by about 21 percent by 2020.

Total electricity consumption is projected to grow by 1.8 percent per year through 2020, led by growth in the residential and commercial sectors (Figure 3). Between 1970 and 2000, the average annual growth in electricity demand was 3.0 percent, and, during the 1960s, electricity demand grew by more than 7 percent per year. Several factors have contributed to the slowing growth in demand, including increased market saturation of electric appliances, improvements in equipment efficiency and utility investments in demand-side management programs, and more stringent equipment efficiency standards. Throughout the forecast, the projected growth in demand for office equipment, personal computers, and other equipment is dampened by slowing growth or reductions in demand for space heating and cooling, refrigeration, water heating, and lighting, the continuing saturation of electricity appliances, the availability and adoption of more efficient equipment, and efficiency standards.

Energy Intensity

Energy intensity, measured as energy use per dollar of gross domestic product (GDP), has declined since 1970, most notably when energy prices have increased rapidly (Figure 4). Between 1970 and 1986, energy intensity declined at an average rate of 2.3 percent per year as the economy shifted to less energy-intensive industries and more efficient technologies. Without significant price increases and with the growth of more energy-intensive industries, intensity declines moderated to an average of 1.5 percent per year between 1986 and 2000. Through 2020, energy intensity is projected to decline at an average rate of 1.6 percent per year as efficiency gains and structural shifts in the economy offset growth in demand for energy services. Energy

use per person generally declined from 1970 through the mid-1980s, and then tended to increase as energy prices declined. Per capita energy use is expected to increase slightly through 2020, as efficiency gains only partly offset higher demand for energy services.

Electricity Generation

Generation from both natural gas and coal is projected to increase through 2020 to meet growing demand for electricity and offset the decline in nuclear power expected from retirements of some existing facilities (Figure 5). As noted above, the share of coal generation is expected to decline through 2020 because assumptions about electricity industry restructuring, such as higher cost of capital and shorter financial life of plants, favor the less capital-intensive and more efficient natural gas generation technologies. The natural gas share of total generation is expected to increase from 16 to 36 percent between 1999 and 2020. It is projected that 413 gigawatts of new generating capacity will be needed in the forecast period, including cogeneration. Assuming an average plant size of 300 megawatts, this totals to nearly 1,400 new generating plants. This capacity is needed to meet growing electricity demand and to offset the expected retirements of about 9 percent of current generating capacity. The regions with the greatest capacity additions are the Southeast, Midwest, Texas, and California (Figure 6). Of this new generating capacity, it is projected that 92 percent will be fueled by natural gas, 5 percent by coal, and 3 percent by renewables (Figure 7) because natural gas technologies are generally the least expensive options for new capacity when comparing total generation costs.

The use of renewable technologies for electricity generation, including cogeneration, is projected to increase slowly at an average rate of 0.7 percent per year, primarily due to moderate fossil fuel prices. Most of the projected growth in renewable electricity generation is expected from biomass, landfill gas, geothermal energy, and wind power. State mandates and other incentives, including the Federal production tax credit for generation from wind, encourage much of the growth in renewables in the earlier part of the forecast period. Hydropower is expected to decline slightly through 2020, as output from existing facilities declines, and no large new sites are expected to be available for development.

Energy Supply

Total domestic petroleum supply, including refinery gain and natural gas plant liquids, is projected to remain nearly flat through 2020 (Figure 8). However, domestic crude oil production is projected to decline at an average rate of 0.7 percent per year, from 5.9 million barrels per day in 1999 to 5.1 million barrels per day in 2020. Conventional onshore production in the lower 48 States, which accounted for 44 percent of total U.S. crude oil production in 1999, is projected to decrease to 38 percent in 2020, as production from mature areas declines (Figure 9). Production from Alaska is also expected to decline between 1999 and 2020; however, projected declines in production from most of Alaska's oil fields—particularly Prudhoe Bay, the State's largest producing field—are expected to be offset by production from the National Petroleum Reserve–Alaska, which is projected to begin in 2010. Offshore oil production is projected to range from 1.6 to 2.1 million barrels per day throughout the forecast, and production from

enhanced oil recovery is expected to increase later in the forecast period along with the world oil price projections.

As a result of increasing projected petroleum demand, net petroleum imports are expected to rise through 2020, to meet growing demand (Figure 10). Between 1999 and 2020, net imports of petroleum are projected to increase from 51 percent to 64 percent of domestic petroleum demand. In 2020, the United States is expected to require net imports of crude oil and petroleum products totaling 16.5 million barrels per day.

Unlike oil, domestic natural gas production, with its larger and more accessible resource base, is expected to increase from 18.6 trillion cubic feet in 1999 to 29.0 trillion cubic feet in 2020. Increased production comes primarily from lower 48 onshore conventional nonassociated sources, although onshore unconventional production (including coalbed methane and low-permeability formations of sandstone and shale) is expected to increase at a faster rate than other sources as a result of technology advances (Figure 11). Offshore production is projected to increase less rapidly than onshore production but remains a major source of domestic supply. Natural gas production from Alaska is projected to increase slightly through 2020, not including gas from the North Slope. Production of associated-dissolved natural gas from lower 48 crude oil reservoirs generally declines in the projections, following the pattern of domestic crude oil production. In order to fill the gap between domestic production and consumption, net natural gas imports are expected to increase from 3.4 trillion cubic feet in 1999 to 5.8 trillion cubic feet in 2020, mostly pipeline natural gas imports from Canada (Figure 12). Net liquefied natural gas imports are projected to increase from 0.1 to 0.7 trillion cubic feet by 2020. Two liquefied natural gas import facilities at Elba Island, Georgia, and Cove Point, Maryland, were expected to reopen in 2003 at the time the *AEO2001* projections were finalized; however, 2002 appears to be a more likely date at this time.

Coal production is expected to increase from 1,100 million tons in 1999 to 1,331 million tons in 2020, an average of 0.9 percent per year, to meet rising domestic demand. From 1999 to 2020, low-sulfur coal production is expected to increase while the production of high- and medium-sulfur coal declines, due to the need to reduce sulfur dioxide emissions from coal-fired electricity plants required by the Clean Air Act Amendments of 1990. As a result, western coal production—the primary source of new low-sulfur coal—is expected to continue its historic growth, reaching 787 million tons in 2020, an annual growth rate of 2.2 percent (Figure 13). Western coal is surface mined and less costly to produce than eastern coal.

Energy Prices

Energy markets and energy prices are subject to much uncertainty. Random events including severe deviations from normal weather, political disruptions, strikes, and failures of vital equipment, such as refineries, generating plants, and pipelines, are all likely occurrences that may cause energy prices to fluctuate from one year to the next or to fluctuate, sometimes dramatically, from the average annual prices presented in *AEO2001*. Because the occurrence and timing of these events cannot be foreseen, the prices projected in *AEO2001* are based upon the

expected trends for longer-term demand, supply, and technology development.

At the time the *AEO2001* projections were finalized in September 2000, the average world oil price was projected to increase from $17.26 per barrel in 1999 (1999 dollars) to about $27.60 per barrel in 2000, then fall through 2003 (Figure 14). In 2020, the projected price reaches $22.41 per barrel. At this time EIA is projecting a somewhat slower rate of decline in its *Short-Term Energy Outlook.* World oil demand is expected to increase at an average annual rate of 2.1 percent through 2020; however, projected growth in production in both OPEC and non-OPEC nations leads to relatively slow projected growth of prices through 2020. OPEC oil production is expected to reach 57.6 million barrels per day in 2020, nearly double the 29.9 million barrels per day in 1999. The June 2000 recoverable oil resource assessment by the U.S. Geological Survey raised world resources by about 700 billion barrels from the 1994 assessment. As a result, non-OPEC oil production is expected to increase from 44.8 million barrels per day to 59.5 million barrels per day between 1999 and 2020.

The average wellhead price of natural gas is projected to increase from $2.17 per thousand cubic feet in 1999 to $3.13 per thousand cubic feet in 2020 (Figure 15). Natural gas prices have been high in 2000 and 2001, due to higher than expected demand and to tight supplies, resulting from reduced drilling in reaction to low prices in 1998. At this time, EIA's *Short-Term Energy Outlook* projects natural gas prices to be higher in 2001 and 2002 than at the time the *AEO2001* projections were finalized. The higher prices projected for 2001 and 2002 will result in a longer transition period before natural gas stocks can be sufficiently replenished to cause prices to fall to the long-term price path. In the longer-term projections, technological improvements in natural gas exploration and production are expected to slow price increases.

The average minemouth price of coal is projected to decline from $16.98 per ton in 1999 to $12.70 per ton in 2020 (Figure 16). In a continuation of historical trends, the average price of coal is expected to decline through 2020 due to increasing productivity in mining, a shift to lower-cost western production, and competitive pressures on labor costs.

Average retail electricity prices are projected generally to decline from 6.7 cents per kilowatthour in 1999 to 6.0 cents per kilowatthour in 2020, although they increase slightly at the end of the forecast due to rising projected natural gas prices (Figure 17). Electricity industry restructuring is expected to contribute to lower prices through reductions in operating and maintenance, administrative, and other costs. At the time the projections were finalized, twenty-four States and the District of Columbia had passed legislation or promulgated regulations to restructure their electricity markets, which is incorporated in the projections.

Carbon Dioxide Emissions

Energy-related carbon dioxide emissions are projected to increase at an average of 1.4 percent per year from 1999 to 2020, reaching 2,041 million metric tons of carbon equivalent, 35 percent higher than in 1999 and 51 percent higher than in 1990 (Figure 18). Projected increases in carbon dioxide emissions primarily result from continued reliance on coal for electricity

generation and on petroleum fuels in the transportation sector.

Alternative Cases

In order to show the impact of alternative assumptions concerning the key factors driving energy markets, we include a number of alternative cases in *AEO2001*. Two sets of these cases illustrate the impacts of improved technology in energy-consuming equipment and in the production of oil and gas.

One alternative case assumes more rapid improvement in new technologies for end-use demand, through lower costs, higher efficiencies, and earlier availability for new technologies, relative to the reference case, as well as more rapid improvement in the costs and efficiencies of advanced fossil-fired and new renewable generating technologies. As a result, projected energy demand in 2020 is 8 quadrillion Btu lower than in the reference case (Figure 19). Such technology improvements could result from increased research and development, but should not be considered the most optimistic improvements that could occur with a very aggressive program of research and development. The *AEO2001* reference case assumes continued improvements in technology for both energy consumption and production; however, it is possible that technology could develop at a slower rate. In the 2001 technology case, it is assumed that all future equipment choices will be made from the equipment and vehicles available in 2001, with new building shell and industrial plant efficiencies frozen at 2001 levels. Also, new generating technologies are assumed not to improve over time. In this case, efficiencies improve over the forecast period as new equipment is chosen to replace older stock and the capital stock expands; however, projected energy demand in 2020 is 6 quadrillion Btu higher than in the reference case.

Another alternative case assumes more rapid technological improvement in the exploration and production of petroleum and natural gas. By 2020, these assumed improvements are expected to raise natural gas production by 1.1 trillion cubic feet and raise lower 48 crude oil production by nearly 300 thousand barrels per day compared to the reference case. The more rapid technology progress would also be expected to reduce the average wellhead price of natural gas in the United States from $3.13 per thousand cubic feet (1999 dollars) in the reference case to $2.50 per thousand cubic feet in 2020 (Figure 20). Conversely, slower technological improvements are assumed in another case, which reduce natural gas production by 1.9 trillion cubic feet and reduce lower 48 crude oil production by nearly 400 thousand barrels per day in 2020 relative to the reference case. In this slow technology case, the average wellhead price of natural gas in 2020 reaches $4.23 per thousand cubic feet.

Conclusion

Through 2020, continuing growth in the U.S. economy is expected to stimulate more energy demand, with fossil fuels remaining the dominant source of energy. As a result, our dependence on foreign sources of petroleum is expected to increase and domestic natural gas production and natural gas imports are expected to grow significantly. These forecasts incorporate an expectation of efficiency improvements in both demand and supply although different paths for

technological development could lead to slower or more rapid efficiency gains.

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

Figure 1. Energy Consumption by Sector, 1970-2020 (quadrillion Btu)

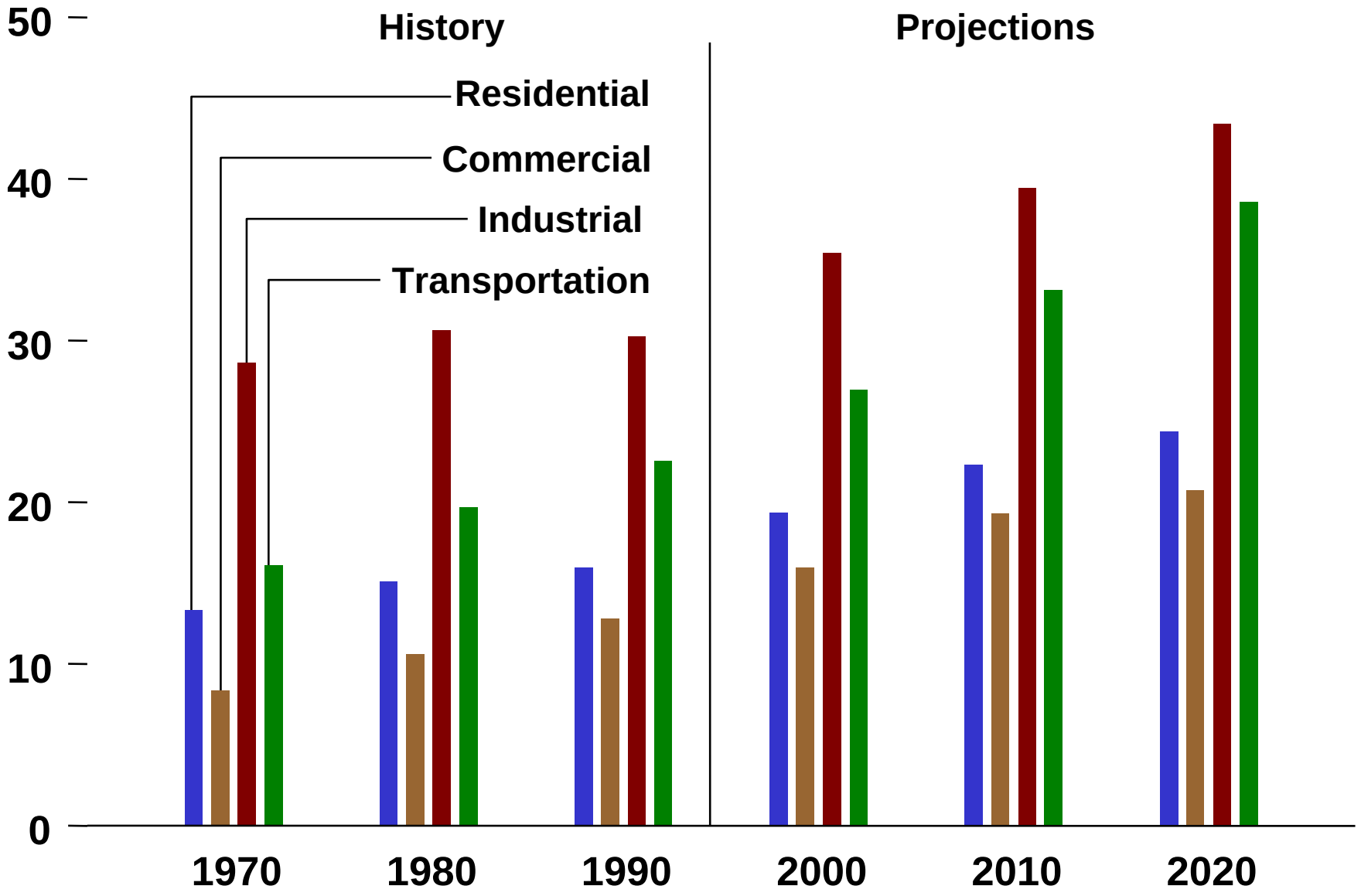

Figure 2. Energy Consumption by Fuel, 1970-2020 (quadrillion Btu)

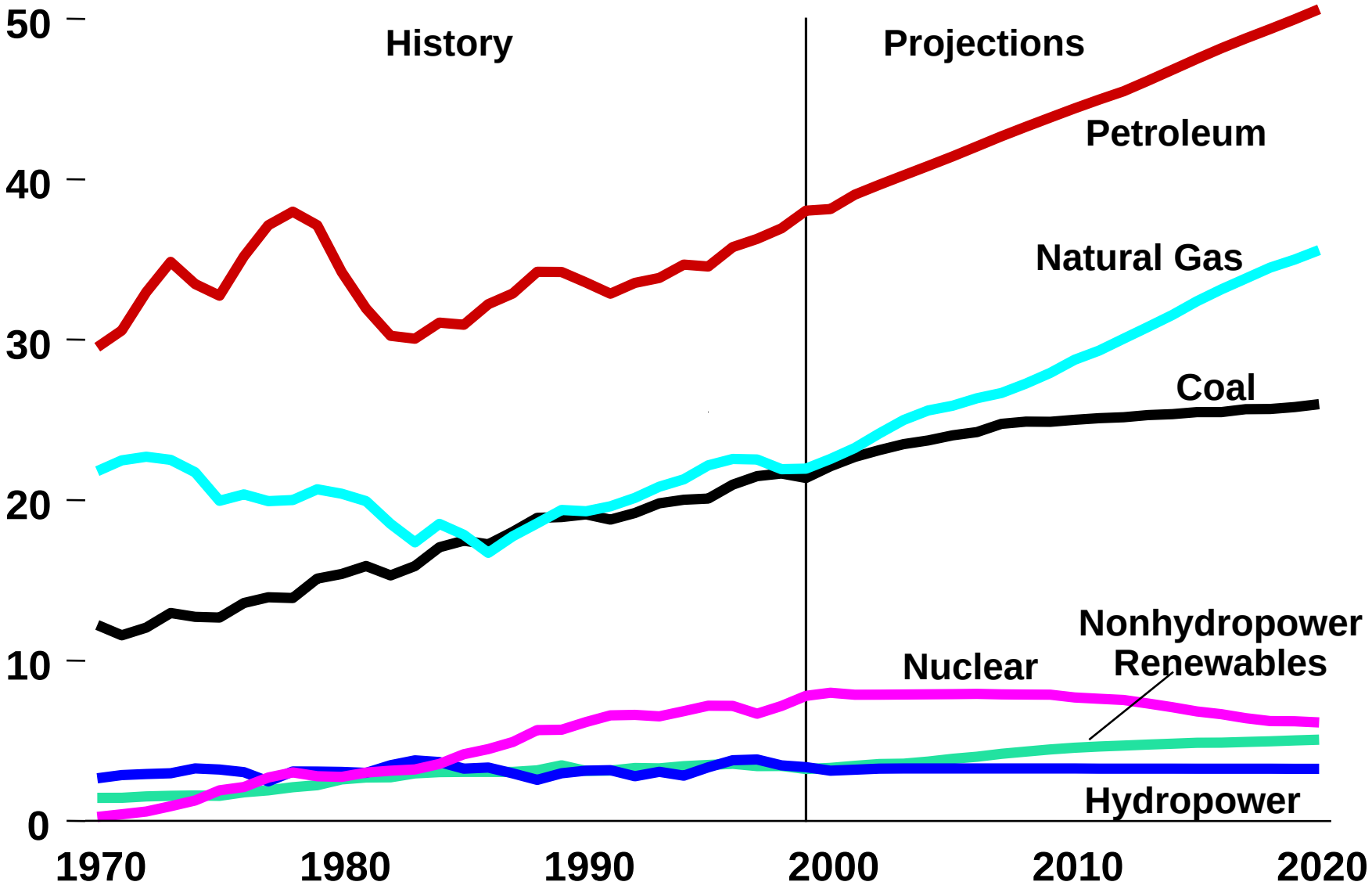

Figure 3. Annual Electricity Sales by Sector, 1970-2020 (billion kilowatthours)

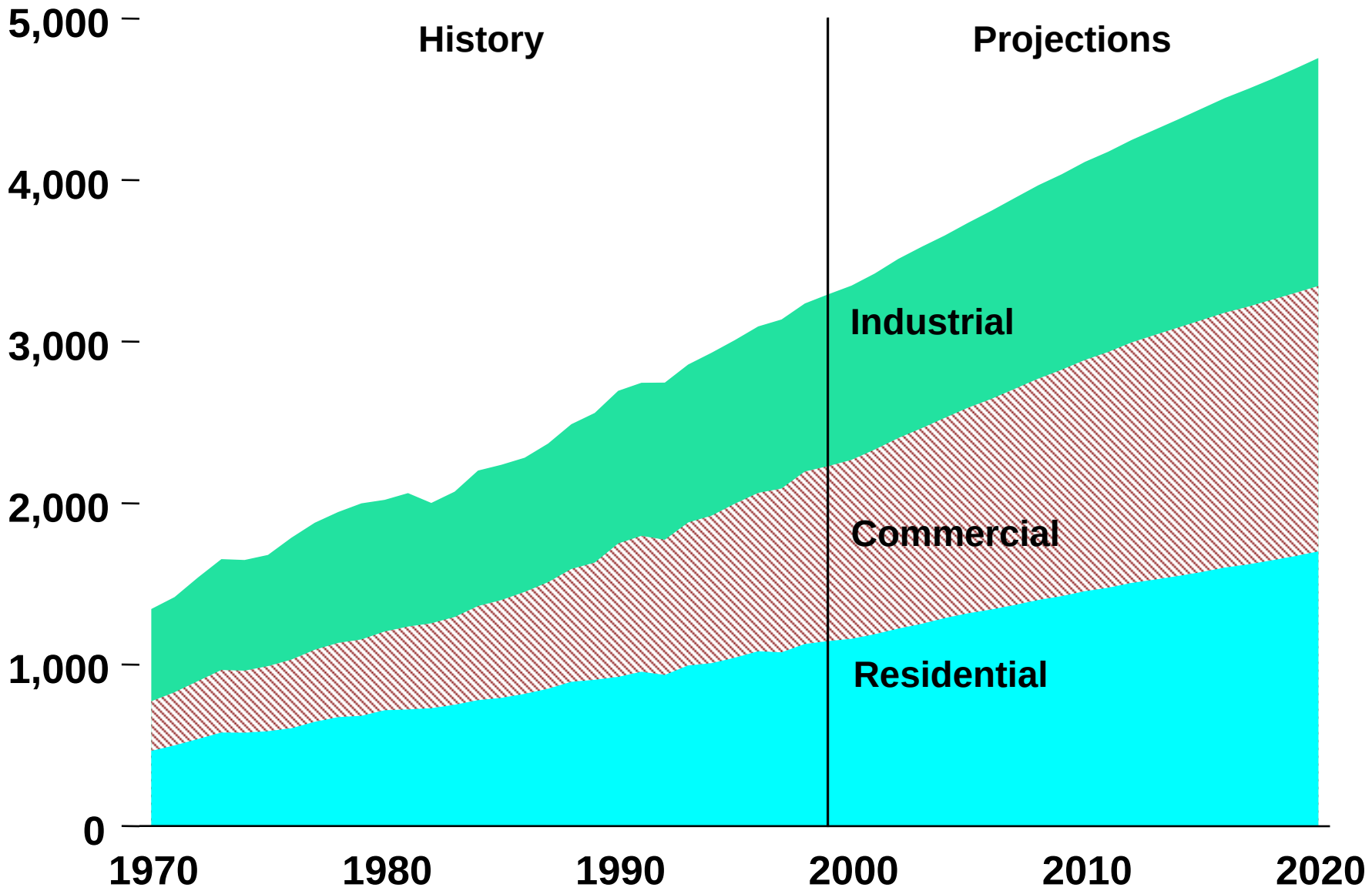

Figure 4. Energy Use per Capita and per Dollar of Gross Domestic Product, 1970-2020 (index, 1970 = 1)

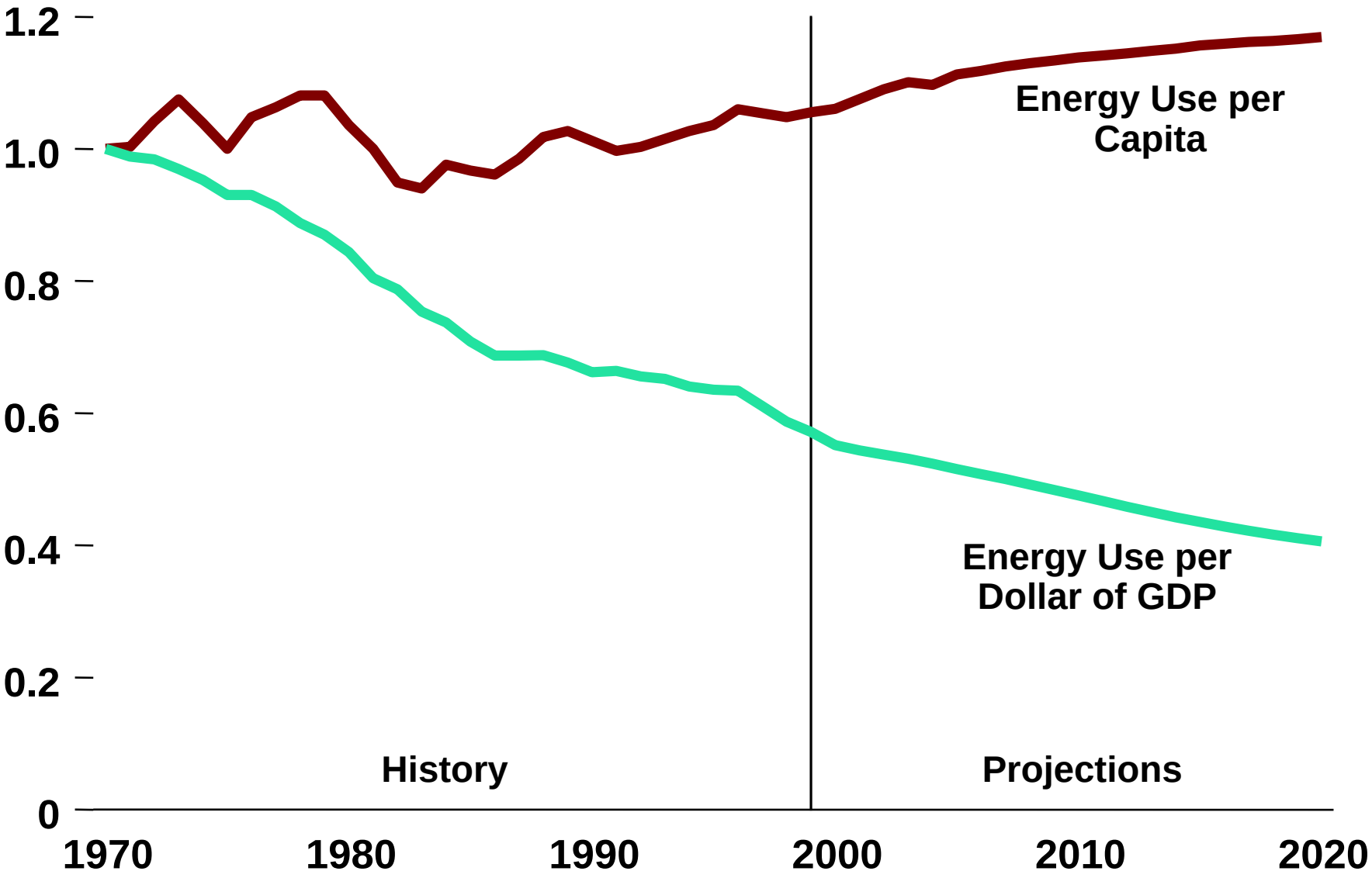

Figure 5. Electricity Generation by Fuel, 1970-2020 (billion kilowatthours)

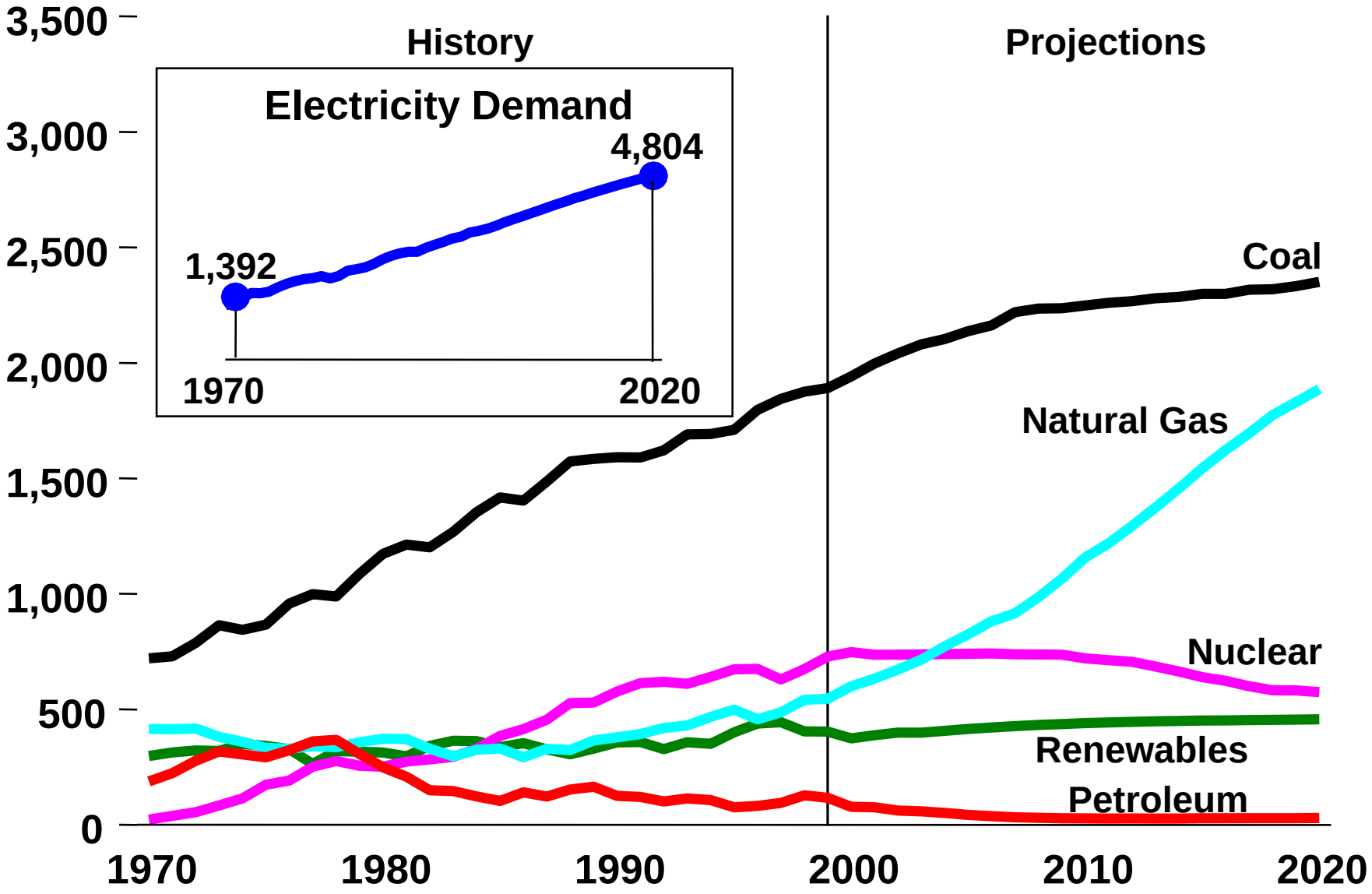

Figure 6. Electricity Generation Capacity Additions by North American Electric Reliability Council Region, 2000-2020 (gigawatts)

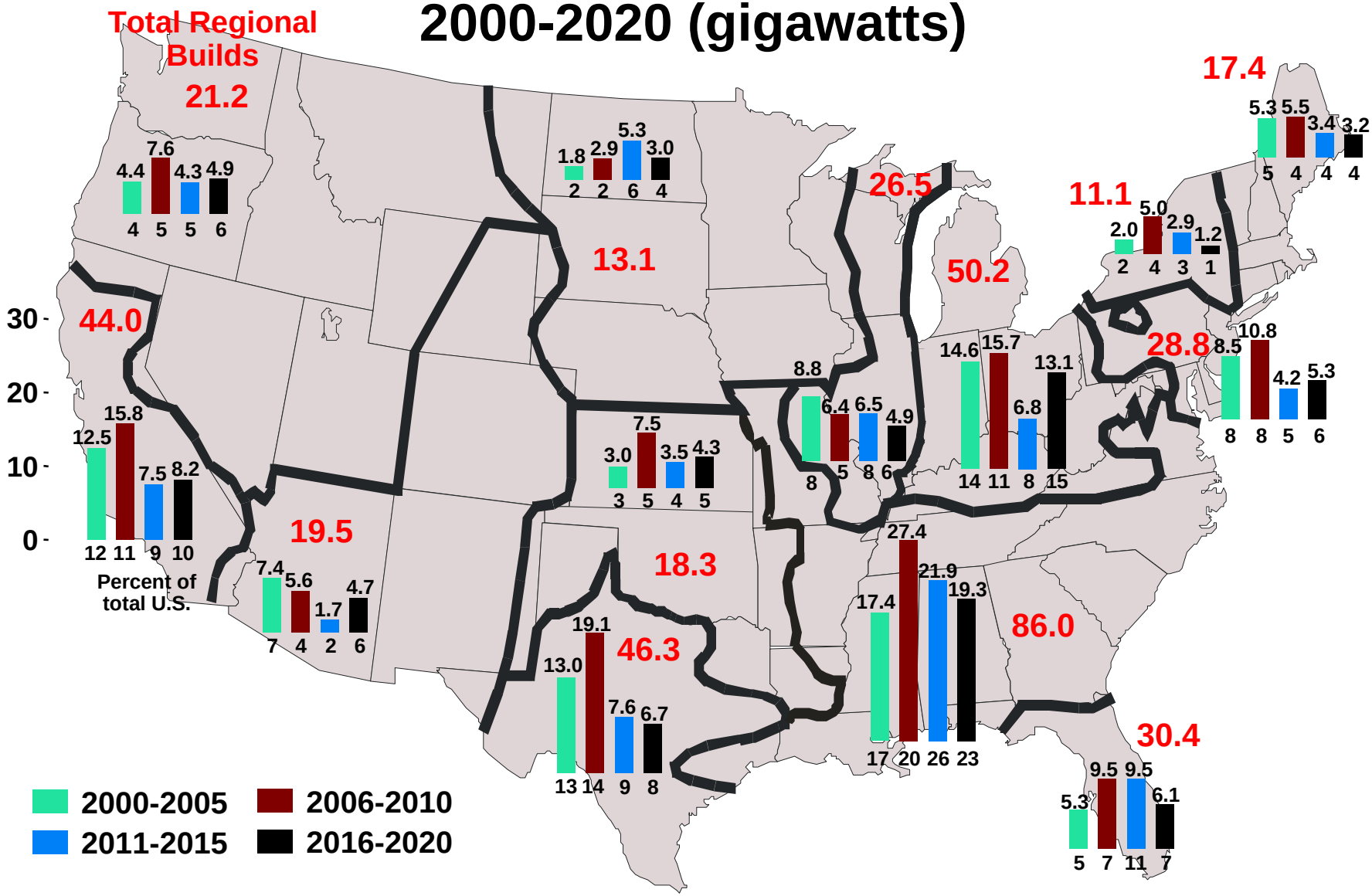

Figure 7. Projected Electricity Generation Capacity Additions by Fuel Type, Including Cogeneration, 2000-2020 (gigawatts)

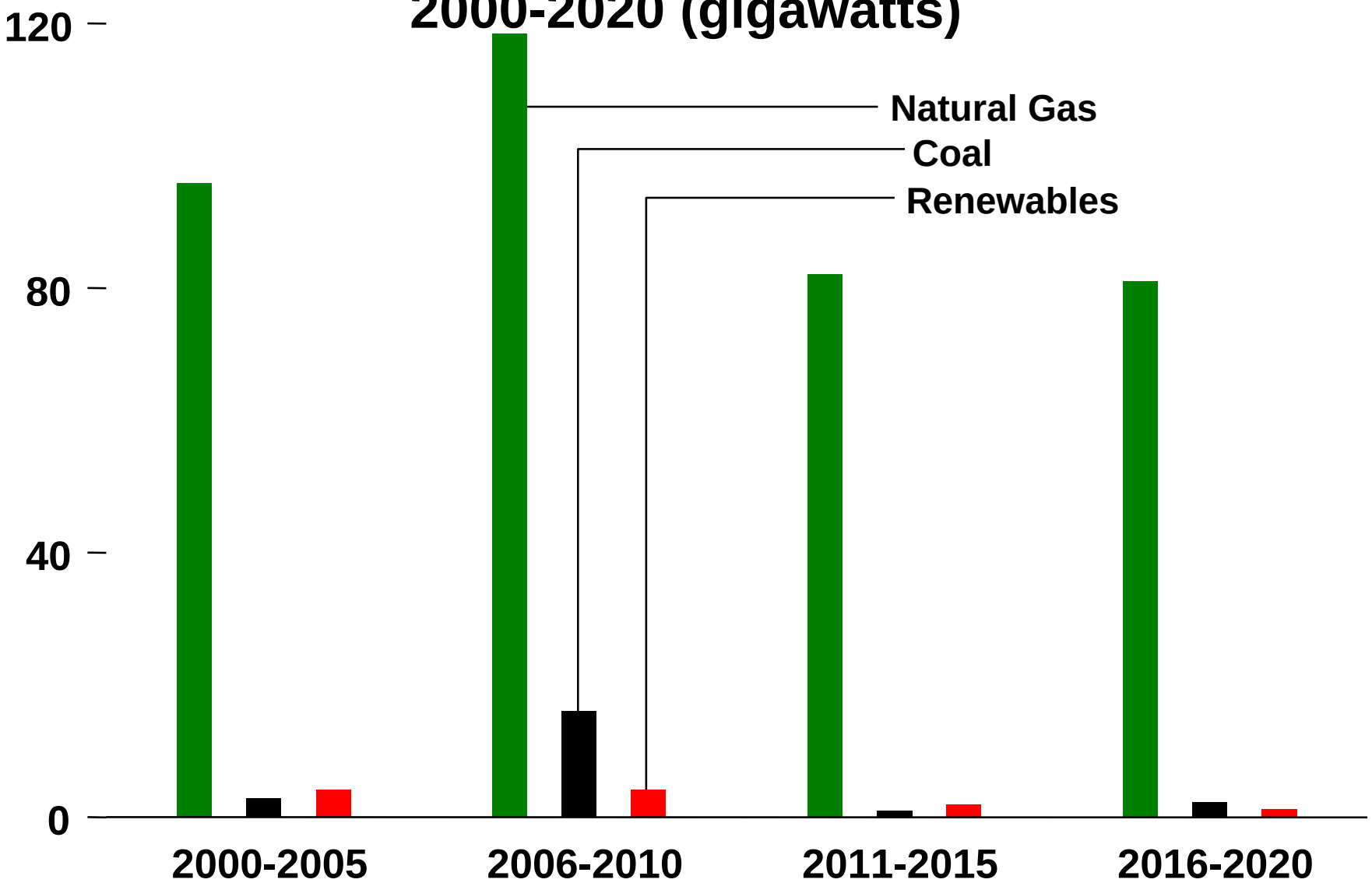

Figure 8. Energy Production by Fuel, 1970-2020 (quadrillion Btu)

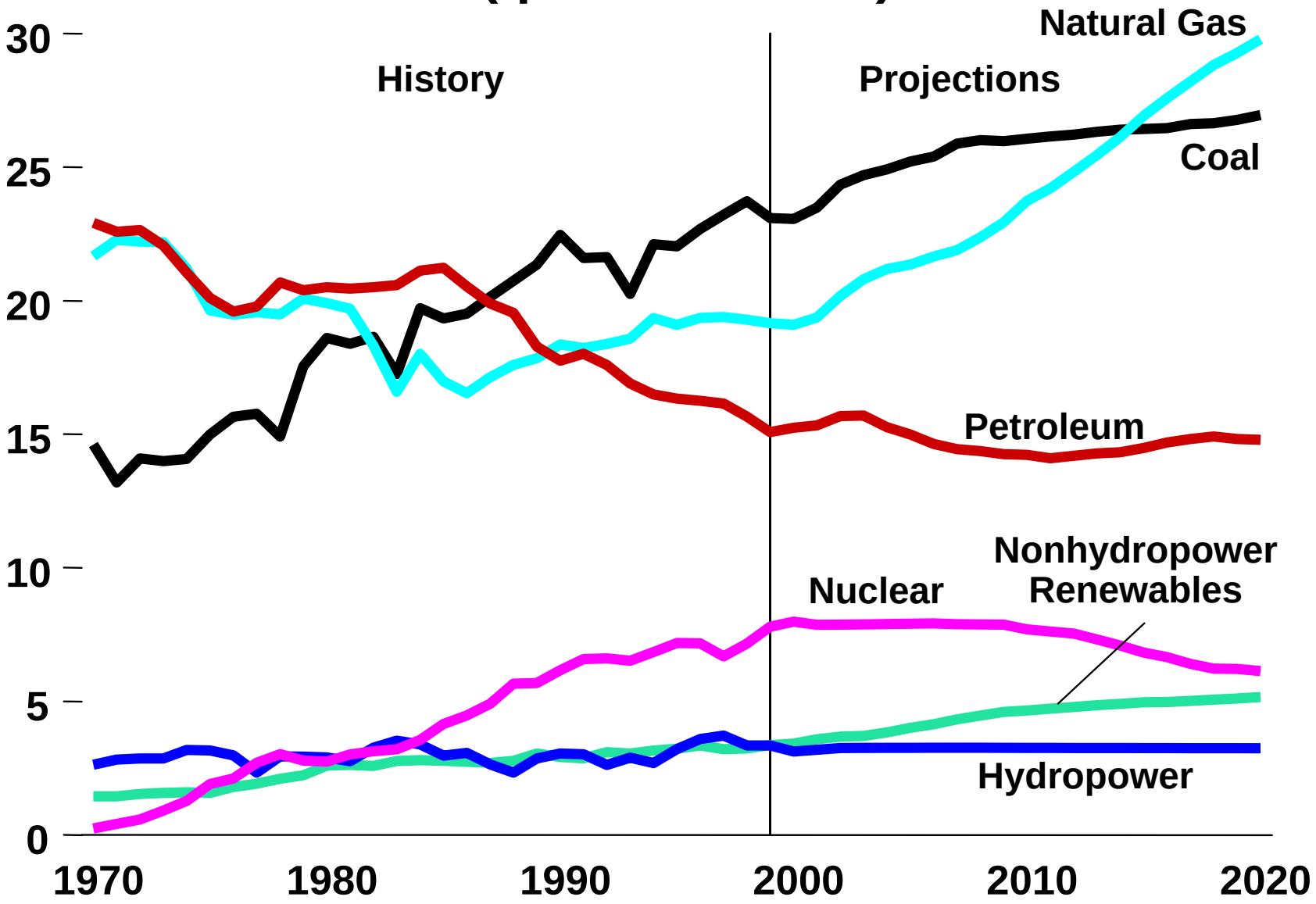

Figure 9. Crude Oil Production by Source, 1970-2020 (million barrels per day)

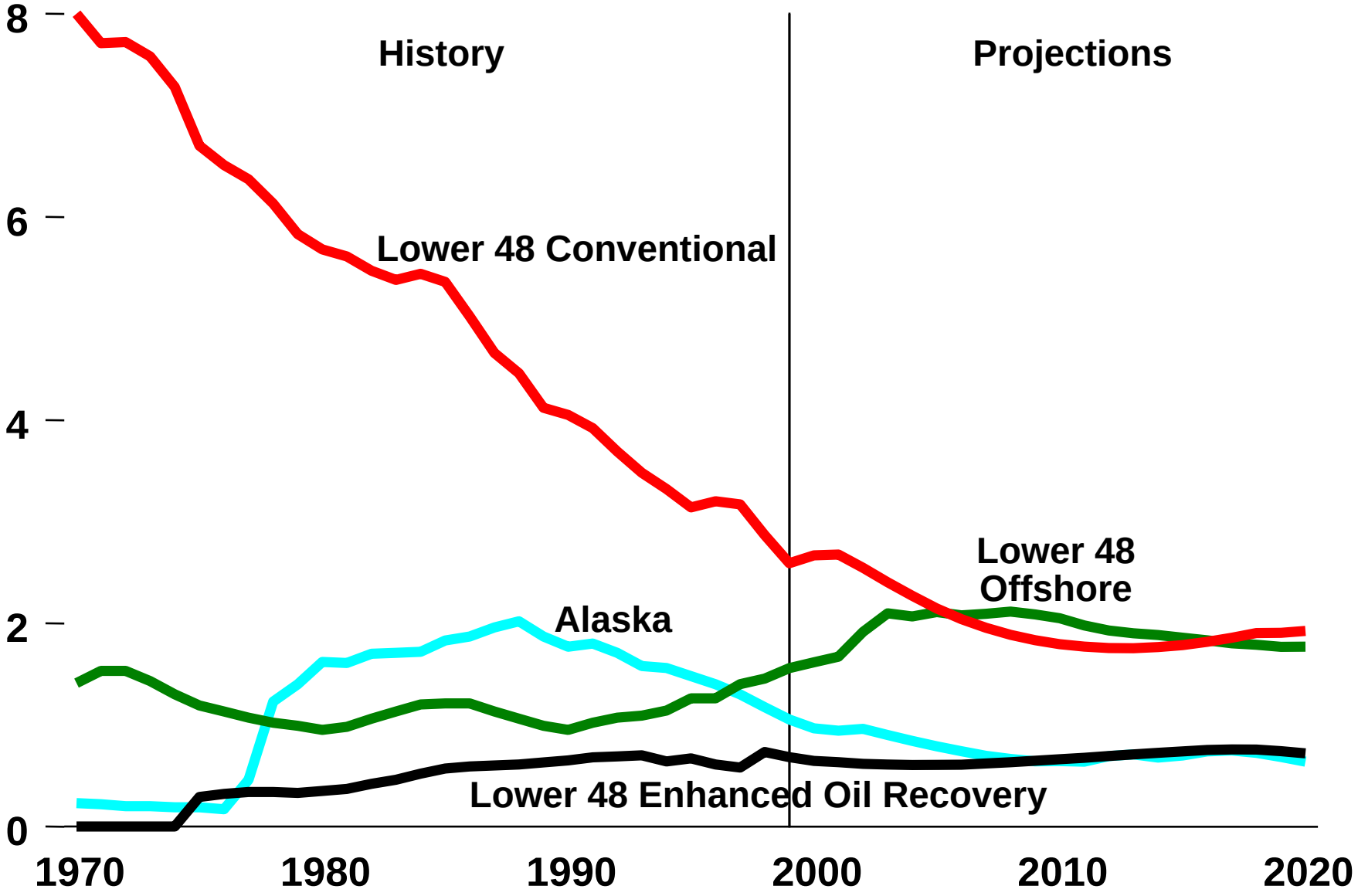

Figure 10. Petroleum Supply, Consumption, and Imports, 1970-2020 (million barrels per day)

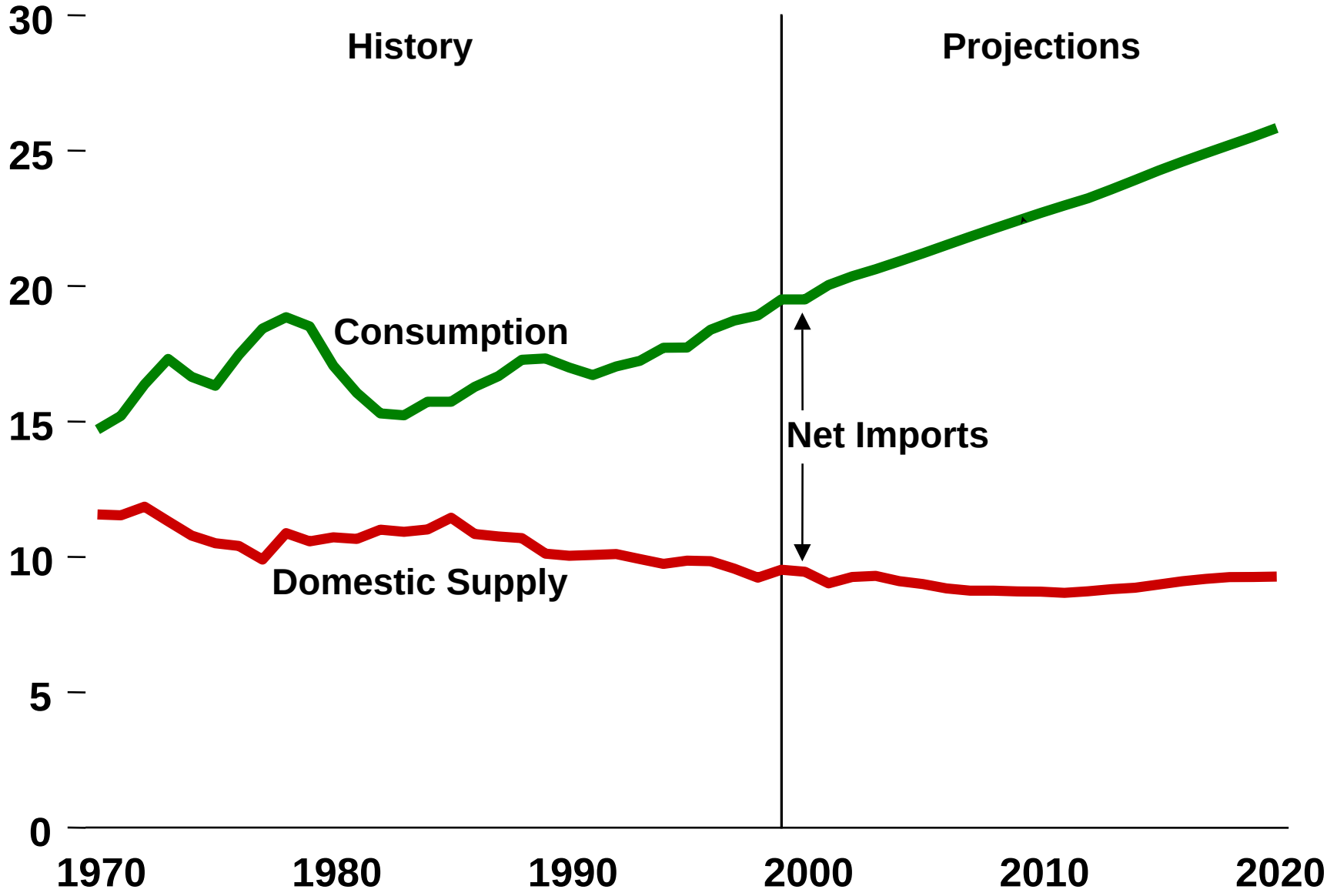

Figure 11. Natural Gas Production by Source, 1990-2020 (trillion cubic feet)

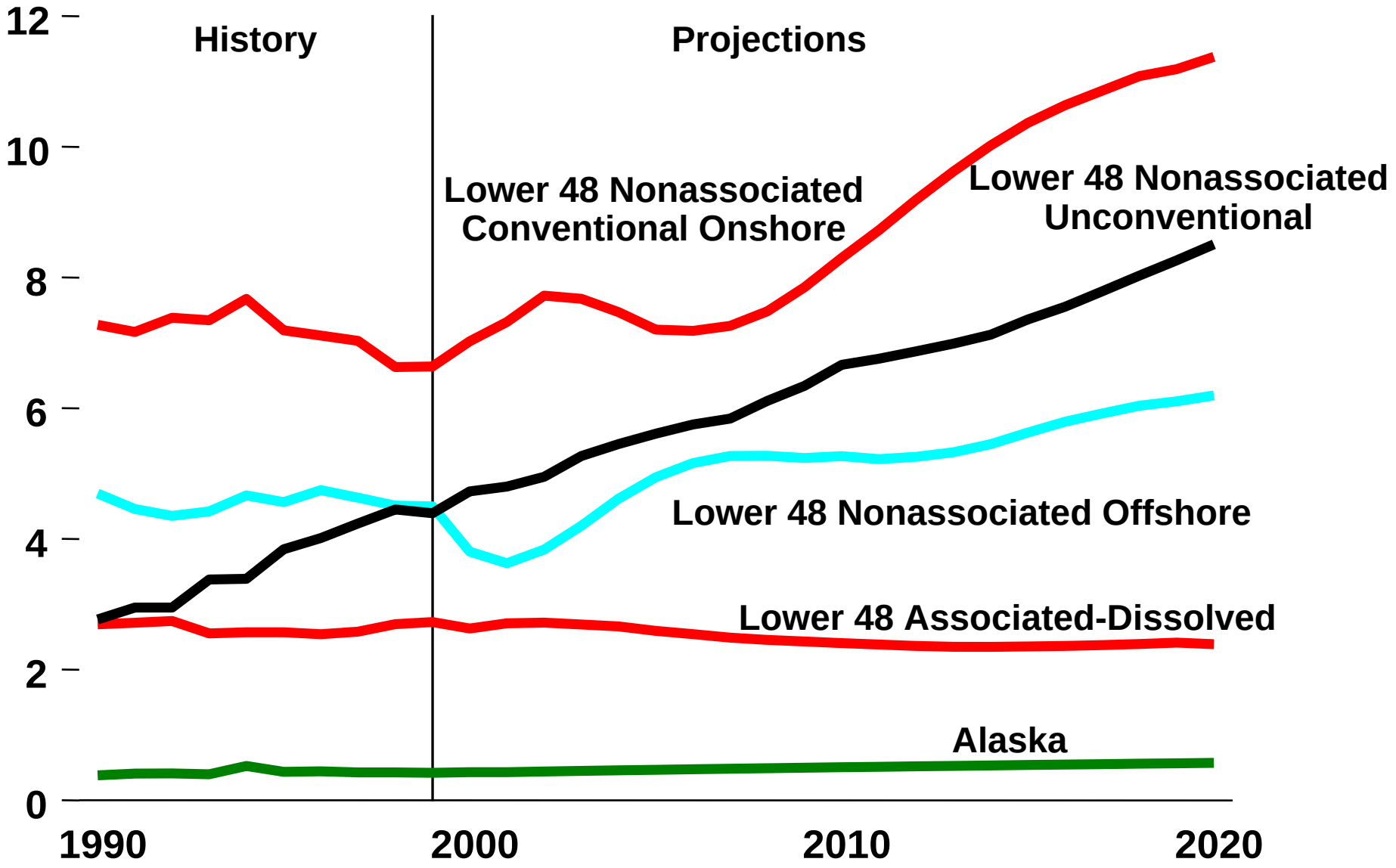

Figure 12. Natural Gas Production, Consumption, and Imports, 1970-2020 (trillion cubic feet)

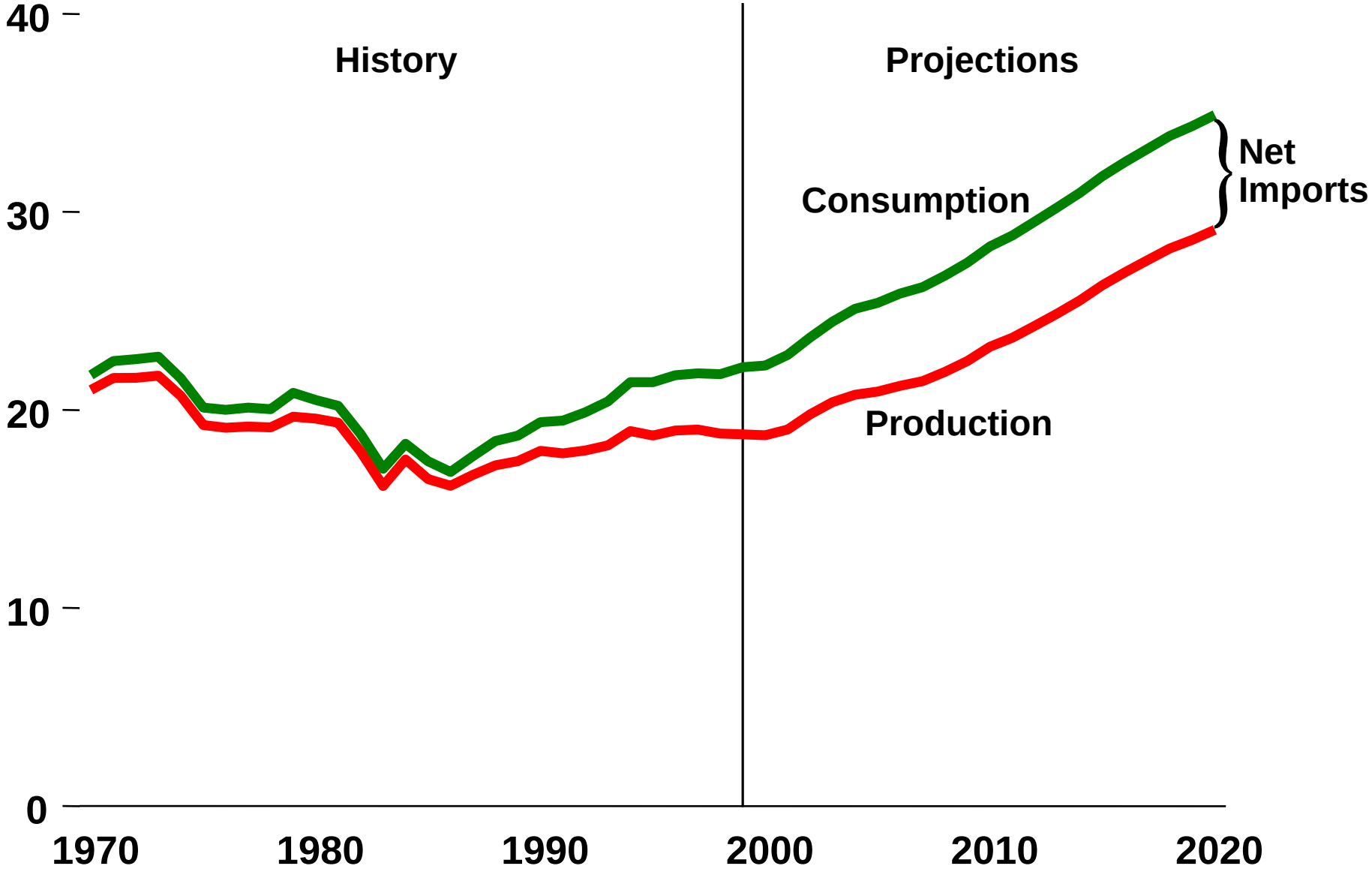

Figure 13. Coal Production by Region, 1970-2020 (million short tons)

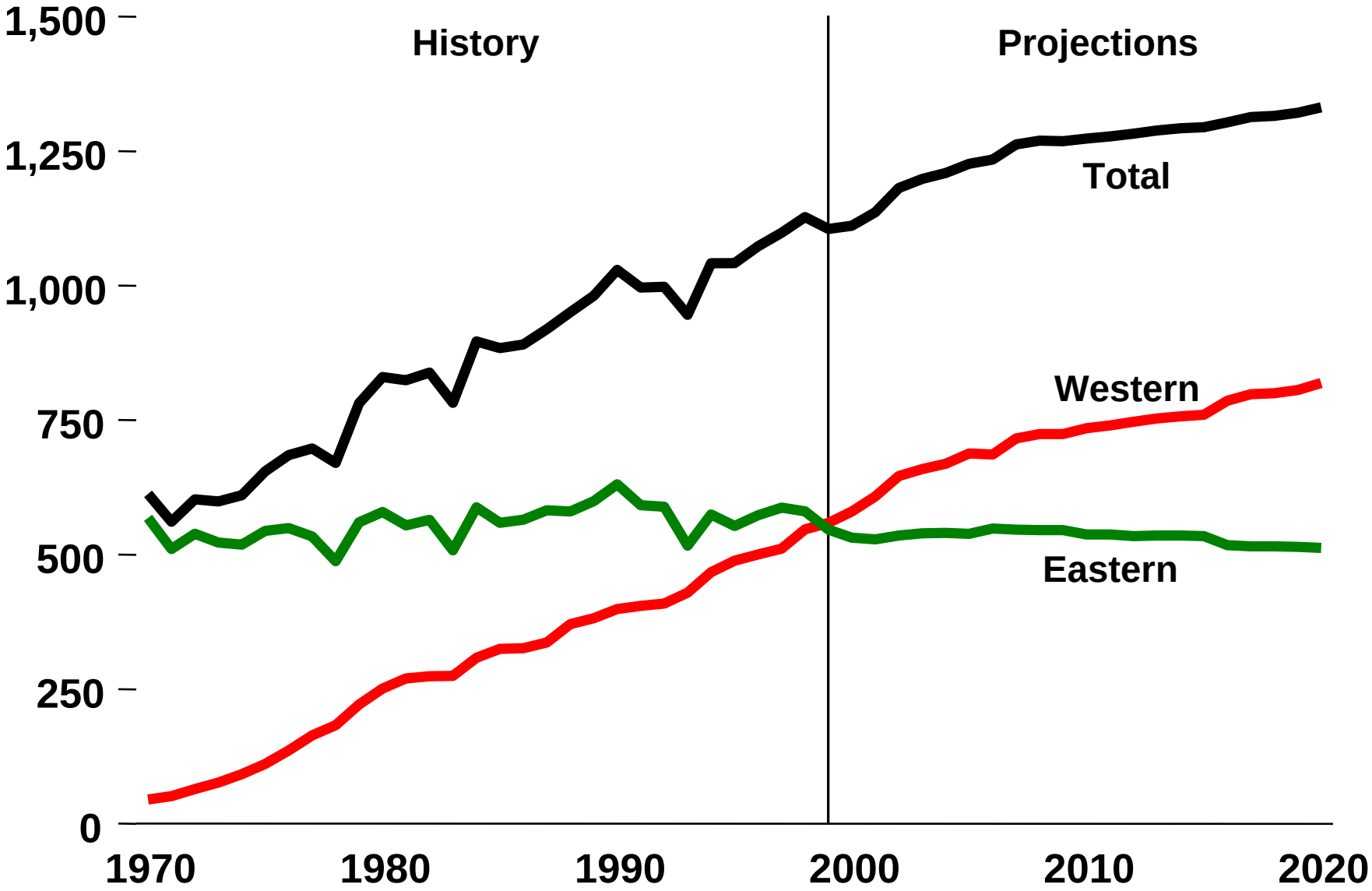

Figure 14. World Oil Price, 1970-2020
(1999 dollars per barrel)

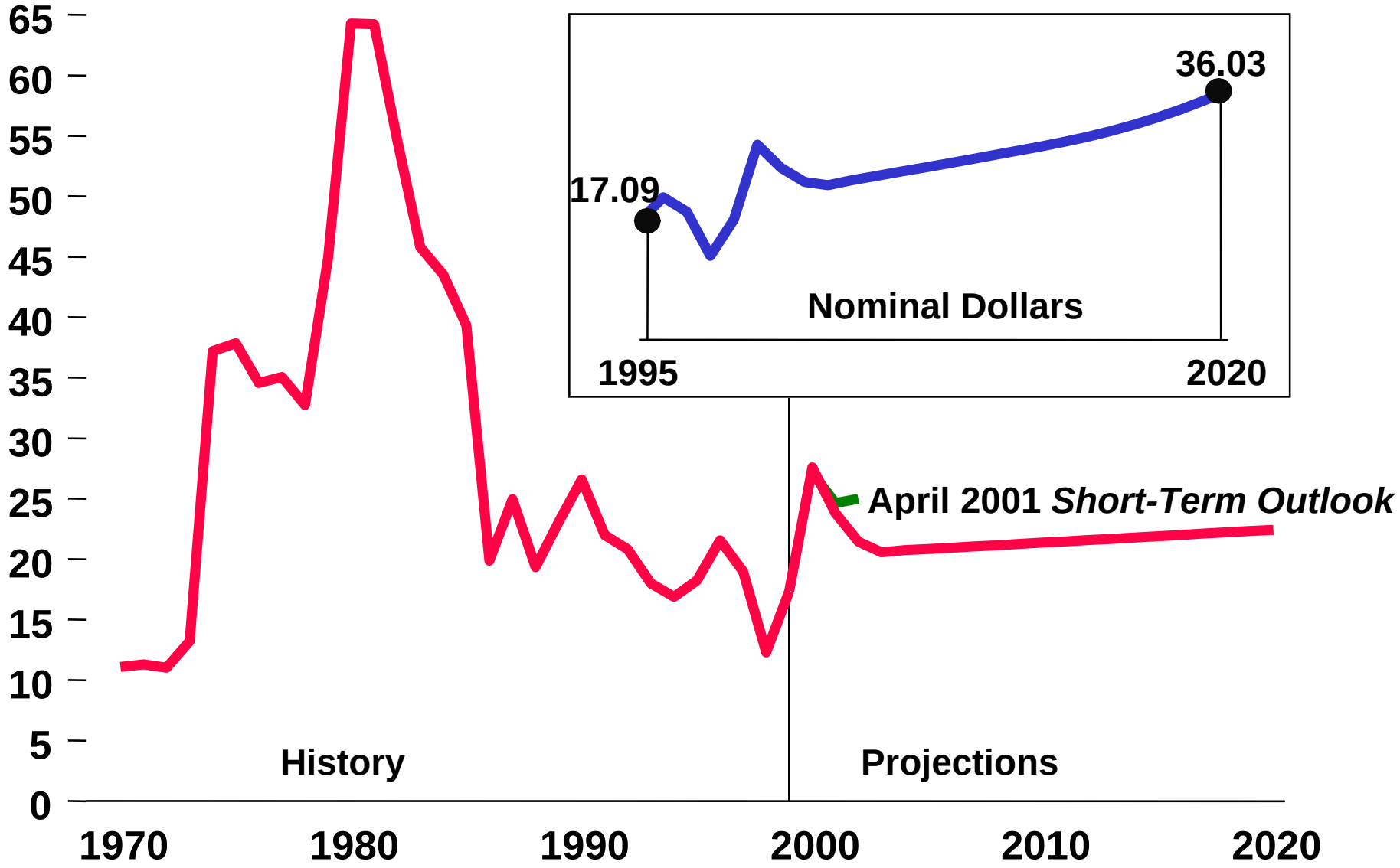

Figure 15. Natural Gas Wellhead Price, 1970-2020 (1999 dollars per thousand cubic feet)

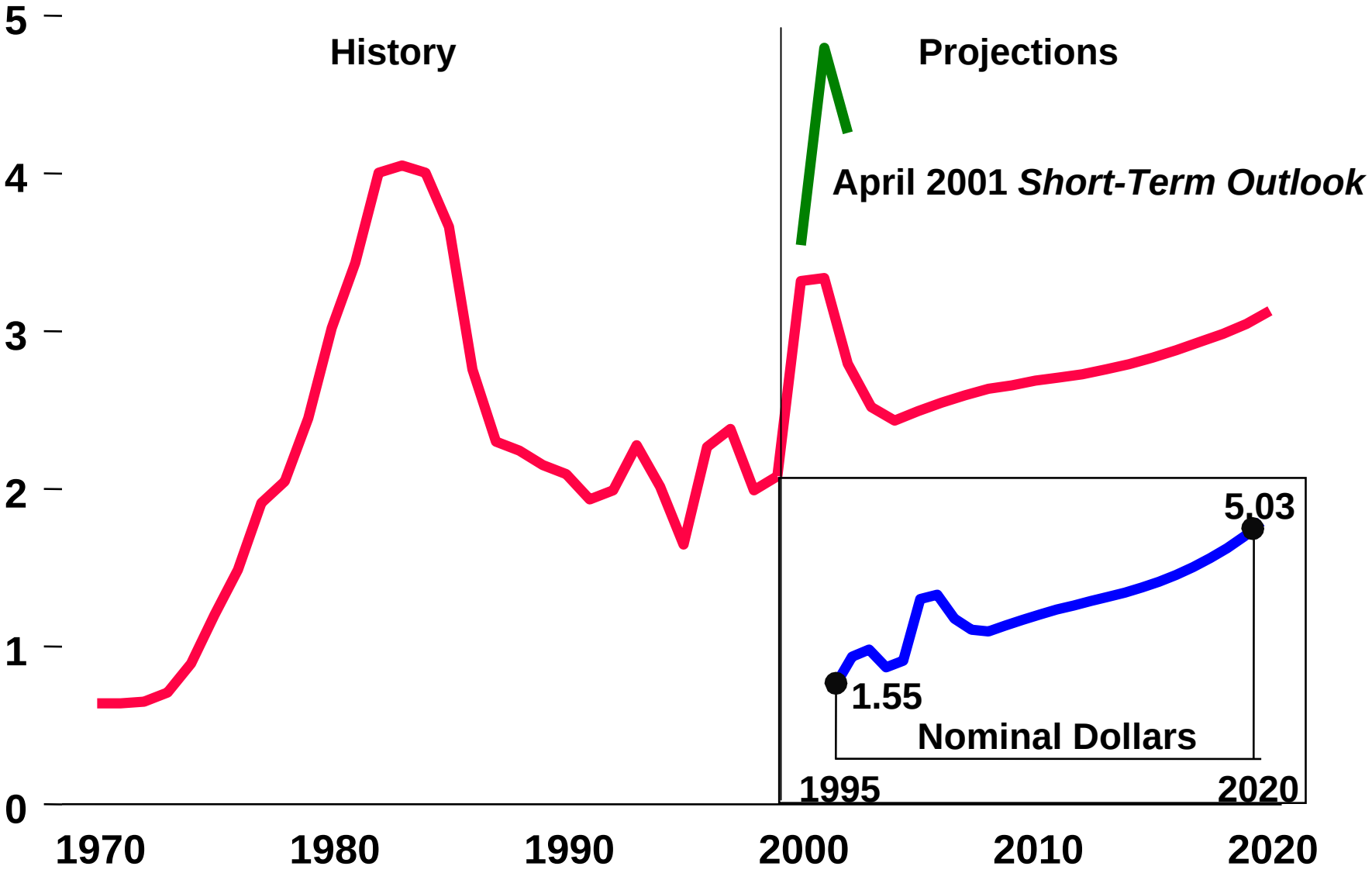

Figure 16. Coal Minemouth Price, 1970-2020 (1999 dollars per ton)

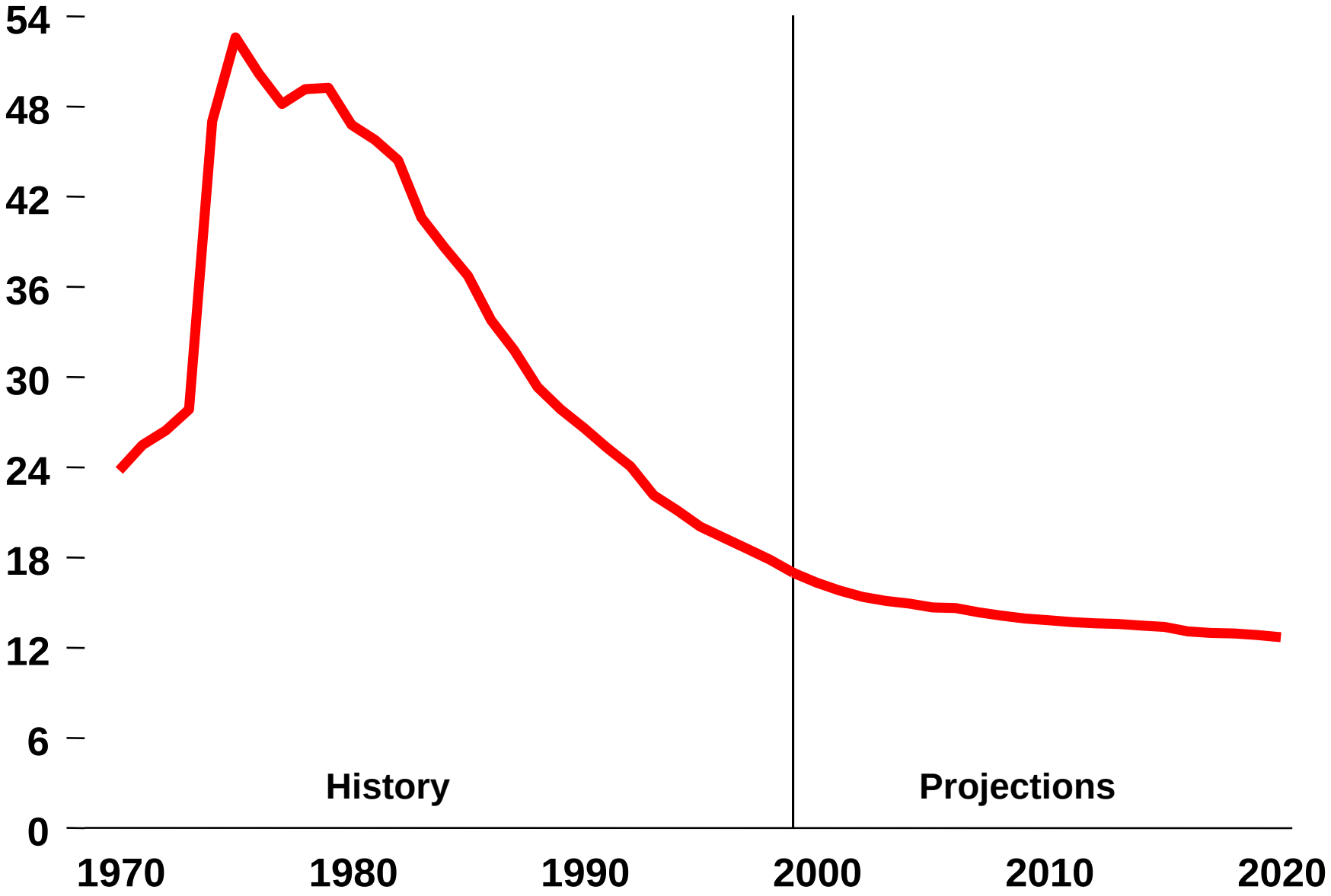

Figure 17. Electricity Price, 1970-2020 (1999 cents per kilowatthour)

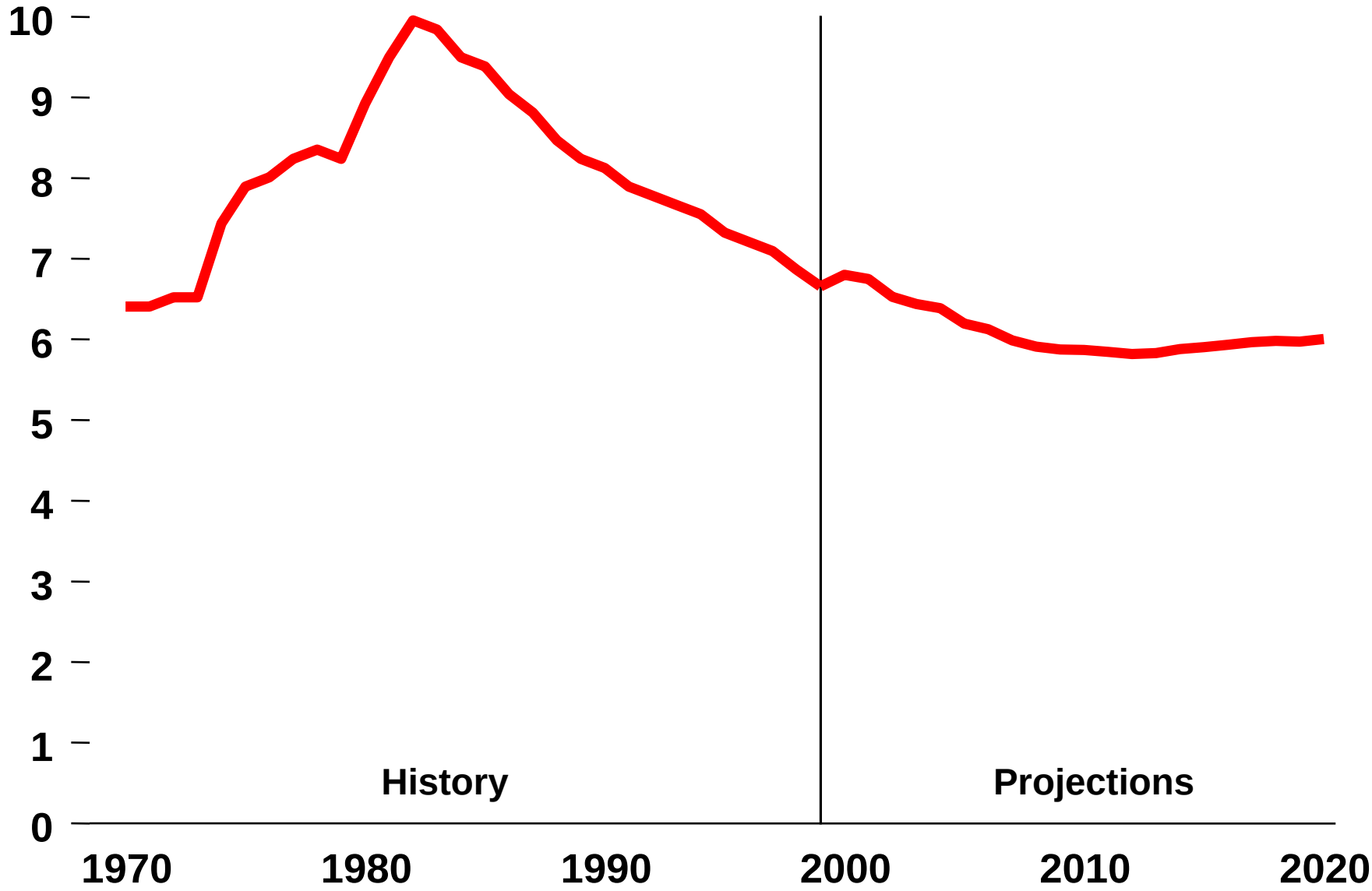

Figure 18. Carbon Dioxide Emissions by Fuel, 2000, 2010, and 2020 (million metric tons carbon equivalent)

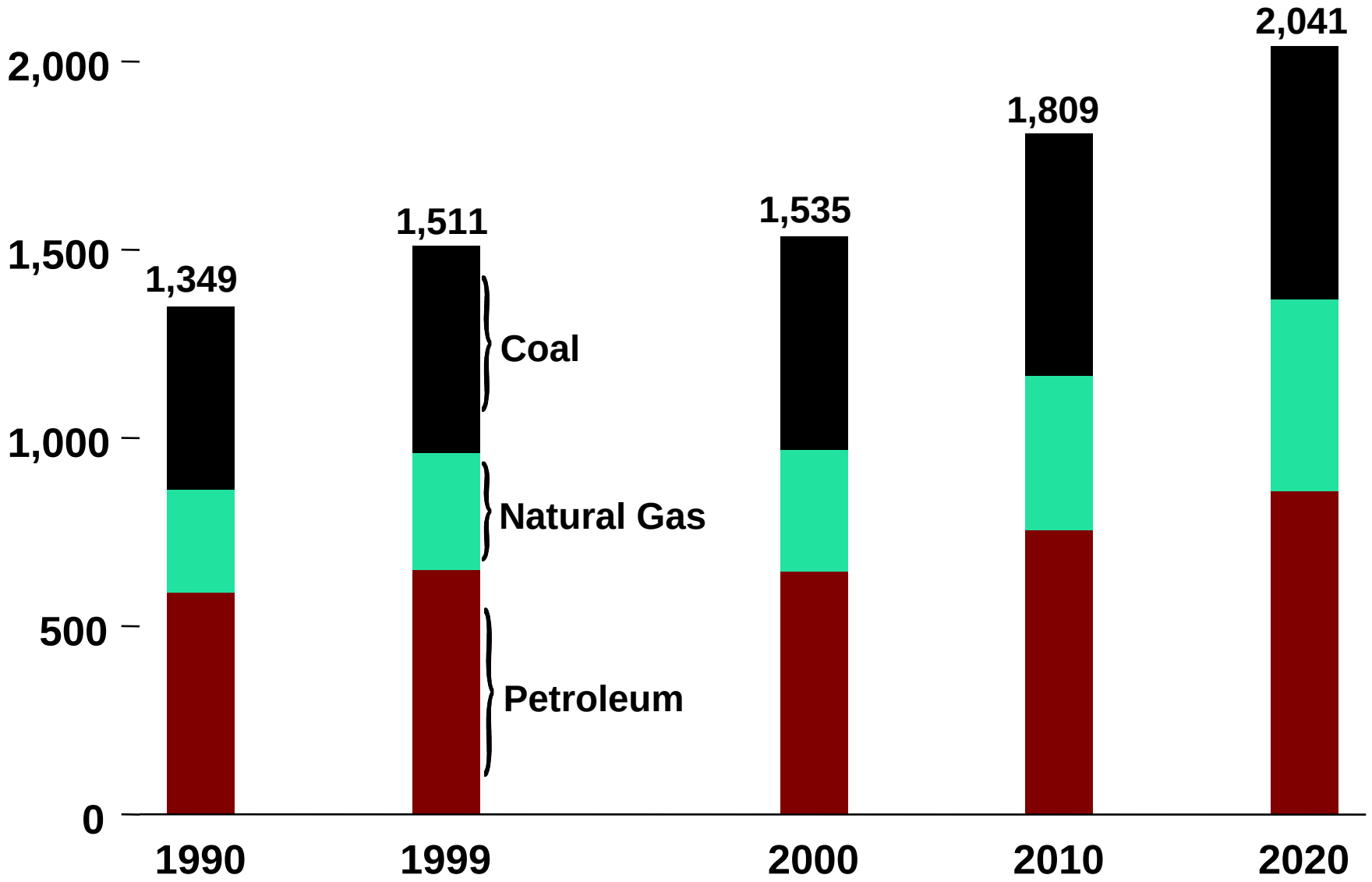

Figure 19. Energy Consumption in Three Technology Cases, 1990-2020 (quadrillion Btu)

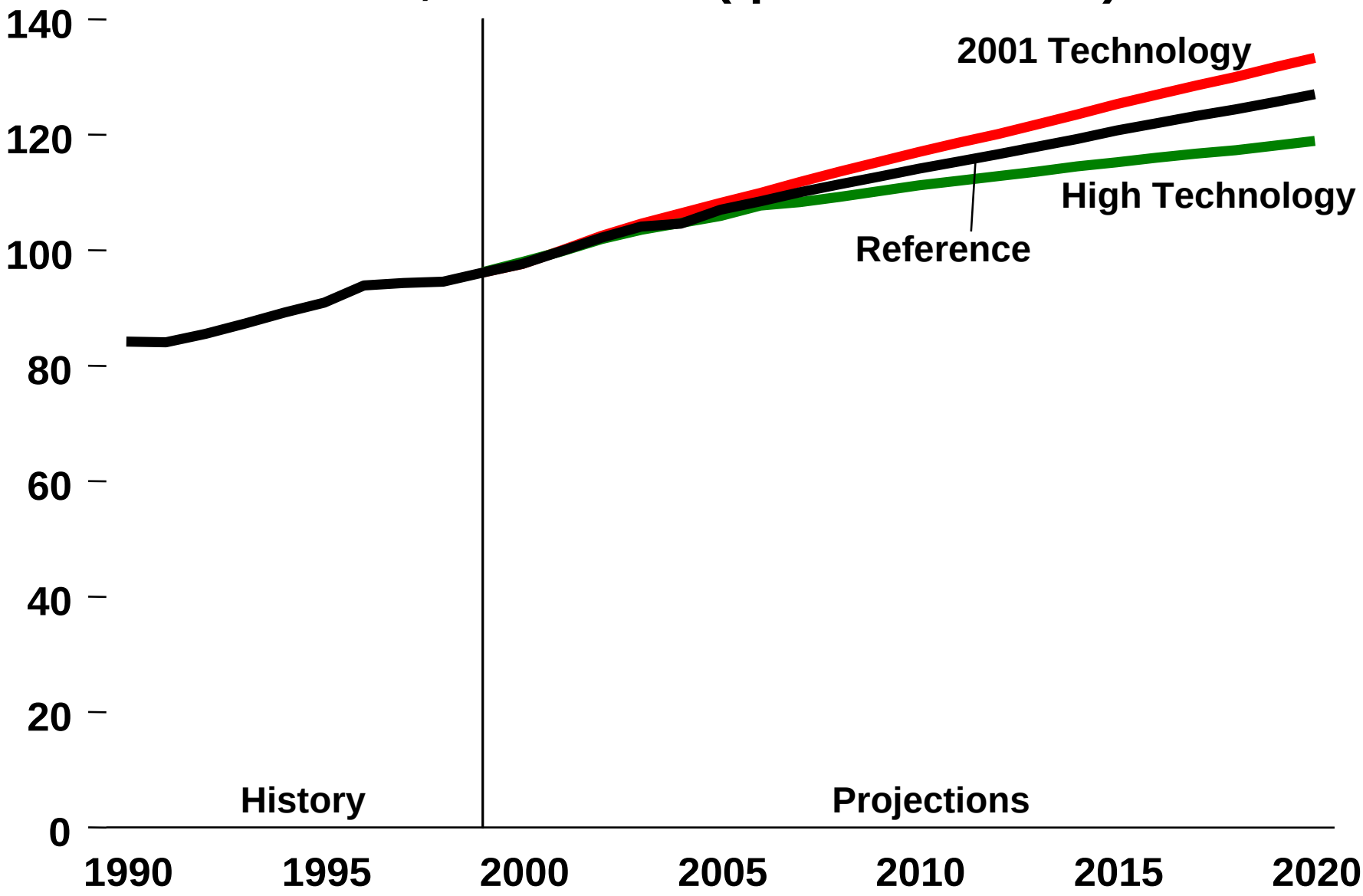

Figure 20. Lower 48 Natural Gas Wellhead Prices in Three Technology Cases, 1970-2020 (1999 dollars per thousand cubic feet)